MSNG-2025

ABSTRACT BOOK

12th INTERNATIONAL CONFERENCE ON MATERIALS SCIENCE AND NANOTECHNOLOGY FOR NEXT GENERATION

(MSNG2025)

10-12 September 2025

SİVAS CUMHURİYET UNIVERSITY

EDITORS

Prof.Dr. Fahrettin YAKUPHANOĞLU
Prof.Dr. Ebru ŞENADIM TÜZEMEN
Prof.Dr. Ahmet EKİCİBİL
Assoc.Prof. Dr. Ahmet Türker TÜZEMEN
Assoc.Prof.Dr. Ayşegül DERE

SPONSORS

T.C.
SİVAS VALİLİĞİ

SİVAS CUMHURİYET ÜNİVERSİTESİ 1974

FIRAT UNIVERSITY 1975

ÇUKUROVA UNIVERSITY 1973

CÜNAM

Stso
Sivas Ticaret ve Sanayi Odası

FYTRONIX
ELECTRONIC
R&D GROUP TECHNOLOGIES

COMMITEES

HONORARY PRESIDENTS

Prof. Dr. Ahmet ŞENGÖNÜL	Rector of Sivas Cumhuriyet University / Türkiye
Prof. Dr. Fahrettin GÖKTAŞ	Rector of Fırat University / Türkiye

CONFERENCE PRESIDENTS

Prof. Dr. Fahrettin YAKUPHANOĞLU	Fırat University / Türkiye
Prof. Dr. Ebru ŞENADIM TÜZEMEN	Sivas Cumhuriyet University / Türkiye

ORGANIZING COMMITTEE

Ahmet EKİCİBİL	Çukurova University / Türkiye
Faruk KARADAĞ	Çukurova University / Türkiye
Serkan AKKOYUN	Sivas Cumhuriyet University / Türkiye
Esin KASAPOĞLU	Sivas Cumhuriyet University / Türkiye
Emine ÖZTÜRK	Sivas Cumhuriyet University / Türkiye
Rana ÖZBAKIR	Sivas Cumhuriyet University / Türkiye
Fatih UNGAN	Sivas Cumhuriyet University / Türkiye
Ali Osman AYAŞ	Adıyaman University / Türkiye
Ahmet Türker TÜZEMEN	Sivas Cumhuriyet University / Türkiye
İlkay DEMİR	Sivas Cumhuriyet University / Türkiye
Ayşegül DERE	Fırat University / Türkiye
Doğan KAYA	Çukurova University / Türkiye
Rachid THALJAOUI	Monastir University / Tunisia
Burhan COŞKUN	Kırklareli University / Türkiye

EDITORS OF ABSTRACT BOOK

Prof. Dr. Fahrettin YAKUPHANOĞLU	Fırat University / Türkiye
Prof. Dr. Ebru ŞENADIM TÜZEMEN	Sivas Cumhuriyet University / Türkiye
Prof. Dr. Ahmet EKİCİBİL	Çukurova University / Türkiye
Assoc. Prof. Dr. Ahmet Türker TÜZEMEN	Sivas Cumhuriyet University / Türkiye
Assoc. Prof. Dr. Ayşegül DERE	Fırat University / Türkiye

SCIENTIFIC COMMITTEE

Abdulkarim AMİROV - Immanuel Kant Baltic Federal University /Russia
Abdulkerim KARABULUT - Erzurum Teknik University / Türkiye
Adem TATAROĞLU - Gazi University / Türkiye
Adnan ÖZDEMİR - Kahramanmaraş İstiklal University / Türkiye
Adrian M.T. SILVA - University of Porto / Portugal
Ahmet EKİCİBİL - Çukurova University / Türkiye
Ahmet Faruk ÖZDEMİR - Süleyman Demirel University / Türkiye
Ahmet ORAL - Middle East Technical University / Türkiye
Ahmet Türker TÜZEMEN - Sivas Cumhuriyet University / Türkiye
Ali Abdolahzadeh ZIABARI - Lahijan Branch, Islamic Azad University / Iranian
Ali COŞKUN - University of Fribourg / Switzerland
Ali Kemal HAVARE - Toros University / Türkiye
Ali Osman AYAŞ - Adıyaman University / Türkiye
Ali Suat YILDIZ - Sivas University of Sci. And Technology/ Türkiye
Arif KÖSEMEN - Muş Alparslan University / Türkiye
Arife GENCER İMER - Van Yüzüncü Yıl University / Türkiye
Atilla COŞKUN - Muğla Sıtkı Koçman University / Türkiye
Bekir ÖZÇELİK - Çukurova University / Türkiye
Berna BÜLBÜL - Balıkesir University / Türkiye
Berrin ÖZDEMİR - Çukurova University / Türkiye
Betül KAKFASLIOĞLU YILDIZ - Sivas University of Sci. and Technology / Türkiye
Bilgehan GÜZEL - Çukurova University / Türkiye
Buket SAATÇİ - Erciyes University / Türkiye
Burhan COŞKUN - Kırklareli University / Türkiye
Bünyemin COŞUT - Gebze Technical University / Türkiye
Byeong-Kwon JU - Korea University / Korea
Cem ÇELEBİ - İzmir Institute of Technology / Türkiye
Ceren ORAK - Sivas University of Sci. And Technology / Türkiye
Cevher AK - Toros University / Türkiye
Christian WENGER - Innov. for High Performance Microelect./ Germany
Christoph STAMPFER - USA RWTH Aachen University / Germany
Chung GWIY-SANG - Ulsan University / Korea
Cumali SABAH - Middle East Tech. University / Northern Cyprus
D. D. ZAITSEV - Moscow State University / Russia
D. Esra YILDIZ - Hitit University / Türkiye
D. S. PATIL - North Maharashtra University / India
Darina ARSOVA - Institute of Solid State Physics / Bulgaria
Denis NIKA - Moldova University / Moldova
Deniz SUNAR ÇERÇİ - Yıldız Technical University / Türkiye
Dever NORMAN - Henderson State University / USA
Dionysios DIONYSIOU - University of Cincinnati / USA
Doğan KAYA - Çukurova University / Türkiye
E. Hassan ALY - Ain Shams University / Egypt
Ebru ŞENADIM TÜZEMEN - Sivas Cumhuriyet University / Türkiye
Ebru YABAŞ - Sivas Cumhuriyet University / Türkiye
Elias STATHATOS - Tecnological-Educational Inst. of Patras / Greece
Emine ALDIRMAZ - Amasya University / Türkiye
Emine GÜNERİ - Erciyes University / Türkiye
Emine ÖZTÜRK - Sivas Cumhuriyet University / Türkiye
Emmanuel KOUDOUMAS - Tech. Educational Institute of Crete / Greece
Emmanuel KYMAKIS - Tech. Educational Institute of Crete / Greece
Emre Bahadır AL - Sivas Cumhuriyet University / Türkiye
Emre Ozan POLAT - ICFO-The Institute of Photonic Sciences / Spain
Esin KASAPOĞLU - Sivas Cumhuriyet University / Türkiye
Esra ALVEROGLU - Istanbul Technical University / Türkiye
Evangelos VITORATOS - University of Patras / Greece
Faruk KARADAĞ - Çukurova University / Türkiye
Fatih UNGAN - Sivas Cumhuriyet University / Türkiye
Fatma GÖDE- Mehmet Akif Ersoy University / Türkiye
Feng Hua ZHANG - Nanyang Technological University / Singapore
Ferda MİNDİVAN - Bilecik Şeyh Edebali University / Türkiye
Fikret IŞIK - Trakya University / Türkiye
Filiz ŞENKAL - Istanbul Technical University /Türkiye
Fumihiko HIROSE - Yamagata University / Japan
Gabriel CONSTANTINESCUI - University of Aveiro / Portugal
Gamze BARIM - Adıyaman University / Türkiye
Giorgio SBERVEGLIERI - University of Brescia / Italy
Gökhan DEMİREL - Gazi University / Türkiye
Gönül AKÇA - Çukurova University / Türkiye

Grzegorz KARCZEWSKI - Polish Academicy of Sciences / Poland
H. GHANEM - Fayoum University Fayoum / Egypt
Habibe USLU TECİMER - Karabük University / Türkiye
Hadi HEIDARI - University of Glasgow / United Kingdom
Haluk KORALAY - Gazi, University / Türkiye
Harun MİNDİVAN - Bilecik Şeyh Edebali University / Türkiye
Hülya DOĞAN - Sivas Cumhuriyet University / Türkiye
Hülya METİN GÜBÜR - Mersin University / Türkiye
Hüseyin TECİMER - Karabük University / Türkiye
Hwan Kyu KIM - Korea University / Korea
Hye-Won SEO - Jeju National University / South Korea
İbrahim EROL - Afyon Kocatepe University / Türkiye
İbrahim İNANÇ - 19 Mayıs University / Türkiye
İlkay DEMİR - Sivas Cumhuriyet University / Türkiye
İlker DOĞAN - The Netherlands Organisation / Netherlands
İmran AVCI - VU-University of Amsterdam/ Netherlands
İskender ÖZKUL - Mersin University / Türkiye
İsmail ALTUNTAŞ - Sivas Cumhuriyet University / Türkiye
Jingkun XU - Technology Normal University / China
Jongeun RYU - Portugal University of California / USA
José M. KENNY - University of Perugia / Italy
Juan Carlos Martinez-ANTON - Complutense University of Madrid / Spain
Kamuran GÖRGÜN - Eskişehir Osmangzi University / Türkiye
Kasım OCAKOĞLU - Tarsus University / Türkiye
Katerina POMONI - University of Patras / Greece
Khasan S. KARIMOV - GIK Institute / Pakistan
Kristina RUSIMOVA - University of Bath / United Kingdom
Kübra YAKINCI - İskendurun Technical University / Türkiye
Lee XINLIANG - Technische Universitat Dresden / Germany
Luis BANARES - Universidad Complutense de Madrid / Spain
Luisa TORSI - Universita Bari Aldo Moro / Italy
M. Eyyüphan YAKINCI - İskenderun Technical University / Türkiye
Mahmut KUŞ - Konya Technical University / Türkiye
Marco Antonio SCHIAVON - Universidade Federal de São João Del Rei / Brazil
Mehmet ACET - University of Duisburg-Essen / Germany
Mehmet Enver AYDIN - Dicle University / Türkiye
Mehmet GÜRSUL - Çukurova University / Türkiye
Mehmet KARAKILÇIK - Çukurova University / Türkiye
Mehmet Sait BOZGEYİK - Kahramanmaraş Sütçü İmam University / Türkiye
Merih PALANDÖKEN - İzmir Katip Çelebi University / Türkiye
Merve ÖZCAN - Toros University / Türkiye
Meryem Derya ALYÖRÜK - Aksaray University / Türkiye
Metin ÖZDEMİR - Çukurova University / Türkiye
Michal BABIJ - University of Wroclaw / Poland
Mikhail I. VASILEVSKIY - University of Minho / Portugal
Mohamed BOUOUDINA - Univeristy of Bahrain / Kingdom Of Bahrain
Muhammad ATIF - King Saud University Riyadh / Saudi Arabia
Muhammad Hassan SAYYAD - Ghulam Ishaq Khan Institute / Pakistan
Muharrem KARAASLAN - Iskenderun Technical University / Türkiye
Muhittin DOĞAN - Gaziantep University / Turkiye
Mujdat ÇAĞLAR - Eskişehir Technical University / Türkiye
Murat KÖKSAL - Sivas Cumhuriyet University / Türkiye
Murat SOYLU - Bingöl University / Türkiye
Mustafa AKYOL - Alparslan Türkeş Sci. and Tech. University/Türkiye
Mustafa ERKOVAN - Sakarya University / Türkiye
Mustafa Kemal BAHAR - Sivas Cumhuriyet University / Türkiye
Mustafa TEPE - Ege University / Türkiye
Nadir DİZGE - Mersin University / Türkiye
Nihat TUĞLUOĞLU - Giresun University / Türkiye
Nourah AL SENANY - King Abdulaziz University / Saudi Arabia
Nouredine SENGOUGA - Université de Biskra / Algeria
Oğuzhan AKGÖL - İskenderun Technical University / Türkiye
Osman DAYAN - Çanakkale Onsekiz Mart University / Türkiye
Önder METİN - Koç University / Türkiye
Panagiotis LIANOS - University of Patras / Greece
Pedram Khalili AMİRİ - Northwestern University / USA
Pınar BAŞER - Sivas Cumhuriyet University / Türkiye
Polycarpos FALARAS - Scientific Research Center / Greece

Quanmin GUO - University of Birmingham / United Kingdom
Quentin M. RAMASSE - University of Liverpool / United Kingdom
R. O. OCAYA - University of Free State / South Africa
Rachid THALJAOUI - Monastir University / Tunisia
Ram K. GUPTA - Pittsburg State University / USA
Ramin YOUSEFI - Islamic Azad University / Iranian
Rana ÖZBAKIR - Sivas Cumhuriyet University / Türkiye
Raşit TURAN - Middle East Technical University / Türkiye
Recep ŞAHİNGÖZ - Yozgat Bozok University / Türkiye
Recep ZAN - Ömer Halisdemir University / Türkiye
Richard J. COBLEY - Swansea University / United Kingdom
Robin JONES - University of Bath / United Kingdom
Roland MAINZ - Helmholtz Zentrum Berlin, Germany
S. MANSOURI - University of Gabès / Tunusia
S. WAGEH - Menoufia University / Egypt
Sabit HOROZ - Sivas University of Sci. and Technology / Türkiye
Salem EL-FAIFY - Khalid University / Saudi Arabia
Salih YILMAZ - Alparslan Türkeş Sci. and Tech. University/Türkiye
Salim ÇERÇİ - Yıldız Technical University / Türkiye
Sarani ZAKARIA - Universiti Kebangsaan Malaysia / Malaysia
Savaş SÖNMEZOĞLU - Kahramanoğlu Mehmet Bey University / Türkiye
Seda BEYAZ - Balıkesir University / Türkiye
Sedat ŞENGÜL - Trakya University / Türkiye
Sefa ERTÜRK - Niğde Ömer Halisdemir University / Türkiye
Selda KILIÇ ÇETİN - Çukurova University / Türkiye
Sema YILDIRIM - Erciyes University / Türkiye
Serap GÜNEŞ - Yıldız Technical University / Türkiye
Serap ŞENTÜRK DALGIÇ - Trakya University / Türkiye
Serdar AKSU - APPLE Inc. / USA
Serdar SARIÇİFTÇİ - Johannes Kepler Linz University / Austria
Sezen ÖZÇELİK - Hakkari University / Türkiye
Subhash CHAND - National Institute of Technology / India
Şemsettin ALTINDAL - Gazi University / Türkiye
Şükrü ÇAVDAR - Gazi, University / Türkiye
Şükrü KARATAŞ - Kahramanmaraş Sütçü İmam University / Türkiye
T. M. FARAG - Al-Azhar University / Egypt
Tamer ABDALLAH - Ain Shams University / Egypt
Tayyar GÜNGÖR - Burdur M. Akif Ersoy University / Türkiye
Thomas UNOLD - Helmholtz Zentrum Berlin / Germany
Timuçin Emre TABARU - Sivas University of Sci. and Technology / Türkiye
Tülay HURMA - Eskişehir Technical University / Türkiye
Ursel BANGERT - University of Limerick / Ireland
V. DOROZHKIN - Kudrinskaja Moscow / Russia
Vasilios KARANIKOLAS - Patras University / Greece
Veysi GÜÇKAN - Çukurova University / Türkiye
Volkan ALTUNAL - Çukurova University / Türkiye
W. Aslam FAROOQ - King Saud University / Saudi Arabia
Walid Tawfiq YOUNES - King Saud University / Saudi Arabia
Witold Daniel DOBROWOLSKI - Polish Academicy of Sciences / Poland
Wojtek WLODARSKI - RMIT University / Australia
Wolfgang ENSINGER - Technische Universität Darmstadt / Germany
Y.Azizan – KALANDARAGH - Sabalan University of Advanced Tech. / Iranian
Yasemin ÇAĞLAR - Eskişehir Technical University / Türkiye
Yasemin ÇİFTÇİ ÖZTEKİN - Gazi University / Türkiye
Yasemin ŞAFAK ASAR - Gazi University / Türkiye
Young HEE - Sungkyunkwan University / South Korea
Z. LIU - Peking University / China
Zehra YEĞİNGİL - Toros University / Türkiye
Zeki YARAR - Mersin University / Türkiye
Zeyad A. ALAHMED - King Saud University / Saudi Arabia

FOREWORD

It is a pleasure for us to offer you Abstracts Book for the 12th international conference on Materials Science and Nanotechnology for Next Generation; MSNG2025. Our goal was to create a scientific platform that introduces the newest results on internationally recognized experts to local students and colleagues and simultaneously displays relevant Turkish achievements to the world. The positive feedback of the community encouraged us to proceed and transform a single event into a conference series. Now, MSNG2025 is honored by the presence of over 150 colleagues from various cities and countries. We stayed true to the original MSNG2025 concept and accepted contributions from all fields of materials science and technology to promote multidisciplinary discussions. The focal points of the conference emerged spontaneously from the submitted abstracts: energy applications, advanced materials, electronic and optoelectronic devices. Further fields of interest include e.g. new advanced and functional materials, advanced-functional composites, biomaterials, smart materials, dielectric materials, optical materials, magnetic materials, organic semiconductors, inorganic semiconductors, electronic materials, graphene, and more.

Our warmest thanks go to all invited speakers, authors, and contributors of MSNG2025 for accepting our invitation, visiting Sivas and using MSNG2025 as a medium for communicating your research results.

We hope that you will enjoy the conference and look forward to meeting you again in
one of the forthcoming MSNG2026 event.

Prof. Dr. Ebru Şenadım TÜZEMEN & Prof. Dr. Fahrettin YAKUPHANOĞLU
Conference Chairs

INVITED SPEAKER TALKS

Zn^2G: Next Generation ZnO and its application

M. Carbone[1,2*], L. Casoli[1], C. Ricci[1], G.A. Bracchini[1], J. Arata-Badano[1], L. Gontrani[1], E.M. Bauer[2]

[1]*Startnetics - Department of Chemical Science and Technologies, University of Rome Tor Vergata, Rome, Italy*
[2] *Institute of Structure of Matter, Italian National Research Council, CNR-ISM, Monterotondo, Italy*

[*]**Corresponding e-mail:** carbone@uniroma2.it

ZnO is an extremely versatile, biocompatible compound that has attracted growing interest in fields ranging from optoelectronics to energy conversion, agriculture, and biomedical applications. Its wide band gap, high exciton binding energy, and tunable surface chemistry make ZnO a cornerstone for next-generation nanotechnologies. At the same time, its non-toxic nature, antimicrobial activity, and intrinsic fluorescence enable promising uses in biosensing, wound healing, and tissue regeneration.

Recent advances in synthetic methodologies have made it possible to finely tailor ZnO nanostructures, with control over morphology, defect density, and surface chemistry. These parameters critically determine optical and electronic behavior, particularly the intensity and stability of fluorescence across a broad temperature range. Among innovative strategies, γ-radiation-assisted synthesis [1] offers unique advantages for producing defect-controlled ZnO nanoparticles under mild and environmentally friendly conditions, avoiding high temperatures or hazardous reagents. Parallel progress in the fabrication of ZnO thin films is opening new opportunities for biomedical applications, including antimicrobial coatings and healing-promoting layers for wound dressings.

In line with the global shift toward sustainable nanotechnology, the use of deep eutectic solvents (DES) and purely aqueous synthetic environments is emerging as a scalable, green route to ZnO nanostructures [2]. These methods not only minimize environmental impact but also enhance reproducibility and allow the integration of ZnO into hybrid composites with polymers, biomolecules, or other oxides. Such combinations improve stability, biocompatibility, and multifunctionality, extending ZnO's reach into real-world applications.

Practical demonstrations will be presented in agriculture, where ZnO nanostructures improve *Vicia faba* crop productivity, in pesticide sensing, where defect-engineered ZnO enhances selectivity and sensitivity, and in optical platforms exploiting ZnO's exceptionally bright fluorescence for imaging and diagnostic applications [3]. By merging structural, spectroscopic, and functional insights, this contribution positions ZnO as a model system for next-generation nanomaterials, demonstrating how advanced synthesis, defect engineering, and green chemistry approaches can be combined to deliver both technological performance and environmental responsibility.

References

[1] C. Ricci, E. M. Bauer, I. Lampre, C. Humbert, H. Remita, Radiation-Induced Photoluminescence Enhancement of Zinc Oxide and Zinc Oxide-Polyvinyl Alcohol Nanocomposite: A Green and Controllable Approach for Tailor-Made Optoelectronics, J. Phys. Chem. Solids 202, 112704 (2025).

[2] L. Gontrani, L. Casoli, O. Russina, E. M. Bauer and M. Carbone, Templating effect travelling on the edge between an ionic liquid and a DES: the case of fluorescent ZnO nanostructures in choline nitrate, Mater. Adv. 6, 2154 (2025).

[3] M. Carbone, S. De Rossi, D. T. Donia, G. Di Marco, B. Gustavino, L. Roselli, P. Tagliatesta, A. Canini & A. Gismondi, Biostimulants promoting growth of *Vicia faba* L. seedlings: inulin coated ZnO nanoparticles, Chem. Biol. Technol. Agric. 10, 134 (2023).

Sivas Cumhuriyet University Nanophotonics Application and Research Center (CÜNAM): A Journey from Vision to National Research Infrastructure Success

S. ELAGÖZ

Sivas Cumhuriyet University, Physics Department (Retired)

***Corresponding e-mail:** Sezaielagoz@gmail.com

The Sivas Cumhuriyet University Nanophotonics Application and Research Center (CÜNAM) represents a significant success story in Türkiye's scientific and technological landscape. Established with the initiation of its infrastructure in 2006, CÜNAM achieved recognition as one of the twelve National Research Infrastructures in Türkiye under Law No. 6550 in 2013. As a pioneering center for internationally standardized R&D, CÜNAM focuses on semiconductor-based advanced research, development, and high value-added production, particularly for optoelectronic and electronic device applications.

This presentation highlights CÜNAM's comprehensive capabilities and strategic impact. The center excels in the epitaxial growth and characterization of crucial semiconductor device structures, including Quantum Cascade Lasers (QCLs) for gas sensing and defense applications, Short Wavelength Infrared (SWIR) detectors for night vision and industrial control, Tandem Solar Cells for high-efficiency green energy solutions, Vertical-Cavity Surface-Emitting Lasers (VCSELs) for high-speed data and 3D sensing, and Laser Diodes vital for fiber optics and national defense systems. CÜNAM's state-of-the-art infrastructure, valued at over $10 Million, encompasses specialized laboratories for crystal growth (featuring an AIXTRON MOCVD system), structural, electrical, optical, and surface characterization.

With a dedicated team of researchers and students, CÜNAM has successfully executed 60 projects with a budget exceeding $15 Million, including significant contributions to national defense initiatives and numerous collaborations with institutions like ASELSAN and TÜBİTAK. Beyond its research output of over 150 articles, CÜNAM is committed to human resource development, providing extensive training and R&D opportunities for undergraduate, master's, and doctoral students. Its global engagement is further enhanced by collaborations with international partners and the CÜNAM OTOLAB system, which provides online access to its infrastructure for both domestic and international users. CÜNAM stands as a testament to the successful transformation of a vision into a leading national asset driving technological independence in Türkiye.

Dual Graphene Integration in Solution-Processed CTS Thin-Film Solar Cells

R. Zan[1*]

[1]*Department of Physics, Niğde Ömer Halisdemir University, Niğde, Türkiye.*

[*]**Corresponding e-mail:** recep.zan@ohu.edu.tr

Copper tin sulfide (Cu_2SnS_3, CTS) is an earth-abundant, non-toxic, p-type semiconductor with a high absorption coefficient, making it a promising absorber for low-cost thin-film photovoltaics [1, 2]. However, performance is often limited by film quality and interface defects.

In this work, graphene was integrated into CTS films and the solar cell fabrication process via two routes. In the first, pristine and doped graphene, synthesized by liquid-phase exfoliation, was incorporated as a dopant in the CTS precursor solution. In the second, graphene grown by chemical vapor deposition was employed as an interfacial layer. This dual integration enhanced film morphology, crystallinity, and compositional uniformity, while suppressing secondary phases and promoting grain growth under optimized sulfurization. Optical and electrical analyses revealed improved light absorption, homogeneity, and charge transport [3, 4].

These results highlight solution-processable and thin film graphene integration as an effective strategy to boost the structural, optical, and electrical performance of CTS absorbers for flexible, high-efficiency solar cells.

Acknowledgement

This study was supported by the project number 122F217 carried out by TÜBİTAK.

References

[1] MA Olgar, S Erkan, R Zan, Comparative Study of CZTS-based Solar Cells Fabricated on Mo, Ni and Cu Flexible Substrates, Journal of Alloys and Compounds, 1011, 166041 (2025)

[2] D Ozbek, S Erkan, MA Olgar, R Zan, Use of graphene as an interlayer in CZTS-based thin film solar cell employing various substrate temperatures, Journal of Alloys and Compounds, 1013, 178543 (2025)

[3] MA Olgar, S Erkan, A Altuntepe, R Zan, Nitrogen doped single layer graphene for CZTS-based thin film solar cells, Optical Materials, 150, 115167 (2024).

[4] S Erkan, A Yagmyrov, A Altuntepe, R Zan, MA Olgar, Integration of single layer graphene into CZTS thin film solar cells, Journal of Alloys and Compounds, 920, 166041 (2022).

Recent Developments on Electromagnetic Wave Absorbing Materials

M. Akyol[1*]

[1]Department of Materials Science and Engineering, Faculty of Engineering,Adana Alparslan Türkeş Science and Technology University, Adana, Türkiye

[*]**Corresponding e-mail:** makyol@atu.edu.tr

Electromagnetic wave (EMW) absorbing materials have garnered significant attention in recent years due to their critical applications in stealth technology, electromagnetic interference (EMI) shielding, and wireless communication systems. Recent developments in this field focus on designing lightweight, broadband, and highly efficient absorbers with enhanced thermal and mechanical stability. Advances in nanotechnology have enabled the fabrication of novel materials, including carbon-based nanostructures (e.g., graphene, carbon nanotubes), 2D-nanostructures (e.g., transition metal dichalcogenides, Mxenes), conducting polymers (e.g., polyaniline, polypyrrole), and magnetic-dielectric composites that exhibit strong attenuation capabilities across a wide frequency spectrum. Emerging strategies such as the integration of metamaterials, hierarchical porous architectures, and gradient impedance matching have further improved absorption performance, especially in the GHz range.

Beyond conventional EMW shielding and absorption, the ability to dynamically tune EMW responses via external stimuli (mechanical, thermal, or electric fields) offers new functional capabilities for advanced electronics and wireless technologies. In the talk, I have highlight the recent material innovations, design approaches, and performance enhancement mechanisms, aiming to provide a comprehensive understanding of current trends and future prospects in EMW shielding and absorption technologies.

Acknowledgement: This work was supported by the The Scientific and Technological Research Council of Türkiye (TÜBİTAK) under Project Number: 223M012.

On the temperature and voltage dependence of complex dielectric, complex electric modulus, ac conductivity, and Nyquist behavior in Au/(CF:rGO:PVA) n-Si structures

Ş. Altındal[1*]

[1]*Department of Physics, Faculty of Science, Gazi University, Ankara, TÜRKİYE*

[*]**Corresponding e-mail:** altundal@gazi.edu.tr

In this work, we aimed that the fabricated new type of Au/(CF:rGO-doped PVA) structures instead of conventional metal-oxide-semiconductor (MOS) structures. For this aim, the capacitance-voltage-temperature (C-V-T) and the conductance-voltage-temperature (G-V-T) measurements were performed in wide range of temperature and voltage at 500 kHz. After that their temperature and voltage dependence of fundamental the real and imaginary components of complex dielectric constant ($\varepsilon^*=\varepsilon'+j\varepsilon''$), complex electric modulus ($M^*=M'+jM''$), ac electrical conductivity, and Nyquist behavior of them have been investigated in detail by considered polarization processes, hoping mechanisms, temperature, and voltage/electric-field effects on them. Findings experimental results indicate that all these parameters have strong functions of temperature and voltage both in the depletion and accumulation region. Such behavior of them was explained by the temperature, electric field, interfacial and dipole type polarization, hopping mechanism, and interface traps effects [1-5]. Both the value of ε' and ε'' decrease with increasing frequency almost as exponentially. Phase angel (θ) vs V plots were drawn, and it was reached at about 90° in the inversion region. The higher value of ε' even at moderate frequencies show that the (CF:rGO-doped PVA) interfacial layer can be successfully used instead of traditional insulators in respect of high electrons or energy storage applications.

Keywords: Maxwell-Wagner type polarization; Basic dielectric properties and ac conductivity; Temperature and voltage dependence; Nyquist plots; Hopping mechanisms

References

[1] R. B. Bozkurt, E. E. Baydilli, A. Kaymaz, Ş. Altındal, H. Durmuş, Dielectric properties and polarization mechanisms of the DLC-interlayered Schottky structures under low-moderate and high-temperatures, Materials Science and Engineering: B, 320 (2025) 118406. https://doi.org/10.1016/j.mseb.2025.118406.

[2] G. Kandhol, H. Wadhwa, S. Chand, S. Mahendia, S. Kumar, Study of dielectric relaxation behavior of composites of Poly (vinylalchohol) (PVA) and Reduced graphene oxide (RGO), Vacuum, 160 (2019) 384-393. https://doi.org/10.1016/j.vacuum.2018.11.051.

[3] A. Khalkhali, E. E. Tanrıkulu, S. Altındal Yerişkin, A. A. Alsaç, K. Yıldız, A study regarding dielectric response and ac electrical conductivity of Schottky structures (SSs) interlaid with (Fe_3O_4-PVA) by using dielectric spectroscopy method. *J Inorg Organomet Polym* (2025) https://doi.org/10.1007/s10904-025-03667-x.

[4] H. P. P. V. Shanmugasundram, E. Jayamani, K. H. Soon, A comprehensive review on dielectric composites: Classification of dielectric composites, Renewable and Sustainable Energy Reviews, 157 (2022) 112075. https://doi.org/10.1016/j.rser.2022.112075.

[5] Ç. Ş. Güçlü, A. Khalkhali, S. A. Hameed, İ. Taşçıoğlu, A. Demirci, Ş. Altındal, Dielectric response of Au/(Co:PVA)/n-Si/Al structures under varying frequencies and bias voltages. *J Mater Sci: Mater Electron* 36 (2025) 1431. https://doi.org/10.1007/s10854-025-15485-5.

Pseudopotential Approximation from the Crystal of Atoms or Molecules to Superlattice Application

Y. Ergün[1*], and M. Hoştut[1,2]

[1] *METU-MEMS Center, Ankara, Turkey*
[2] *Department of Mathematics and Science Education, Akdeniz University, Antalya,* Turkey

[*]**Corresponding e-mail:** yukselergun22@gmail.com

Pseudopotantial and pseudo-wave function of crystal structure, especially late 1950 and first half of 1960 have been investigated. In this presentation we explaine the nearly free electron behaviour for valans electrons and developing the atomic form factors to obtain eigen-value matrix at the reciprocal space. After bulk paremeters obtained which we calculate k-space superlattice band structure. Afterwards, absorption coefficient of GaSb/AlSb/InAs superlattice have been obtained. As a result, experimentai and therotical results are have been compared. In this work also we study midwave(3-5 micron), long wave (8-12 micron) results will be shown. this method is very useful and very fat compared with k.p calculation method that will be told near future at this Institute.

References

[1] K. Akel, M. Hoştut, T. Akın and Y. Ergün, Interband optical absorption obtained by pseudopotential method for type-II InAs/GaSb SL photodetectors, J. Phys. D: Appl. Phys. 54, 195103 (2021).

ORAL PRESENTATIONS

Impact of TMAl and SiH_4 Flow Rates on the Structural and Electronic Properties of Lattice-Matched InAlAs for Quantum Cascade Lasers

Abdulrhman ALKRDY[1,2], Dudu Hatice ÜNAL[1,2], Merve Nur KOÇAK [1,3],İsmail ALTUNTAŞ[1,2] and İlkay DEMİR[1,2,*]

[1]Sivas Cumhuriyet University Nanophotonics Application and Research Center-CÜNAM, Sivas, 58140, Turkey[2] Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Turkey
[3] Department of Metallurgy and Materials Science, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Turkey

[*]**Corresponding e-mail:** idemir@cumhuriyet.edu.tr

Quantum cascade lasers (QCLs) are unipolar semiconductor devices that employ intersubband optical transitions in multiple quantum well structures, enabling tailored emission through precise quantum engineering [1]. Their high power, efficiency, and design flexibility make them indispensable for mid-infrared applications [2]. In lattice-matched InGaAs/InAlAs QCLs on InP, InAlAs serves as the barrier material, providing strong carrier confinement, optimized electron mobility, and controlled tunneling rates. Achieving high-quality InAlAs barriers is therefore a prerequisite for reliable QCL performance, as interface sharpness and doping precision directly influence transport dynamics [3].

Motivated by these considerations, this study systematically investigates the structural, optical, and electronic properties of InAlAs layers grown by metal–organic vapor phase epitaxy (MOVPE), with particular emphasis on the growth parameters that critically govern barrier quality and device reliability. Specifically, the influence of trimethylaluminum (TMAl) flow was examined, as it directly determines the V/III ratio and thereby the composition of InAlAs barriers—factors that strongly affect carrier confinement and interface sharpness. In addition, the effect of silane (SiH_4) flow on intentional n-type doping was explored, given that precise control of doping concentration is vital for tailoring carrier density, optimizing transport properties, and ensuring stable operation in unipolar QCL designs.

To evaluate these parameters, the structural, optical, and morphological characteristics were analyzed using high-resolution X-ray diffraction (XRD), UV–Vis spectrophotometry, and atomic force microscopy (AFM). XRD results revealed a strong correlation between indium concentration and the position of satellite peaks, while optical measurements confirmed a bandgap shift toward lower energies with increasing indium content. Building on these findings for unintentionally doped layers, the study further demonstrated that in n-type InAlAs, carrier density can be tuned through SiH_4 flow without introducing significant changes in structural or optical properties. These results underscore that accurate control of both composition in i-InAlAs and doping in n-InAlAs is indispensable for achieving the structural and electronic quality required in high-performance QCL structures.

Acknowledgments

This work is based on results obtained during the ongoing Ph.D. thesis of Merve Nur Koçak, titled “Development of Short- and Mid-Wavelength Quantum Cascade Lasers”. Merve Nur Koçak is supported by the YÖK (Council of Higher Education) 100/2000 Ph.D. Scholarship Program and The Scientific and Technological Research Council of Turkey (TÜBİTAK) 2211/A Program. This study supported by The Scientific Research Project Fund of Sivas Cumhuriyet University, Turkey under the project number MRK-2024-004 and The Scientific and Technological Research Council of Turkey (TUBITAK) under the project number 22AG074.

References

[1] C. Deutsch et al., “High-Power Growth-Robust InGaAs/InAlAs Terahertz Quantum Cascade Lasers,” ACS Photonics, vol. 4, no. 4, pp. 957–962, Apr. 2017.

[2] M. S. Vitiello, G. Scalari, B. Williams, and P. De Natale, “Quantum cascade lasers: 20 years of challenges,” Opt Express, vol. 23, no. 4, p. 5167, Feb. 2015.

[3] M. N. Koçak and İ. Demir, “Superlattice Structure of Quantum Cascade Lasers: Structural and Morphological Effects of AsH_3 Flow,” Cumhuriyet Science Journal, vol. 46, no. 2, pp. 384–389, Jun.

Towards a Pressure-Sensitive MOSFET-Based Wireless Sensor for Urodynamic Pressure Mapping

Ahmed HARB[1*], Mustafa ISTANBULLU[2]

[1,2]*Department of Biomedical Engineering, Faculty of Engineering, ADANA, TÜRKİYE*

[*]**Corresponding e-mail:** ahmadwaheeb96@gmail.com

Bladder dysfunctions, including urinary incontinence and neurogenic bladder, affect millions worldwide and are currently assessed using catheter-based urodynamic studies. While effective, these methods are invasive, uncomfortable, and prone to measurement errors [1]. To address this unmet need, we propose a novel wireless, biocompatible MEMS pressure sensor concept for continuous bladder pressure monitoring.

The design is based on a floating-gate FET architecture utilizing two-dimensional materials such as graphene and MoS_2. In this concept, a suspended diaphragm deflects under pressure, modulating the transistor current and thereby converting bladder pressure into an electrical signal [2, 3]. Planned simulations include diaphragm mechanics in COMSOL Multiphysics and transistor-level modeling in Silvaco TCAD. Biocompatible encapsulation with Parylene-C and wireless data transmission through Bluetooth Low Energy or passive LC resonance are also envisioned [4].

This work is in its initial phase, focusing on sensor design and multiphysics modeling. Future validation will employ a bladder simulator to benchmark accuracy, stability, and comfort against conventional balloon catheters. The anticipated outcome is a reusable, minimally invasive, and real-time monitoring platform. Beyond urodynamics, this concept provides a promising pathway for integrating MEMS, advanced 2D materials, and wireless telemetry into next-generation implantable biosensors.

References

[1] Kárpáti, T., et al., Prototype MEMS capacitive pressure sensor design and manufacturing, Period. Polytech. Electr. Eng. Comput. Sci. 57(1), 3–7 (2013).

[2] Tan, R., et al., Development of a fully implantable wireless pressure monitoring system, Biomed. Microdevices 11(1), 259–264 (2009).

[3] Wang, F., et al., Piezopotential gated two-dimensional InSe field-effect transistor for pressure sensing, Nano Energy 70, 104457 (2020).

[4] Lee, H. Y., et al., Sensitivity-Enhanced LC Pressure Sensor for Wireless Bladder Pressure Monitoring, IEEE Sens. J. 16(12), 4715–4724 (2016).

Limitations of the Halpin-Tsai Model in Nanoparticle-Reinforced Epoxy Composites

Ahmet ÇETİN[1*]

[1] *Adiyaman University Department of Mechanical Engineering, Adıyaman, Türkiye*

[*]**Corresponding e-mail:** acetin@adiyaman.edu.tr

The utilization of nanoparticle-reinforced epoxy composites has become pervasive in advanced engineering applications, owing to their enhanced mechanical performance. The Halpin–Tsai model, renowned for its semi-empirical simplicity, is frequently employed to estimate the elastic modulus of such systems. However, this model assumes a constant filler modulus and shape factor, and does not account for changes in particle size, dispersion quality, or interphase effects all of which become increasingly critical at higher reinforcement levels [1].

The present study undertakes an analytical evaluation of the Halpin–Tsai model by comparing its predictions for elastic modulus across a range of nanoparticle contents (0.5–5 wt%) with experimental data from the literature. While the model consistently predicts a monotonic increase in stiffness with filler loading, experimental observations reveal a peak followed by a decline beyond approximately 2–3 wt%, attributed to particle agglomeration and interface degradation [2, 3].

Agglomeration has been shown to increase the effective particle size and reduce load transfer efficiency. This is due to poor dispersion and weak interfacial bonding. The classical Halpin–Tsai model, being insensitive to these microstructural effects, fails to capture the observed stiffness drop at higher filler ratios. In addressing this, several researchers have proposed extensions to the model that incorporate nanoparticle size and interphase properties [4], or account for hierarchical filler structures involving both nano- and micro-scale reinforcements.

The present work underscores the necessity for modified micromechanical models that encompass particle-level phenomena such as aggregation and interphase effects. This study contributes to the understanding of why classical approaches may misrepresent the mechanical response of nanocomposites and offers a basis for future model development.

References

[1] Zare, Y., Development of Halpin-Tsai model for polymer nanocomposites assuming interphase properties and nanofiller size. Polymer Testing, 51, (2016)

[2] Sokhandani, N., et al., Experimental investigation and semi-empirical modeling of mechanical behavior in Gr, GO, and rGO nanocomposites. Results in Engineering, 26, (2025)

[3] Wang, J., et al., Synergistic effect of interface and agglomeration on Young's modulus of graphene-polymer nanocomposites. International Journal of Solids and Structures, 292, (2024)

[4] Luo, Z., et al., Modified rule of mixtures and Halpin–Tsai model for prediction of tensile strength of micron-sized reinforced composites and Young's modulus of multiscale reinforced composites for direct extrusion fabrication. 10(7), (2018)

Investigation of Structural, Morphological, Optical and Photocatalytic Effects of ZnO-TiO2 Heterostructured Thin Film Produced by Physical Vapor Deposition (PVD) Method

A. Çetin[1*], M. Şimşir[1], E. Şenadım Tüzemen[2,3], A. Özer[4]

[1] Sivas Cumhuriyet University, Faculty of Engineering, Department of Metallurgical and Materials Engineering, Sivas, Turkey
[2] Sivas Cumhuriyet University, Department of Physics, Faculty of Science, Sivas, Turkey
[3] Sivas Cumhuriyet University, Nanophotonics Research and Application Center, Sivas, Turkey
[4]Lead Principal Material Scientist in Geoship, Nevada City, Kaliforniya, Birleşik Devletler

[*]**Corresponding e-mail:** ctnahmet@gmail.com

With the rapid growth of industrialization and urbanization, the spread of organic pollutants in water and air environments has become a serious global concern, leading to the deterioration of environmental quality. In this context,< photocatalysis has emerged as a cost-effective, eco-friendly, and highly efficent method for pollutant removal. The photocatalytic process relies on the excitation of semiconductor materials under light irradition, generating electron-hole pairs that initiate surface reactions leading to the degradition of contaminants.

Among the semiconductor materials widely used in photocatalytic applications, titanium dioxide (TiO_2) and zin oxide (ZnO) are the most prominent. TiO_2 is well known for its high chemical stability, low cost and strong oxidation capability, whereas ZnO is notable for its high electron mobility and versatile morphologies. Howeveri both materials suffer from limitations such as relativelywide band gap (~3.2 eV) and fast electron-hole recombination, which significantly reduce their photocatalytic efficiency when used individually. Costructing ZnO-TiO_2 heterostructures has benn shown to facilitate charge seperation suppress recombination, and thus photocatalytic activity. Thin film techologies play a crucial role in controlling the structural and optical properties od such heterostructures. Among them, Physical Vapour Deposition (PVD) has attracted considerable attention due to its ability to produce high-purity, homogeneous thin films with well-controlled thickness.

This study investigated the photocatalytic performance of thin films obtained using the PVD method. The structural, morphological, and optical properties of the films were characterized, and the relationship between these properties and photocatalytic activity was discussed. The film, produced at room temperature and annealed at 500°C for 1 hour, was exposed to UVA light in a photoreactor. Measurements using a UV-Vis spectrometer revealed %96 degredetion of methylene blue solution. Optical measurements revealed a direct energy band gap of 3.10-3.20 eV for ZnO-TiO_2.

References

[1] M. Pérez-González, S. A. Tomás, M. Morales-Luna, M. A. Arvizu and M. M. Tellez-Cruz, Optical, structural, and morphological properties of photocatalytic TiO_2–ZnO thin films synthesized bythe sol–gel process, Thin Solid Films 34310, 1–6 (2015).

Effect of Hydrogen Incorporation on the Structure and Storage Capacity of WS_2

Ali ALTUNTEPE[1*], Recep ZAN[2]

[1]Optical Excellence Application and Research Center, Sivas University of Science and Technology , Sivas 58000, Türkiye

[2]Department of Physics, Niğde Ömer Halisdemir University,51000, Niğde Türkiye

[*]**Corresponding e-mail:** alialtuntepe@sivas.edu.tr

Hydrogen is a clean energy carrier, and the search for efficient storage materials is a continuous challenge [1]. Layered transition metal dichalcogenides such as WS_2 possess high surface area, structural integrity, and accessible active sites to accommodate hydrogen interaction. Investigating the morphological and structural transformation of WS_2 on hydrogen storage is therefore crucial to assess its viability in solid-state storage systems [2].

Bulk WS_2 powders were examined before and after hydrogen uptake to evaluate their structure, morphology, and storage characteristics. XRD confirmed the 2H-WS_2 phase with the prominent (002) peak at $2\theta = 14.32°$, while hydrogenated WS_2 (H-WS_2) exhibited peak shifts and a reduction in crystallite size from 76.05 nm to 27.89 nm, indicative of lattice distortions as a result of hydrogen incorporation. BET analysis revealed 15.41 m^2/g of surface area with mesoporous nature, supported by SEM results. FTIR spectra confirmed the presence of W–S, S–S, and OH vibrations with enhanced OH bands in H-WS_2 and provided the proof of hydrogen absorption. Bulk WS_2 thermal conductivity was found to be 10.98 W/m·K. WS_2 achieved a storage capacity of 2 wt% (375 sccm) at 9 bar hydrogen pressure. These findings illustrate the structural versatility and future-oriented hydrogen storage promise of WS_2, a solid-state energy storage candidate.

The structural versatility and 2 wt% capacity reported here indicate that WS_2 is ideally suited for future solid-state systems of hydrogen storage with a path towards clean energy technologies.

References

[1] Sakintuna B, Lamari-Darkrim F, Hirscher MJIjohe. Metal hydride materials for solid hydrogen storage: a review. 2007;32:1121-40.

[2] Lim KL, Kazemian H, Yaakob Z, Daud WWJCE, Engineering-Biotechnology TICPEP. Solid-state materials and methods for hydrogen storage: a critical review. 2010;33:213-26.

Structural, Magnetic and Magnetocaloric properties of La based Na substituted $LaNaMnNiO_6$ Double Perovskite Manganite system

İbrahim Barış SEVER[1], Arda Kandemir[2], **Ali Osman AYAŞ**[1*], and Ahmet Ekicibil[2]

[1] *Department of Physics, Faculty of Science and Letters, Adıyaman University, Adıyaman, Türkiye.*
[2] *Department of Physics, Faculty of Science and Letters, Çukurova University, Adana, Türkiye*

***Corresponding e-mail:** aliosmanayas@gmail.com

In today's world, the need for energy efficiency and environmentally friendly technologies is greater than ever. In this context, magnetic cooling systems based on the magnetocaloric effect, which offer a revolutionary alternative to traditional gas compression cooling systems, are of great importance [1-4]. This innovative technology has the potential to shape the future of the cooling industry, combining both environmental sustainability and energy-saving capabilities. The magnetocaloric effect is based on the principle that certain special materials heat up when exposed to a magnetic field and cool down when the magnetic field is removed. This physical phenomenon is caused by the alignment of the material's magnetic moments with the magnetic field and the entropy change that occurs when this alignment is disrupted [5-7].

Traditional refrigerators, air conditioners, and other cooling systems use refrigerants that damage the ozone layer (such as CFCs and HCFCs) and contribute to the greenhouse effect (such as HFCs). Magnetic cooling systems, on the other hand, do not require these harmful gases. Magnetic cooling systems are theoretically much more efficient than traditional gas compression systems. They do not contain mechanical and inefficient parts such as compressors, which eliminates friction losses. Research and prototypes show that magnetic cooling can provide energy savings of 20% to 50% compared to current technologies [8-9]. Magnetic cooling technology is not limited to household refrigerators and air conditioners. Thanks to its potential to operate across a wide temperature range, it has a broad range of applications, including medical applications, industrial cooling, climate control in transportation vehicles, and space and aviation systems. For this reason, researchers continue their efforts to develop materials that can operate across a wide temperature range, have high cooling capacity, and possess optimal properties.

Among these materials, double perovskite materials such as La_2MnNiO_6 have begun to attract the attention of researchers due to their rich physical properties and have been studied in an increasing number of scientific studies in recent years [10-11]. In this context, $LaNaMnNiO_6$ double perovskite materials were produced by replacing La and Na elements in region A and having Mn-Ni elements in equal proportions in region B. The structural, magnetic, and magnetocaloric properties of these materials were investigated. Structural analysis revealed that the displacement did not change the crystal structures of the materials, which were found to be in the $R\bar{3}c$ space group with a rhombohedral structure. It was found that all samples exhibited a magnetic phase transition from the ferromagnetic to the paramagnetic phase, and that the temperature at which this phase transition occurred decreased by approximately 10 K with the La-Na substitution, while the change in magnetic entropy increased by approximately 10 times.

The fact that all samples exhibit a second-order magnetic phase transition increases the suitability of these materials for use as magnetic coolants, while the significant increase in magnetic entropy change has been welcomed as a positive result.

Keywords: Affordable and clean energy; Magnetic refrigeration; Magnetocaloric Effect, Magnetic entropy change; Double perovskit manganites.

References

[1] Gschneidner KA, Pecharsky VK (1996) Recent developments in magnetic refrigeration. Reports on Progress in Physics 209–221.

[2] Phan M-H, Yu S-C (2007) Review of the magnetocaloric effect in manganite materials. J Magn Magn Mater 308(2):325–340.

[3] Gutfleisch O, Willard MA, Brück E, Chen CH, Sankar SG, Liu JP (2011) Magnetic materials and devices for the 21st Century:Stronger, Lighter, and More Energy Efficient. Adv Mater 23(7), 821–842.

[4] Zaidi N, Khadhraoui S, Cherif A (2024) The Effect of Cr-doped on structural, magnetic and magnetocaloric properties of La0.8Sr0.15Na0.05Mn(1-x)CrxO3 (x=0.00, 0.15 and x=0.20) Compounds.J Nanosci Adv Mater 3(1):32–41.

[5] Snini K, Ellouze M (2022) Magnetic and magnetocaloric properties of 0.5Pr0.67Ba0.22Sr0.11Mn0.95Fe0.05O3/ 0.5Pr0.67Ba0.22Sr0.11Mn0.9-Fe0.1O3 composite. J Nanosci Adv Mater 1(1):20–24.

[6] V. Chaudhary, X. Chen, R.V. Ramanujan (2019) Iron and manganese based magnetocaloric materials for near room temperature thermal management Progress in Materials Science 100, 64-98.

[7] Ayaş AO, Çetin SK, Akça G, Akyol M, Ekicibil A (2023) Magnetic refrigeration: Current progress in magnetocaloric properties of perovskite manganite materials Mater Today Commun 35:105988.

[8] Gschneidner Jr KA, Pecharsky VK, Pecharsky AO, Zimm CB (1999) Recent developments in magnetic refrigeration. Mater Sci Forum 315-317:69–76.

[9] Gschneidner KA, Pecharsky VK (2000) Magnetocaloric materials. Annu Rev Mater Sci 30(1):387–429.

[10] Krishna Murthy J, Devi Chandrasekhar K, Mahana S, Topwal D, Venimadhav A (2015) Giant magnetocaloric effect in Gd2NiMnO6 and Gd2CoMnO6ferromagnetic insulators. J Phys D Appl Phys 48(35):355001–355001

[11] Moon JY, Kim MK, Choi YJ, Lee N (2017) Giant anisotropic magnetocaloric effect in double-perovskite Gd2CoMnO6 single crystals. Sci Rep. 7(1):16099–16099

Investigating effect of A-Site Pb substitution with La on the magnetic, and magnetocaloric properties of $LaPbNiMnO_6$ double perovskite manganite

Arda Kandemir[1*], Ali Osman AYAŞ[2], Ahmet Ekicibil[1]

[1] Department of Physics, Faculty of Science and Letters, Çukurova University, Adana, Türkiye
[2] Department of Physics, Faculty of Science and Letters, Adıyaman University, Adıyaman, Türkiye.

[*]**Corresponding e-mail:** ardakandemir88@gmail.com

The escalating global energy demand, particularly from refrigeration systems, presents a significant environmental challenge, highlighting the crucial need for sustainable cooling technologies [1]. The associated increase in greenhouse gas emissions represents a direct threat to public health and motivates research into alternative and environmentally solutions [2, 3]. In the last decade, green technologies have gained importance as a feasible solution to these problems. Given the substantial global energy consumption by refrigeration systems, enhancing their efficiency holds significant potential for energy savings. Replacing gas-compression cooling system with alternative methods such as magnetic refrigeration offers a promising road map. Magnetic refrigeration is a promising alternative to the current cooling system as it is an environmental technology and economical. The magnetic cooling system is based on the magnetocaloric effect which can be described as a thermal response of the material when it is exposed to external magnetic field. The magnetic entropy change and magnetic phase transition temperature are important factors, and these parameters vary with the choice of compound as a refrigerant for the system. To identify an effective compound, it is important for materials to exhibit significant temperature variation under a low magnetic field.

With the guidance of these aspects, we investigated the magnetic and magnetocaloric effect of the $LaPbNiMnO_6$ double perovskite compound. For the production of the compound, sol-gel synthesis method was used. To understand the crystal structure of the compound, the X-ray diffraction method conducted at room temperature. Furthermore, Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy was utilized to carry out the morphological and elemental features. The compound's magnetic features were determined by using analyses of temperature-dependent magnetization and magnetic field-dependent magnetization. According to temperature-dependent magnetization examination, the compound exhibits a magnetic phase transition around 264.7 K that the transition from a ferromagnetic to a paramagnetic state. Using isothermal curves, the maximum magnetic entropy change was determined under a 5 T magnetic field variation and it is 1.6 Jkg-1K-1.

Guided by these properties, the compound can be a possible candidate being a magnetic cooling refrigerant for magnetic cooling applications.

Keywords: Magnetocaloric effect; Double Perovskite; magnetic cooling systems; affordable and clean energy

References

[1] M. Falsaperna and P. J. Saines, Development of magnetocaloric coordination polymers for low temperature cooling. Dalton Transactions 51(9), (2022) 3394-3410.

[2] X. Miao, C. Wang, T. Liao, S. Ju, J. Zha, W. Wang, J. Liu, Y. Zhang, Q. Ren, F. Xu and L. Caron, Novel magnetocaloric composites with outstanding thermal conductivity and mechanical properties boosted by continuous Cu network. Acta Materialia 242, (2023) 118453.

[3] A. Kitanovski, Energy Applications of Magnetocaloric Materials. Advanced Energy Materials 10(10), (2020) 1903741.

Illumination effect on the current-voltage (I-V) characteristics in the metal/insulator/semiconductor (MIS) type photodiodes

Arif Baştuğ[1*]

[1]*Department of Physics, Faculty of Science and Art, Aksaray University, Aksaray-TÜRKİYE*

[*]**Corresponding e-mail:** abastug@aksaray.edu.tr

In this present study, the basic electrical characteristics of the Al/SiO_2/p-Si photodiodes have been investigated both in dark and under 50 mW/cm^2 illumination intensity by using the forward and reverse bias current-voltage (I-V) data in voltage range of ±3V. The basic electrical parameters of the photodiode like reverse-saturation current (Io), ideality-factor (n), zero-bias barrier height (Φ_{Bo}), series and shunt resistance (Rs, R_{sh}) were calculated both in dark and light conditions. To determine voltage dependent of basic electrical parameters and calculation method, n, Rs and BH values were also calculated from Cheung function and compared their obtained thermionic emission (TE) theory. All these parameters were found strong functions of light and applied bias voltage. The obtained higher value of n was attributed to the existence of interfacial layer, barrier in homogeneity, interface traps/states (D_{it} or N_{ss}). The photosensitivity (S), photo-responsivity (R), and photo-detectivity (D*) were also calculated as function of applied bias voltage under 50 mW/cm^2 illumination intensity. The energy dependent curves of the N_{ss} were obtained by using the Card-Rhoderick method by considering voltage-dependence of BH and n. The higher values of S, R, and D* are indicated that these Al/SiO_2/p-Si diodes can be used in the photonic-applications.

Keywords: Photo sensitivity and photo responsibility; Physical parameters; Energy dependent profile of interface traps, Series resistance and interfacial layer effects on the current-voltage characteristics

References

[1] K. Yıldız, S. Altındal Yerişkin, A. Khalkhali, A. Dere, F. Yakuphanoglu, Photonic sensor based quaternary metal oxide semiconductor by controlling of solar photon intensity, Sensors and Actuators A: Physical, 393,2025, 116727, 0924-4247, https://doi.org/10.1016/j.sna.2025.116727.

[2] H. Elamen, Y. Badali, M. Ulusoy, Y. Azizian-Kalandaragh, Ş. Altındal, M. T. Güneşer, The photoresponse behavior of a Schottky structure with a transition metal oxide-doped organic polymer (RuO_2:PVC) interface. *Polym. Bull.* **81**, 403–422 (2024). https://doi.org/10.1007/s00289-023-04725-5.

[3] A. B. Ulusan, A. Tataroğlu, Ş. Altındal, Y. Azizian-Kalandaragh, Photoresponse characteristics of Au/($CoFe_2O_4$-PVP)/n-Si/Au (MPS) diode. *J Mater Sci: Mater Electron* **32**, 15732–15739 (2021). https://doi.org/10.1007/s10854-021-06124-w

Physical and Photodiode Properties of Ir-doped NiO Films

Arsen Demiroglu[1,*], Mujdat Caglar[1]

[1]*Department of Physics, Faculty of Science, Eskisehir Technical University, Eskisehir, 26470, Türkiye*

[*]**Corresponding e-mail:** arsendemiroglu@eskisehir.edu.tr

In the present study, pure and Ir-doped NiO films were deposited on glass and n-Si substrates via sol-gel spin coating method. The results clearly show that, Ir doping greatly influences NiO. XPS study revealed the presence of Ir^{+4}. According to the XRD results, the crystallite size and lattice parameter decreases while microstrain increases depending on the increasing Ir doping. The optical properties were examined by using UV-Visible spectrophotometer attached integrated sphere. The optical band gap decreased while the Urbach energy increased, indicating that the defect states increases with Ir doping. SEM results showed that the surface of NiO films improved with Ir doping. Photodiode analysis involved conducting I-V measurements between -2 V and +2 V in the dark and at a light intensity of 100 mW/cm². According to the I-V results, all devices exhibited photodiode characteristics due to an increase in current at reverse bias under illumination. While the ideality factor increased with Ir doping, the barrier height decreased. C-V measurements were conducted between -2 V and +2 V at 1 MHz to analyse the junction properties of the Ir-doped NiO-based devices. A clear change in capacitance at forward and reverse bias proved a varying depletion region. Additionally, capacitance decreased with increasing Ir doping, indicating broadening of the depletion region. In conclusion, our results demonstrate the potential of Ir-doped NiO-based devices for use in photonic applications in the visible spectrum.

Optimization of FDM 3D Printer Parameters: An Experimental and Data-Driven Investigation on Tensile Strength and Surface Roughness with PETG Filament

A.Kaptan[1,*]

[1] *Department of Motor Vehicles and Transportation Technologies, Sivas Technical Sciences Vocational School, Sivas Cumhuriyet University, Sivas, Türkiye*

[*] **Corresponding e-mail:** akaptan@cumhuriyet.edu.tr

This study systematically demonstrates the effects of critical process parameters on mechanical performance (tensile strength, σ) and surface finish (Ra) during FDM 3D printing using PETG filament. A Taguchi L27 orthogonal array was used for experimental planning, and three levels of layer thickness (0.12–0.28 mm), infill ratio (20–80%), printing speed (40–80 mm/s), nozzle temperature (220–250 °C), and scanning angle (0°–90°) were investigated. Samples were produced on a FlashForge Adventurer 5M Pro printer with a 0.4 mm nozzle, subjected to tensile tests according to ASTM D638 Type V, and Ra measurements were evaluated using the ISO 4287 (cut-off 0.8 mm) approach. The multi-criteria objective (σ↑, Ra↓) was combined with the desirability approach, and a single optimum setting was reported. OLS-based impact assessment (adj. R^2=0.990, Ra model adj. R^2=0.974) was used for non-categorical parametric analysis, and Random Forest (5-fold cross-validation) was used for estimation (R^2≈0.47 for σ; R^2≈0.32 for Ra).

The findings show that the combination of thinner layer, lower speed, nozzle temperature around 245 °C, and 0° scan angle increases σ while decreasing Ra; the fill rate has a positive but limited effect on σ, with a secondary effect on Ra. The recommended optimum parameters were determined as follows: 0.12 mm layer thickness, 80% fill rate, printing speed of 50–60 mm/s, nozzle temperature of 245 °C, 0° scan angle, table temperature of 85 °C, and 30% fan speed ratio.

Structural and Surface Morphology of Martensitic Stainless Steel – Glass powder Composite Materials During Corrosion Study

Ayse Nur ACAR[1*], Dogan Kaya[2,3*], Abdul Kadir Eksi[4], Ahmet Ekicibil[2]

[1]*Çukurova University, Ceyhan Engineering Faculty, Mechanical Engineering Department, Adana, Turkiye*
[2]*Çukurova University, Art and Science Faculty, Physics Department, Adana, Turkiye*
[3]*Çukurova University Institute of Natural and Applied Sciences, Department of Advance Materials and Nanotechnology Adana, Turkiye*
[4]*Çukurova University, Engineering Faculty, Mechanical Engineering Department, Adana, Türkiye*

[*]**Corresponding e-mail:** anacar@cu.edu.tr

Martensitic stainless steel (MSS) is a steel that commonly applied in industrial areas such as medical, aerospace and possesses ferritic structure, martensitic laths and carbide precipitations. This steel presents good mechanical properties and corrosion resistance. Heat treatment and additive materials can change and/or enhance the properties of this steel. When austenitizing temperature increased, the amounts of dissolved carbides and the proportions of alloying elements in the martensite matrix increases and austenite grains coarsen [1, 2]. The existence of dispersing Cr-rich carbides in the microstructure importantly affect corrosion resistance of MSS [3]. In this study, it is examined the glass powder (GP) effect on the structural and surface morphology of corrosion resistance of MSS produced by powder metallurgy immersed into the seasalt solution. For this, 410 MSS was mixed homogeneously with 5-25 % of GP separately. Powder mixtures pressed 12 tonnes pressure and sintered at 1250°C temperature for 2 hours. The surface morphology of these composite materials were characterized using optical microscopy, scanning electron microscopy images, energy-dispersive X-ray spectroscopy analysis and X-ray diffraction analysis for crystal structure determination before and after corrosion test. More crystal structures obtained in MSS-25%GP whereas smooth surface appearance show on the surface of control sample. It is showed that this sample has more corrosion resistance according to samples. These results show that changing GP amount in the MSS importantly affects crystallinity, surface and structural properties of MSS.

Key Words: Structural Property, Surface Morphology, Martensitic Stainless Steel, Glass Powder, Corrosion Resistance
Acknowledgement: Authors are greatly thankful to Cukurova University research funding with a Grand Number of FBA-2021-13966

References

[1] G.S. da Fonseca, K.H. Ferreira, S.C. de Oliveira, P.S.N. Mendes, L.P. da Silva Vitorino, E.A. Ferreira, Influence of austenitizing, quenching, and tempering on the hardness and corrosion resistance in martensitic stainless steel EN 1.4116, Journal of Materials Research and Technology 36 (2025) 5396-5405.
[2] H.-J. Chen, P.-C. Hsiao, H.-K.C. Chien, K. Lin, Y.-T. Chuo, C.-Y. Huang, H.-C. Lin, Effects of heat treatment on microstructure, mechanical properties and corrosion resistance 13Cr-2Ni-2Mo martensitic stainless steel, Mater. Charact. 223 (2025) 114909.
[3] B. Gao, T. Xu, L. Wang, Y. Liu, J. Liu, Y. Zhang, Y. Sui, W. Sun, X. Chen, X. Li, Achieving a superior combination of tensile properties and corrosion resistance in AISI420 martensitic stainless steel by low-temperature tempering, Corros. Sci. 225 (2023) 111551.

Analysis of impedance spectroscopy for hydroxyapatite-based biosensors

A.Dere[1]*, N. Özdemir[2], F.Yakuphanoglu[3]

[1]Firat University, Vocational School of Technical Science, Department of Electric and Energy, Elazig, Türkiye
[2]Firat University, Department of Metallurgical and Materials Engineering, Elazig 23119, Türkiye
[3]Firat University, Department of Physics, Elazig, 23200

***Corresponding e-mail:** a.dere@firat.edu.tr

Biosensors designed to monitor a biological reaction on the surface of transducers offer an alternative to many advanced biosystems due to their easy transportation and simple use. Impedance spectroscopy, which is sensitive to surface events and bulk properties, is one of the most effective techniques used to understand the modification of a biological surface. Therefore, in our study, hydroxyapatite based nickel, zinc and Strantium doped biomaterials were produced by hydrothermal method using biocompatible materials at constant temperature and time and their impedance analysis was performed. Biosensor properties were investigated depending on the dielectric properties of HAp based nickel, zinc and Strantium in the range of 0 to 20 MHz. According to the results obtained, it was observed that the frequency value of the dielectric constant and dielectric loss factor was constant at low frequencies and showed a sudden increase after approximately 18 MHz. This distinct and selective change in the dielectric constant indicates that a material can function as a biosensor..

References

[1] Elif Burcu Bahadır, Mustafa Kemal Sezgintürk, A review on impedimetric biosensors, Semicond. Artificial Cells, Nanomedicine, and Biotechnology An International Journal. 44,248–262 (2014).

[2] Ayşegül Dere, Development Of Nano-Structured Hydroxyepatite Based Bioceramic Coatings On Ti6al/Nb Surface For Bıomedical Applications, Firat University Institute of Science Ph.D. Thesis (2023)

Impact of Initial Processing Conditions on the Structure and Electrical Properties of Mixed-Phase Manganite Composite Materials

B. Altan[1*], Y.S. Ak[1], Ö. Birgi[1] and A. Coşkun[1]

[1]*Department of Physics, Faculty of Sciences, Muğla Sıtkı Koçman University, Muğla, Türkiye*

[*]**Corresponding e-mail:** barisaltan.mu@gmail.com

This work explores how initial processing conditions affect the structural and electrical properties of mixed-phase manganite composites based on $La_{0.67}Ca_{0.33}MnO_3$ [1] and $La_{0.835}Na_{0.165}MnO_3$ [2]. These parent compounds exhibit magnetic phase transitions above and below room temperature, respectively. Both parent compounds were synthesized using the sol–gel method and then calcined at 600 °C to produce nanosized precursor powders with controlled homogeneity. To reveal how the initial state of these precursors influences the final composite properties, two distinct fabrication strategies were employed.In the first approach, equal quantities of the calcined powders (0.5 g each) were mixed, pelletized, and sintered directly at 1000 °C to produce the composite material. In the second approach, individual pellets (1 g each) of the parent compounds were sintered separately at 1000 °C to promote crystallization. These pellets were then ground into powders, mixed in equal portions (0.5 g each), and subjected to a second sintering step at 1000 °C. The resulting materials were examined using X-ray diffraction (XRD) to determine phase composition and lattice parameters, scanning electron microscopy (SEM) combined with energy-dispersive X-ray spectroscopy (EDS) to analyze the microstructure and composition, and X-ray fluorescence (XRF) to verify the elemental ratios. Temperature-dependent resistivity (R–T) measurements were performed to evaluate transport properties and identify variations in transition behavior arising from differences in processing history. Comparative analysis revealed that precursor condition and processing route govern phase distribution, grain morphology, and crystallinity, thereby modifying the electrical response of the composites. These findings provide valuable insight into tailoring manganite composites with controlled functional properties, particularly for applications requiring optimized performance at room temperature.

References

[1] W. Zhong, W. Chen, W. Ding, N. Zhang, Y. Du, Q. Yan, Magnetocaloric properties of Na-substituted perovskite-type manganese oxides, Solid State Communications 106 (1998) 55–58. https://doi.org/10.1016/S0038-1098(97)10239-3

[2] L.E. Hueso, P. Sande, D.R. Miguéns, J. Rivas, F. Rivadulla, M.A. López-Quintela, Tuning of the magnetocaloric effect in $La_{0.67}Ca_{0.33}MnO_{3-\delta}$ nanoparticles synthesized by sol–gel techniques, Journal of Applied Physics 91 (2002) 9943–9947. https://doi.org/10.1063/1.1476972

The Influence of Sintering Temperature on The Structural Properties of $A_{0.67}Sr_{0.33}MnO_3$ (A = La, Gd, Nd, Pr) Perovskite Manganites

B. Altan[1*], Y.S. Ak[1], Ö. Birgi[1], İ.B. Bürhan[1], E. Taşarkuyu[1] and A. Coşkun[1]

[1]Department of Physics, Faculty of Sciences, Muğla Sıtkı Koçman University, Muğla, Türkiye

[*]**Corresponding e-mail:** barisaltan.mu@gmail.com

In this study, perovskite-type manganites with the composition $A_{0.67}Sr_{0.33}MnO_3$ (A = La, Gd, Nd, Pr) were synthesised using the sol–gel method [1]. The effect of calcination temperature on their structural and microstructural properties was investigated. Following gel preparation and drying, the obtained precursor powders were subjected to thermal treatment at four different temperatures (900 °C, 1000 °C, 1100 °C and 1200 °C) for 24 hours to promote crystallisation and phase stability. The characterisation of the synthesized samples was conducted using a range of analytical techniques, including X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDS). XRD analysis confirmed the formation of a perovskite phase for all compounds, with enhanced crystallinity and more pronounced diffraction peaks at elevated calcination temperatures. SEM observations demonstrated a clear correlation between grain coarsening and increased thermal treatment, thereby indicating a strong dependence of grain size on calcination temperature. EDS results verified the homogeneous distribution of the elements La, Gd, Nd, Pr, Sr, Mn and O in the respective compounds, with no detectable impurity phases present. The present study demonstrates that higher calcination temperatures enhance structural ordering and promote grain growth, which plays a decisive role in tuning the physical properties of perovskite manganites. As these materials are the subject of extensive research for utilisation in electronics, spintronics, magnetic cooling [2] and magnetoresistance, it is imperative to comprehend the correlation between synthesis conditions and microstructural evolution. The findings presented herein offer significant insights into the optimisation of processing parameters, with the objective of attaining the desired structural quality and performance characteristics in rare-earth-based manganites.

References

[1] E. Taşarkuyu, A. Coşkun, A.E. Irmak, S. Aktürk, G. Ünlü, Y. Samancıoğlu, A. Yücel, C. Sarıkürkçü, S. Aksoy, M. Acet, Effect of high temperature sintering on the structural and the magnetic properties of $La_{1.4}Ca_{1.6}Mn_2O_7$, Journal of Alloys and Compounds 509 (2011) 3717–3722. https://doi.org/10.1016/j.jallcom.2010.12.011

[2] A. Ezaami, N. Ouled Nasser, W. Cheikhrouhou-Koubaa, A. Cheikhrouhou, Enhancement of magnetocaloric properties in (1−x) $La_{0.7}Ca_{0.2}Sr_{0.1}MnO_3$/x $La_{0.7}Ca_{0.15}Sr_{0.15}MnO_3$ composite system ($0 \leq x \leq 1$), Materials Research Bulletin 95 (2017) 211–215. https://doi.org/10.1016/j.materresbull.2017.07.036

Synthesis, Characterization, and *in vitro* Biological Evaluation of Boron, Magnesium, and Vanadium Doped Bioactive Glasses for Tissue Engineering Applications

Kübra Özkan Güner[1], **Bilge Sema Tekerek**[2*], Ali Can Özarslan[3,6], Yeliz Elalmış[1,6], Cem Özel[1,6], İlkay Turhan Kara[4], Mine Kucak[5,6], Yeşim Ayık[1,7], Sevil Yücel[1,6]

[1]*Department of Bioengineering, Yildiz Technical University, İstanbul, Türkiye*
[2] *Faculty of Engineering and Architecture, Nişantaşi University, İstanbul, Türkiye*
[3] *Department of Metallurgical and Materials Engineering, Istanbul University-Cerrahpasa, İstanbul, Türkiye*
[4] *Department of Nutrition and Dietetics, Istanbul Arel University, İstanbul, Türkiye*
[5] *Department of Molecular Biology and Genetics, Yildiz Technical University, İstanbul, Türkiye*
[6] *Health Biotechnology Joint Research and Application Center of Excellence, Istanbul, Türkiye*
[7] *Department of Bioengineering, Üsküdar University, İstanbul, Türkiye*

[*]**Corresponding e-mail:** bilgesema.tekerek@nisantasi.edu.tr

Bone defects caused by trauma, tumors, infections, and degenerative diseases remain a significant clinical challenge, especially in large bone structures where severe defects require graft materials to assist healing. Although autografts offer benefits like biocompatibility and osteogenic potential, their use is limited by donor site morbidity and availability issues. This has increased interest in developing synthetic materials for tissue engineering. Among these, bioactive glasses (BGs) within the SiO_2–CaO–P_2O_5 system are an important class of ceramics commonly used for repairing or replacing damaged or diseased bone tissue. The inorganic ions embedded in BGs are essential for osteogenesis and angiogenesis, and altering their composition allows precise adjustment of their physicochemical and biological properties.

In this study, various glass compositions, including undoped and doped with boron (B), magnesium (Mg), and vanadium (V), were synthesized through the sol–gel method. Structural characterization included density measurements, particle size analysis, zeta potential, elemental composition (XRF), and thermal behavior (TG–DTA). *in vitro* bioactivity was assessed by immersing samples in simulated body fluid (SBF) over 3, 7, 14, 21, and 28 days, followed by SEM, FT–IR, XRD, and ICP–OES analyses. Cytotoxicity was tested using the MTT assay at concentrations of 10, 5, 2.5, and 1.25 mg/ml. Antibacterial activity was evaluated against *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa in vitro*.

DTA results demonstrated that doping with B and V notably affected all key thermal transitions, with higher V content improving thermal stability. *in vitro* bioactivity tests showed the formation of a cauliflower-like Ca/P layer in SEM images, P–O bond peaks in FT–IR spectra, and hydroxyapatite peaks in XRD patterns for both undoped and doped BGs. MTT assay results indicated that undoped BGs maintained cell viability comparable to the control group across all tested concentrations, while B, Mg, and V-doped BGs showed increased cell viability at lower concentrations. Antibacterial tests revealed a reduction in bacterial colony counts for all BG types compared to the control.

Overall, these findings suggest that B, Mg, and V-doped bioactive glasses possess significant potential for use in bone tissue engineering, soft tissue regeneration, and, due to the insulin-mimetic effects of vanadium, in treating diabetic wounds.

This work was supported by the Presidency of Turkish Health Institutes (TUSEB) within the scope of the 2022-B-03/B Group R&D Projects Call (Project Code 24239). We thank TUSEB for their support.

Design and Construction of An In-Situ Magnetron Sputtering Plasma Monitoring Setup

B. Bilki[1,2*], M. Tosun[1,3]

[1]*İstanbul Beykent University, İstanbul, Turkey*
[2]*Turkish Accelerator and Radiation Laboratory, Ankara, Turkey*
[3]*İstinye University, İstanbul, Turkey*

[*]**Corresponding e-mail:** burakbilki@beykent.edu.tr

Magnetron sputtering is among the most commonly used techniques for deposition of metallic and insulating thin films on various types of substrates. The film thickness and morphology can be tuned to very fine levels as the understanding of the individual components of the sputtering process such as the ionization of the working gas and the dynamics of the plasma, the sputtering of the target material and the deposition of the target material on the substrate, is improved [1]. One of the most feasible ways to understand the magnetron sputtering process in detail is to inspect the characteristics of the light generated by the plasma [2]. The atoms and ions of the working gas as well as the sputtered material can be identified and measured for their densities and dynamics. The measurements so far, on the other hand, were either performed from outside the vacuum chamber or with methods that interfere with the plasma inside the chamber. In order to obtain critical insight into the formation and development of the magnetron sputtering plasma and to address the existing issues associated with different processes, we are in the process of conducting a high timing precision, multi-parameter study of the plasma light. The study includes the sampling of the plasma light at various critical locations along the plasma from the target to the substrate at down to 320 picosecond time resolution. The measurement setup includes quartz optical fibers placed at critical locations inside the vacuum chamber, a special feedthrough, and an optical measurement setup that contains Silicon photomultipliers placed on a custom readout board. Here we report on the design and construction of this experimental setup to perform high precision measurements.

References

[1] Gudmundsson J.T.; Physics and technology of magnetron sputtering discharges, Plasma Sources Sci. Technol. 29 (2020) 113001

[2] Anders A. et al.; Drifting Ionization Zone in Sputtering Magnetron Discharges at Very Low Currents, 2014 IEEE Trans. Plasma Sci. 42 2578–9

Frequency dependent electrical parameters, voltage dependent surface states and series resistance in Au/n-Si (MS) structures with polymer interlayer from admittance technique

Çiğdem Ş. Güçlü[1*]

[1]*Department of Physics, Faculty of Science, Gazi University, Ankara, TÜRKİYE*

[*]**Corresponding e-mail:** cigdemguclu@gazi.edu.tr

This study represents the prepared Au/n-Si (MS) structures with cobalt-doped interfacial layer and investigation into the voltage and frequency dependence profiles of some important electrical parameters and the surface states (N_{ss}), series resistance, and interfacial layer effects on them by using admittance measurements ($Y=1/Z=G+j\omega C$) at room temperature. All experimental findings indicate that basic electrical parameters are strong function of frequency as well as applied bias voltage especially at low/moderate frequencies in the depletion zone. But, while N_{ss} are dominated both in weak inversion and depletion regions, Rs and interfacial layer are dominated only at accumulation region. Some basic electrical parameters are extracted from the slope and intercept voltage of the reverse bias C^{-2} vs V plot for four different frequencies (50, 100, 500, and 1000kHz). The voltage-dependent profiles of N_{ss} and R_s were extracted both from the low-high (C_{HF}-C_{LF}) frequency capacitance and Hill-Coleman techniques, but R_s vs V profile was obtained admittance technique for various frequencies [1-3]. To determine R_s effects on the admittance measurements at high frequency both the capacitance and conductance versus voltage plots were adjusted and obtained results show that the value of R_s is more effective at accumulation region for high frequencies.

Keywords: Metal doped polymer interfacial layer; Surface states and series resistance; Hill-Coleman and high-low frequency capacitance techniques; Frequency and voltage dependence

This study was supported by Scientific and Technological Research Council of TURKIYE (TUBITAK) (Project Number 124C419).

References

[1] Ç. Ş. Güçlü, Ş. Altındal, E. Erbilen Tanrikulu, Voltage and frequency reliant interface traps and their lifetimes of the MPS structures interlayered with CdTe:PVA via the admittance method. Physica B: Condensed Matter, **677** 415703 (2024) https://doi.org/10.1016/j.physb.2024.415703

[2] Y. Badali, Ç. Ş. Güçlü, Electric and dielectric responses of Au/n-Si structure by Mn doped PVC interfacial layers. Phys. Scr. **99,** 8 085947 (2024) https://doi.org/10.1088/1402-4896/ad5f69

[3] Ç. Ş Güçlü, E. E. Tanrıkulu, M. Ulusoy, Y.Azizian-Kalandaragh, Frequency-dependent physical parameters, the voltage-dependent profile of surface traps, and their lifetime of Au/(ZnCdS-GO:PVP)/n-Si structures by using the conductance method. J Mater Sci: Mater. Electron. 35, 348 (2024). https://doi.org/10.1007/s10854-024-12111-8

Bioactive Pollen-Integrated Cryogels: Potential Applications in Tissue Engineering

D.Demir[1*], S.Ceylan[2*], S.L.İpek[3,4], O.Kahraman[1]

[1]*Department of Chemistry and Chemical Process Technologies, Tarsus University, Mersin, Türkiye*
[2]*Department of Bioengineering, Adana Alparslan Türkeş Science and Technology University, Adana, Türkiye*
[3]*Department of Food Engineering, Adana Alparslan Türkeş Science and Technology University, Adana, Türkiye*
[4]*Department of Chemistry, Dumlupınar University, Kütahya, Türkiye*

[*]**Corresponding e-mail:** didemdemir@tarsus.edu.tr, sceylan@atu.edu.tr

The integration of natural bee-derived products into polymer-based biomaterials has emerged as a promising strategy in tissue engineering, owing to their inherent biological properties such as antimicrobial, antioxidant, and wound-healing activities [1]. While materials incorporating bee products like honey, bee bread, propolis, and royal jelly have been widely explored, the use of pollen in scaffold fabrication remains relatively under-investigated.

In this study, cryogel-based scaffolds enriched with pollen and pollen extracts were developed and characterized. The natural polymers chitosan and gelatin were used in combination for cryogel synthesis. Different amounts of powdered pollen and its ethanol extract (25, 50, and 100% weight of the polymer amount in the mixture) were added to the cryogenic structure to evaluate potential structural changes in the existing scaffold for tissue engineering applications. Morphological evaluations for all gels revealed an architecture with interconnected porous structures. The materials exhibited high water retention capacity and maintained this property with the addition of bioactive agents in both forms. The structural transformation of pollen and the release of its phytochemical components via extraction were investigated for microbiological and cell viability. Furthermore, the controlled release behavior of pollen and its phytochemicals was assessed over time in phosphate buffer saline at 37˚C (pH 7.4).

The results indicate that pollen-functionalized cryogels possess strong potential as multifunctional scaffolds in regenerative medicine, offering not only structural integrity but also enhanced biological performance through sustained antioxidant activity and cytocompatibility. This dual functionality highlights their suitability for promoting tissue repair and cellular regeneration in bioengineered systems.

Acknowledgment: This study was financially supported by the Adana Alparslan Türkeş Science and Technology University Scientific Research Projects Unit (Grant No: 25103003).

References

[1] D. Demir, O. Kahraman, S.L. İpek and S. Ceylan, Bee products loaded polymeric films as a potential dressing material for skin treatments, Biofunctional Materials, 3(2), 115 (2025).

Investigation of Catalytic Activities of PtAu-Co Nanoparticles in Alkaline Media

Dogan Kaya[1,2*], Emre Can Tayfun[1], Mustafa Akyol[3], Faruk Karadag[1], Ahmet Ekicibil[1]

[1]*Department of Physics, Faculty of Art and Sciences, Cukurova University, Adana, Türkiye*
[2]*Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Cukurova University, Adana, Türkiye*
[3]*Materials Engineering Department, Faculty of Engineering, Adana Alparslan Turkes Science and Technology University, Adana, Türkiye*

[*]**Corresponding e-mail:** dogankaya@cu.edu.tr

Multimetallic nanoalloys are emerging as key materials for next-generation energy conversion and storage technologies, including fuel cells, water electrolyzers, and metal-air batteries, due to their tunable surface chemistry and synergistic catalytic properties [1, 2]. In this study, a series of PtAu-Co nanoalloys with varying compositions were synthesized to investigate the relationship between composition, structure, and electrocatalytic activity. X-ray diffraction analyses confirmed the formation of a face-centered cubic (FCC) with a space group of fm-3m for all samples, with lattice parameters decreasing as Pt content increased, consistent with the smaller atomic radius of Pt relative to Au. Transmission electron microscopy revealed uniformly dispersed nanoparticles with average diameters below 10 nm, without significant agglomeration. X-ray photoelectron spectroscopy demonstrated that Pt and Au were predominantly in the metallic state, while Co was mainly present as surface oxides, potentially enhancing metal–oxide interface synergy. Electrochemical characterization via linear sweep voltammetry and cyclic voltammetry showed that the Pt-rich sample $[(Pt_{0.60}Au_{0.30})\text{-}(Co)_{0.10}]$ exhibited the highest catalytic activity toward both the hydrogen evolution reaction, attributable to its high crystallinity, small particle size, and favorable surface chemistry. These findings highlight the critical role of compositional tuning in optimizing the structural and surface properties of multimetallic nanoalloys for advanced electrocatalytic applications.

Acknowledgement: We would like to express our sincere gratitude for the support by Cukurova University, Adana, Turkey, under Scientific Research Funding Grant Numbers: FBA-2023-15712.

References

[1] H. Lin, Y. Liu, J. Deng, L. Jing, Z. Wang, L. Wei, Z. Wei, Z. Hou, J. Tao, H. Dai, Bimetallic nanoparticles: advances in fundamental investigations and catalytic applications, Environmental Science: Advances, 4 (2025) 33-56.

[2] F. Liu, C. Shi, X. Guo, Z. He, L. Pan, Z.-F. Huang, X. Zhang, J.-J. Zou, Rational Design of Better Hydrogen Evolution Electrocatalysts for Water Splitting: A Review, 9 (2022) 2200307.

Effect of Annealing Time on the Optical, Structural and Mott-Schottky Measurement of the Constant Electrodeposited WO_3 Thin Films

E. Değirmenci and G. Atak*

[1]*Department of Physics Engineering, Hacettepe University, Ankara, Türkiye*
[2] *Department of Physics Engineering, Hacettepe University, Ankara, Türkiye*

***Corresponding e-mail:** gbaser@hacettepe.edu.tr

Depending on the crystal structure and quality, WO_3 films are n-type semiconductor materials with energy band gaps in the range of 2.5-3.5 eV. WO_3 is a good candidate for cathodic electrochromic layer and metal oxide photoelectrode material for photoelectrochemical water splitting due to its high coloration efficiency and optical modulation value, high stability in alkaline media, and suitable optical band gap [1].

In this study, WO_3 thin films of different thicknesses were deposited by the electrodeposition method using a potentiostat and an electrochemical cell, which is an advantageous method with the potential to easily control film morphology, a low-cost, and has the potential for large-area film coating [2].

Tungsten trioxide (WO_3) thin films were deposited by electrodeposition using $Na_2WO_4.2H_2O$ with deionized water, H_2O_2 and $HClO_4$ electrolyte solution at -0.7 V versus Ag/AgCl with a continuous potential. After deposition the films were annealed at 300°C with various time (30 min – 6 h). The optical (UV-Vis-NIR spectrophotometer), morphological (SEM and EDX) and structural (XRD) properties of the films were characterized in detail. With the M-S measurement (in 0.5 M H_2SO_4) and UV-Vis spectroscopy their energy band diagrams were analyzed also in detail.

The authors want to thank the Scientific and Technological Research Council of Turkey (TÜBİTAK) for financial support with Project ID 223M337 and Hacettepe University Scientific Research Projects Coordination Unit with Project ID FHD-2024-21270 and FKB-2024-21248.

References

[1] A. Chithambararaj, P. Nandigana, M. Kaleesh Kumar, A.S. Prakash, S. K. Panda, Enhanced electrochromism from non-stoichiometric electrodeposited tungsten oxide thin films, Applied Surface Science 582, 15242430 (2022)

[2] N. Sy Pham, L. Thanh Nguyen, H. T. Nguyen, V. Q. Nguyen, T. B. Thi Nguyen et al. Long-term stability electrochromic electrodes based on porous tungsten trioxide and nickel oxide films via a facile triple pulse electrodeposition, Ceramics International 49, 33413–33417 (2023)

Development of a Permanent Hair Dye Formulation Made from Natural Ingredients

E. ECER[1,2*] and Ü. AÇIKEL[2]

[1]Department of Chemical Engineering, Sivas Cumhuriyet University, Sivas, Türkiye/ Ezel Kozmetik Research and Development Laboratory, Sivas, Türkiye
[2]Department of Chemical Engineering, Faculty of Engineering, Sivas Cumhuriyet University, Division of Process and Reactor Design, Sivas, Türkiye

***Corresponding e-mail:** ecerelif34@gmail.com

Synthetic oxidative hair dyes, which are widely used in the modern cosmetics industry, cause short-term side effects such as dermatological irritation, dryness, and erythema of the scalp, and long-term side effects such as hormonal imbalances, oxidative stress-induced cellular damage, and potential carcinogenic effects [1]. Additionally, the production, use, and waste management processes of these components create negative effects such as the release of toxic substances into the environment and the disruption of biological balance in water ecosystems, threatening environmental sustainability. This study aims to develop an environmentally friendly and safe hair dye formulation that can provide a permanent coloring effect using completely natural pigments and phytochemical extracts that do not contain toxic components. The formulation process utilized walnut (Juglans regia), henna (Lawsonia inermis), chamomile (Matricaria chamomilla), and Polygonum extract, which has been reported in the literature to have melanocyte-stimulating effects. Samples were prepared under different pH conditions using hot and cold process techniques, and physicochemical properties (pH, density, viscosity), organoleptic criteria (odor, color homogeneity), and microbial load analyses were performed. Stability studies were conducted at room temperature, 4°C, and under accelerated conditions (45°C, 55% relative humidity). Initial dyeing tests on white hair samples achieved 55–75% coverage, and short-term tests found the formulation to be physically stable and microbiologically safe. The preliminary findings suggest that natural pigments could offer an effective, sustainable, and safe alternative for developing permanent hair dye without the use of synthetic oxidative agents. In the subsequent stages of the study, long-term stability, biodegradability, and toxicological safety tests will be conducted to comprehensively evaluate the product's ecological and biological reliability.

References

[1] Nohynek, G. J., Fautz, R., Benech-Kieffer, F., & Toutain, H. (2004). Toxicity and human health risk of hair dyes. Food and Chemical Toxicology, 42(4), 517-543.

Computing-Based Measurement Architecture for Semiconductor and Photovoltaic Characterisation

E. Kayhan[1]*, M.N. Koçak[2], İ. Demir[3], E. Şenadım Tüzemen[4], A.G. Yüksek[5]

[1] *Department of Computer Engineering, Faculty of Engineering, Sivas Cumhuriyet University, Sivas, Türkiye*
[2] *Nanophotonics Application and Research Center, Sivas Cumhuriyet University, Sivas, Türkiye*
[3] *Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University, Sivas, Türkiye*
[4] *Department of Physics, Faculty of Science, Sivas Cumhuriyet University, Sivas, Türkiye*
[5] *Department of Computer Engineering, Faculty of Engineering, Sivas Cumhuriyet University, Sivas, Türkiye*

***Corresponding e-mail:** emirhankayhan58@outlook.com

The objective of this work is to integrate measurement procedures in photovoltaic and semiconductor device characterization into a reproducible, traceable, software-defined platform. The proposed computer architecture manages both LED-based light sources and the SMU in unison using a Python-based back end. Real-time user interaction is enabled by a React-based web interface using the application of RESTful API and WebSocket protocols. Measurement cycle operation is facilitated with the assistance of pre-established 'recipe' template usage. Reporting to data acquisition is facilitated by version information, audit trails, and calibration metadata retained in a relational database, thus allowing end-to-end traceability. Security for remote access is facilitated by the use of Transport Layer Security (TLS/SSL) and JSON Web Token (JWT)-based authentication protocols. Single-board computer (SBC) deployment in a container is optimized for economic deployment in field applications.

The system has been configured to minimize operator dependency to minimize measurement uncertainty and, therefore, enhance repeatability. This is achieved through providing software-level synchronisation for current-voltage (I-V) and current-time (I-t) measurements. The system has proved to provide data integrity in multi-user and multi-session environments, thereby facilitating scalable laboratory capacity. Device drivers are abstracted using PyVISA and PySerial libraries; measurement timing achieves a deterministic form with uniformly rising system clock. Data is logged in International System of Units (SI) units, double timestamps, and quality indicators. Raw data is kept in native form, and derived parameters are kept in separate tables. The system is protected by role-based access control (RBAC) and immutable audit trails. The system deployment availability is limited by the impact of network latency resulting from SBC implementation.

The system operates with low latency and minimal jitter budgets at high concurrency; prescription and calibration versioning offers inter-institutional data comparability. Software-based timing in systems without hardware trigger support and management of heterogeneous device fleets are limitations of the system. Future efforts will incorporate hardware triggers, self-calibration, and anomaly detection based on telemetry. This architecture provides a secure, scalable, and enterprise-standard-compliant characterization framework that accelerates the digitization of measurement processes for both laboratory and field applications.

This work was supported by the Scientific Research Project Fund of Sivas Cumhuriyet University, Turkey, under the project number **F-2025-732**.

References

[1] Alwar, S., Samithas, D., Boominathan, M., Balachandran, P., & Mihet-Popa, L. (2022). Performance analysis of thermal image processing-based photovoltaic fault detection and PV array reconfiguration—A detailed experimentation. Energies, 15(22), 8450

Artificial Intelligence-Based Decision Support Systems in Semiconductor Manufacturing: MOVPE Application

E. Kayhan[1]*, M.N. Koçak[2], İ. Demir[3], E. Şenadım Tüzemen[4], A.G. Yüksek[5]

[1] Department of Computer Engineering, Faculty of Engineering, Sivas Cumhuriyet University, Sivas, Türkiye
[2] Nanophotonics Application and Research Center, Sivas Cumhuriyet University, Sivas, Türkiye
[3] Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University, Sivas, Türkiye
[4] Department of Physics, Faculty of Science, Sivas Cumhuriyet University, Sivas, Türkiye
[5] Department of Computer Engineering, Faculty of Engineering, Sivas Cumhuriyet University, Sivas, Türkiye

*Corresponding e-mail:** emirhankayhan58@outlook.com

This present study suggests the concept of a dynamic, ever-learning artificial intelligence-based decision support system in optimizing Metal Organic Vapour Phase Epitaxy (MOVPE) processes. The propositions are that the processes are critical in the production of semiconductors. MOVPE processes are typically characterized by high costs and a trial-and-error approach, attributable to their multivariable nature, which depends on various parameters like gas flow rate, temperature, pressure, and growth time. The system constructed collects structural, electrical, and optical characterisation data from experimental growths in a central database and analyzes them using machine learning and deep learning methods. Here, in this context, the application of tools such as artificial neural networks, support vector machines, Gaussian process regression, and ANFIS is facilitated through a comparative mode, thus making it possible to predict optimal growth parameters with high accuracy. Furthermore, the system is continuously enhanced through the provision of new inputs.

The decision support mechanism proposed here should be able to cut the number of experiments by as much as 70%, hence saving time and expense. In addition, the predicted accuracies are expected to be ±10 nm for layer thickness, >90% for alloy ratios, and >95% for carrier density. Most importantly, the system's flexible architecture enables easy adaptation not only to MOVPE processes but also to similar epitaxial growth technologies. From an academic perspective, the approach is a sound foundation for generating fresh articles and thesis studies. From an industrial perspective, the introduction of the software module to process control in semiconductor production facilities can provide efficiency and dependability.

Its strategic achievements are the innovational development of local software infrastructure for MOVPE optimisation in Turkey, and reduction of foreign dependency. Moreover, integration ability of the system with digital twin technologies and Industry 4.0 solutions makes the work a typical research product turned into a sustainable and reproducible model of digital transformation. Finally, this research provides four-dimensional contributions in terms of accuracy, speed, cost, and reliability in semiconductor manufacturing and is one of the forerunners of the information-oriented paradigm revolution.

This study supported by The Scientific Research Project Fund of Sivas Cumhuriyet University, Turkey under the project number MRK-2024-004 and The Scientific and Technological Research Council of Turkey (TUBITAK) under the project number 22AG074 and 125F070.

References

[1] G. B. Stringfellow, Organometallic Vapor-Phase Epitaxy: Theory and Practice, 2nd ed. San Diego, CA, USA: Academic Press, 2019.

Investigation of Catalytic Activities of PtAuCo Nanoparticles in Alkaline Media

Emre Can Tayfun[1*], Dogan Kaya[1,2], Mustafa Akyol[3], Faruk Karadag[1], Ahmet Ekicibil[1]

[1]*Department of Physics, Faculty of Art and Sciences, Cukurova University, Adana, Türkiye*
[2]*Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Cukurova University, Adana, Türkiye*
[3]*Materials Engineering Department, Faculty of Engineering, Adana Alparslan Turkes Science and Technology University, Adana, Türkiye*

[*]**Corresponding e-mail:** emrecntayfun@gmail.com

In recent years, the increasing demand for energy has necessitated the development of high performance catalysts [1]. Therefore, based on noble metal nanoparticles (NPs) by controlling particle sizes have emerged as promising catalytic materials for hydrogen and oxygen evolution reactions [2, 3]. In this study, Co added PtAu NPs were synthesized using the polyol method and the structural based on noble and catalytic performances were investigated in detail. X-ray diffraction and Rietveld refinement analyses determined the crystal structure of PtAuCo NPs, revealing a face-centered cubic (*fcc*) structure with a space group of *fm-3m* and a crystallite size of 5.62 nm. The particle size distributions, shapes, and surface morphologies of the NPs were determined using Transmission Electron Microscopy and Scanning Electron Microscopy. Spherically shaped NPs were obtained with an average particle size below 10 nm. To investigate the fundamental catalytic mechanisms of the developed triatomic nanostructures, experiments were conducted using a three-electrode system comprising carbon electrodes, a Pt counter electrode, and a Ag/AgCl reference electrode in 1 M KOH. Hydrogen evolution reaction (HER) activities were investigated by LSV and CV curves to determine onset potential, overpotential, specific current density and Tafel slopes measurements were performed to evaluate their catalytic performance. For the HER reaction, the onset potential and the overpotential at 10 mA cm^{-2} were 39.1 mV and 93.5 mV vs. RHE, respectively, while for the OER reaction, the onset potential and overpotential at 50 mA cm^{-2} were recorded as 1.42 V and 1.48 V vs. RHE, respectively.

Acknowledgement: We would like to express our sincere gratitude for the support by Cukurova University, Adana, Turkey, under Scientific Research Funding Grant Numbers: FBA-2023-15712.

References

[1] R. Saha, B. Mondal, P.S. Mukherjee, Molecular Cavity for Catalysis and Formation of Metal Nanoparticles for Use in Catalysis, Chem Rev, 122 (2022) 12244-12307.
[2] P. Kumar, V. Tomar, D. Kumar, R.K. Joshi, M. Nemiwal, Magnetically active iron oxide nanoparticles for catalysis of organic transformations: A review, Tetrahedron, 106-107 (2022).
[3] A. Nyabadza, E. McCarthy, M. Makhesana, S. Heidarinassab, A. Plouze, M. Vazquez, D. Brabazon, A review of physical, chemical and biological synthesis methods of bimetallic nanoparticles and applications in sensing, water treatment, biomedicine, catalysis and hydrogen storage, Adv Colloid Interface Sci, 321 (2023) 103010.

Disentangled UHMWPE Synthesis: New opportunities for UHMWPE processing

G.Korkmaz[1*]

[1] *Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Çukurova University, Adana, Türkiye.*

[*]**Corresponding e-mail:** gedizkorkmaz@outlook.com

With advancements in polymerization technology and polymer processing techniques Ultra High Molecular Weight Polyethylene (UHMWPE) is still preserving and strengthening its position in maritime, manufacturing, defence and healthcare industries owing to its unique physical and chemical properties and affordable cost structure [1]. Still conventional UHMWPE, produced with supported Ziegler catalyst and having high entanglement density, has a a great majority by far in UHMWPE market. On the other hand disentangled UHMWPE (dUHMWPE) start to play a new role in manufacturing and defence industries. Owing to its lower entanglement density and lower melt strength, dUHMWPE brings new processing opportunites as 3D printing or UHMWPE film extrusion [2]. At the heart of this progress in UHMWPE processing, there is a technological breakthrough in polyolefin catalyst technology. Especially, phenoxy-imine (FI) catalyst with pentafluoro phenyl ligand made “living polymerization” possible within “reasonable” reaction conditions. As a product of “ligand based catalyst design” approach, it has roots from metallocene and constrained geometry catalysts. As metallocene and constrained geometry catalysts, FI catalyst synthesized as a homogeneous catalyst. But unlike these two, having tetrahedral structures, it is an octahedral complex. Supporting FI catalyst complexes is another research area, that will enable to use these super-active complexes in larger scale, continuous commercial polyethylene processes. Due to fouling problems in commercial processes, utilization of homogeneous FI complexes in commercial scale reactors are limited with batch type reactors. At the same time with supporting studies for FI catalyst complexes, some researchers start to study modifying supported Ziegler catalyst to obtain dUHMWPE [3]. The aim of this poster is to summarize the studies in FI catalsyt development, studies in modifiying supported Ziegler catalyst to obtain dUHMWPE and to demonstrate the utilization of dUHMWPE in different industries, especially in 3D printing and defence industries.

References

[1] Korkmaz, G., Evolution of Ultra High Molecular Weight Polyethylene Synthesis: A Comprehensive Review of Phenoxy Imine Catalysts for Enhanced Material Properties and Industrial Perspective. Journal of NanoScience in Advanced Materials, 4(1) (2025).

[2] Christakopoulos, F., P.M.H. van Heugten, and T.A. Tervoort, Additive Manufacturing of Polyolefins. Polymers 14(23), (2022).

[3] Wu S.L.,1, Qiao, J., Guan, J., Chen, H.M., Wang, T., Wang, C., Wang,Y., Nascent disentangled UHMWPE: Origin, synthesis, processing, performances and applications. European Polymer Journal 184, (2023) 111799.

Photocatalytic Performance of TiO_2 Thin Films Deposited at Different Substrate Temperatures

Hafize Seda Aydınoğlu[1,2] · Ebru Şenadım Tüzemen[2,3]

[1] *Sivas Cumhuriyet University, Vocational School of Health Services, Sivas, Turkey*
[2] *Sivas Cumhuriyet University, Nanophotonics Research and Application Center, Sivas, Turkey*
[3] *Sivas Cumhuriyet University, Department of Physics, Faculty of Science, Sivas, Turkey*
*

Corresponding e-mail: hsaydinoglu@cumhuriyet.edu.tr

In this study, the photocatalytic degradation efficiency of titanium dioxide (TiO_2) thin films grown by RF magnetron sputtering was investigated under UVA and UVC illumination. The TiO_2 films were deposited on glass substrates at three different substrate temperatures: room temperature (RT), 100 °C, and 200 °C. The photocatalytic activity was evaluated by monitoring the degradation of methylene blue (MB) solution over time using UV-Vis spectrophotometry. The results showed that the film grown at 200 °C exhibited the highest degradation efficiency, achieving 96.15% MB removal after 4 hours of UVC exposure. This high performance was attributed to the denser and more crystalline film structure obtained at the elevated growth temperature. These findings highlight the importance of optimizing the substrate temperature to enhance the effectiveness of TiO_2 thin films for environmental pollutant removal applications [1].

This study is supported by Sivas Cumhuriyet University Scientific Research Project Fund under the project number F-2024-727.

References

[1] H. S. Aydınoğlu and E. Ş. Tüzemen, Effect of substrate temperature on the photocatalytic degradation efficiency of methylene blue using TiO_2 thin films, *React. Kinet. Mech. Catal.* **136**, 875–889 (2025). https://doi.org/10.1007/s11144-025-02872-6

Effect of Substrate Temperature on the Photocatalytic Degradation Performance of NiO Thin Films

Hafize Seda Aydınoğlu[1,2] · Ebru Şenadım Tüzemen[2,3]

[1] *Sivas Cumhuriyet University, Vocational School of Health Services, Sivas, Turkey*
[2] *Sivas Cumhuriyet University, Nanophotonics Research and Application Center, Sivas, Turkey*
[3] *Sivas Cumhuriyet University, Department of Physics, Faculty of Science, Sivas, Turkey*

***Corresponding e-mail:** hsaydinoglu@cumhuriyet.edu.tr

This study explores the photocatalytic behavior of nickel oxide (NiO) thin films in the degradation of methylene blue. The films were deposited on glass substrates by RF magnetron sputtering at room temperature and at 250 °C, followed by thermal annealing at 450 °C for 1 hour. The degradation process was monitored under UV-C light using UV-Vis absorption measurements. It was observed that annealing improved the activity of room-temperature-grown films, while it led to a performance drop in films grown at 250 °C. This is attributed to structural improvements due to annealing in the former case, and grain growth leading to reduced surface area in the latter. The highest degradation efficiency was achieved with the unannealed film deposited at 250 °C, which also showed the shortest half-life and highest reaction rate. The findings demonstrate that both deposition and post-treatment conditions have a direct impact on the photocatalytic efficiency of NiO films [1].

This study is supported by Sivas Cumhuriyet University Scientific Research Project Fund under the project number F-2024-727.

References

[1] Karimi L, Zohoori S, Yazdanshenas ME (2014) Photocatalytic degradation of azo dyes in aqueous solutions under UV irradiation using nano-strontium titanate as the nanophotocatalyst. Journal of Saudi Chemical Society 18:581–588

High Photocatalytic Efficiency of $CoFe_2O_4$ Nanoparticles for Dye Degradation Under UV Light

Hasan Huseyin Isik[1*], Ilknur Baldan Isik[1], Dogan Kaya[1,2], Ahmet Ekicibil[1] and Faruk Karadag[1]

[1]Department of Physics, Faculty of Art and Sciences, Cukurova University, Adana, Türkiye
[2]Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Cukurova University, Adana, Türkiye

[*]**Corresponding e-mail:** hasanhuseyinisik01@gmail.com

Cobalt ferrite ($CoFe_2O_4$) with a cubic spinel structure is favored in various applications due to its high permeability, excellent electrochemical stability, and remarkable electrical and optical properties [1, 2]. In this study, $CoFe_2O_4$ nanomaterial was synthesized using the sol-gel method. X-ray diffraction analysis indicated cubıc phase with a space group of fd-3m and average crystal size was found to be 51 nm, while scanning electron microscopy revealed an average particle size of 86 nm. The photocatalytic activity was evaluated through the degradation of methylene blue dye under UV light irradiation. The $CoFe_2O_4$ nanomaterial demonstrated outstanding photocatalytic efficiency, achieving 93.5% degradation within 3 hours. This superior performance is attributed to its unique magnetic spinel structure that promotes effective charge separation and suppresses electron-hole recombination. Moreover, the nanoscale size provides a high surface area for dye adsorption and reaction. These findings underscore the potential of $CoFe_2O_4$ nanomaterials as efficient photocatalysts for environmental remediation and wastewater treatment.

Acknowledgements: This work was financially supported by Cukurova University, Adana, Turkey, under Scientific Research Funding Grand No: FDK-2023-15837.

References

[1] B. Jeevanantham, Y. Song, H. Choe, M.K. Shobana, Structural and optical characteristics of cobalt ferrite nanoparticles, Materials Letters: X, 12 (2021) 100105.
[2] A.E. Elkholy, F. El-Taib Heakal, N.K. Allam, Nanostructured spinel manganese cobalt ferrite for high-performance supercapacitors, RSC Advances, 7 (2017) 51888-51895.

Influence of RF Power on Structural and Optical Properties of Nitrogen-Doped Ga_2O_3 Thin Films

Hicret Hopoğlu[1,2*] and Ebru Şenadım Tüzemen[1,2]

[1] *Sivas Cumhuriyet University, Department of Physics, Faculty of Science, Sivas, Turkey*
[2] *Sivas Cumhuriyet University, Nanophotonics Research and Application Center, Sivas, Turkey*

[*]**Corresponding e-mail:** akalan23@hotmail.com

In this study, 30% nitrogen-doped Ga_2O_3 thin films were grown on sapphire substrate by RF magnetron sputtering at 60 W, 90 W, and 120 W powers. Each sample was annealed at 850 °C in air for 1.5 h and then evaluated as unannealed. The films were characterized by transmittance, XRD, and FTIR analyses. The results show that RF power affects the film properties. The energy band gap decreased as RF power increased. The energy band gap varied between 5.23–4.80 eV in unannealed films and 4.96–4.84 eV in annealed films. XRD revealed that the crystal structure of the films changed with the annealing process. The chemical bond structure was investigated by FTIR analysis. As a result, the presence of nitrogen doping was detected[1].

This work was supported by the Scientific Research Project Fund of Sivas Cumhuriyet University, Turkey, under the project number F-2025-736.

References

[1] S. Mobtakeri Et Al. , "Gallium oxide films deposition by RF magnetron sputtering; a detailed analysis on the effects of deposition pressure and sputtering power and annealing," Ceramics International , vol.47, no.2, pp.1721-1727, 2021

Investigation of the Optical and Structural Properties of Si/Ga_2O_3 Thin Films

H. Hopoglu[1,2*] and E.S. Tüzemen[1,2]

[1] *Sivas Cumhuriyet University, Department of Physics, Faculty of Science, Sivas, Turkey*
[2] *Sivas Cumhuriyet University, Nanophotonics Research and Application Center, Sivas, Turkey*

[*] **Corresponding e-mail:** akalan23@hotmail.com

In this study, Ga_2O_3 (gallium oxide) thin films were deposited on Si (silicon) substrates using the RF magnetron sputtering method at powers of 60 W, 90 W, and 120 W. The obtained films were examined under both unannealed conditions and after annealing at 850 °C for 1.5 hours in air atmosphere. The optical properties of the films were investigated through reflectance measurements, and the optical band gap (Eg) values were determined using the Kubelka–Munk method [1]. In addition, Fourier Transform Infrared Spectroscopy (FTIR) analyses were carried out to evaluate the chemical bonding structure of the films. The FTIR spectra clearly revealed the characteristic peaks corresponding to Ga–O vibrations, as well as additional vibration peaks originating from the interaction with the Si substrate [2]. The results demonstrated that both RF power and annealing treatment play a critical role in determining the optical band gap and chemical bonding structure of Ga_2O_3 thin films. These findings indicate that Si-based Ga_2O_3 thin films are promising candidates for future applications in optoelectronics and UV photodetectors.

This work was supported by the Scientific Research Project Fund of Sivas Cumhuriyet University, Turkey, under the project number F-2025-736

References

[1] Mohammed, A. A. A., & Lim, W. F. Effects of implementing dual-step nitrogen ambient for growth and post-deposition annealing of Ga_2O_3 films sputtered on silicon. Journal of Materials Science: Materials in Electronics, 35(3), 1763–1776. (2024).

[2] Messeddek, L., Amraoui, F., Arab, L., & Sengouga, N. Effect of different substrates on the structural, morphological, electrical, and optical properties of β-Ga_2O_3 thin films deposited by the sol-gel spin coating method. Journal of Sol-Gel Science and Technology, 113(1), 159–168. (2025).

Effect of Absorption, Multiplication, and Grading Layers in Optimizing InGaAs Avalanche Photodetectors

D.H. Unal[1,2], M.N. Kocak[1,3], and I. Demir[1,4*]

[1]Sivas Cumhuriyet University Nanophotonics Application and Research Centre-CÜNAM, 58140 Sivas, Türkiye
[2] Department of Optical Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye
[3] Department of Metallurgy and Materials Science, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye
[4] Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye

[*]**Corresponding e-mail:** idemir@cumhuriyet.edu.tr

Avalanche photodiodes (APDs) offer high sensitivity, a wide dynamic range, and low noise due to their avalanche ionization-based amplification mechanism, providing superior performance compared to p-n and p-i-n photodetectors [1, 2]. The SAM, SAGM, and SAGCM structures, which were developed to enhance performance, facilitate carrier transport, reduce dark current and noise, and ensure stable gain [3].

This study investigated the effects of absorption, grading, and multiplication layer thickness, as well as doping concentration, on various electrical parameters in APD photodetectors using Silvaco TCAD simulations. Study A demonstrated that increasing the absorption layer thickness increases the breakdown voltage, thereby reducing the avalanche probability. Conversely, increasing the doping level decreases the breakdown voltage, thereby increasing the avalanche probability. Study B revealed that both increasing the multiplication layer thickness and the doping level raise the breakdown voltage and strengthen the avalanche probability. Additionally, increasing the thickness of the impact layer increases the fracture stress, while decreasing the doping level reduces it. Study C showed that increasing the thickness of the grading layer and the doping level increases both the fracture stress and the likelihood of avalanches.

In conclusion, the simulation results demonstrate that device performance in APD designs is directly determined by the thickness of the absorption, multiplication, and grading layers, and the doping levels. These parameters must therefore be considered critical in the design process.

References

[1] Wang, Binhao, and Jifang Mu. High-speed Si-Ge avalanche photodiodes. PhotoniX 3.1 (2022): 8.
[2] Miao, Yuanhao, et al. Review of Ge (GeSn) and InGaAs avalanche diodes operating in the SWIR spectral region. Nanomaterials 13.3 (2023): 606.
[3] Zhao, Yangyang, and Jun Chen. InGaAs/InP SAGCM avalanche photodiode with a heterojunction multiplication layer. Physica B: Condensed Matter 629 (2022): 413637.

Photoluminescence Characteristics of MOVPE-Grown InGaAs/InAlAs Quantum Heterostructures

I. Perkitel[1,2], G.Yolcu[1], D.H.Unal[1], and I. Demir[1,2*]

[1]*Sivas Cumhuriyet University Nanophotonics Application and Research Center-CÜNAM, 58140 Sivas, Türkiye*
[2] *Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye*

[*]**Corresponding e-mail:** idemir@cumhuriyet.edu.tr

InP-based InGaAs/InAlAs quantum heterostructures have attracted great interest for high-speed electronics and optoelectronic devices. Among their most promising applications are quantum cascade lasers (QCLs), which benefit from the large conduction band offset, strong electron confinement, and wide tunability of this material system. InP-based InGaAs/InAlAs QCLs cover a broad mid-infrared range (3.5–24 μm), enabling applications in optical communication, spectroscopy, environmental sensing, and military countermeasures [1, 2].

The development of high-performance optoelectronic devices fundamentally relies on the precision of the epitaxial growth process. In particular, QCL structures, which consist of hundreds of ultra-thin layer repetitions, are extremely sensitive to alloy composition and interface fluctuations; these factors strongly influence their optical response and overall device performance [3]. Consequently, achieving precise control and deeper understanding of their optical properties requires more comprehensive and systematic experimental investigations.

In this study, lattice-mismatched InGaAs/InAlAs quantum heterostructure samples were grown by MOVPE using different stabilization times. A detailed photoluminescence (PL) study will be carried out at various temperatures ranging from 10 K to 300 K and under different laser powers between 20% and 100%, in order to analyze the optical characterization of the samples and to evaluate their optical interband transitions. In addition, the optical interband transitions of InGaAs/InAlAs quantum heterostructures will be theoretically calculated to enable a direct comparison with the PL measurements.

Acknowledgments

The authors acknowledge the usage of the Sivas Cumhuriyet University Nanophotonics Application and Research Center-CÜNAM facilities. This work is based on the completed Master's thesis titled "Growth and Optical Characterization of Lattice-Mismatched ($x \neq 0.53$, $y \neq 0.52$) $In_xGa_{1-x}As/In_yAl_{1-y}As$ Quantum Heterostructures by MOVPE". Izel Perkitel is supported by the The Scientific and Technological Research Council of Turkey (TUBITAK) 2211/A Program. This study supported by The Scientific Research Project Fund of Sivas Cumhuriyet University, Turkey under the project number M-2022-841, and MRK-2024-004 and TUBITAK under the project number 22AG074.

References

[1] Faist, J., Capasso, F., Sivco, D. L., Sirtori, C., Hutchinson, A. L., & Cho, A. Y. (1994). Quantum cascade laser. Science, 264(5158), 553-556.

[2] Demir, I., & Elagoz, S. (2016). Interruption time effects on InGaAs/InAlAs superlattices of quantum cascade laser structures gown by MOCVD. Superlattices and Microstructures, 100, 723-729.

[3] Perkitel, I., & Demir, I. (2023). Effect of Si-doped and undoped inter-layer transition time on the strain-compensated InGaAs/InAlAs QCL active region grown with MOVPE. Journal of Molecular Structure, 1272, 134203.

Optimization of Si-Doped n-AlGaAs Growth by MOVPE

G. Yolcu[1,2], İ. Perkitel[2,3], and İ. Demir[2,3*]

[1] Department of Metallurgical and Materials Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye
[2] Sivas Cumhuriyet University Nanophotonics Research and Application Center-CÜNAM, 58140 Sivas, Türkiye
[3] Department of Nanotechnology Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye

***Corresponding e-mail:** idemir@cumhuriyet.edu.tr

$Al_xGa_{1-x}As$ based laser diodes are used in communications, industry, medicine, and imaging, so precise design and growth are essential. In these devices, n-type $Al_xGa_{1-x}As$ layers inject electrons and guide light; thus, the Al fraction and SiH_4 doping level must be co-optimized to control conductivity and optical loss. n- $Al_xGa_{1-x}As$ was epitaxially grown by MOVPE using TMAl, TMGa, and AsH_3 with SiH_4 as the donor; growth was monitored in situ by 880-nm optical reflectance. HRXRD provided the Al fraction and structural assessment; carrier densities were measured via Hall measurements and corroborated by ECV depth profiling.

By varying group-III/V flows, dopant flow, temperature, pressure, and using delta-doping we observed that when $x \geq 0.30$, the Hall measured electron density could not be increased beyond $5x10^{17}$ cm^{-3} even though ECV indicated more donors were present. This plateau arises because higher Al content makes donors harder to ionize (deeper levels), so fewer electrons become electrically active. In Si-doped $Al_xGa_{1-x}As$ there are shallow and deep donor centers; under UV illumination, ECV can probe deep levels that Hall does not capture [1,2]. High Al increases carbon carryover from TMAl (carbon acts as an acceptor), makes Si donors more likely to convert into DX centers, and facilitates oxygen incorporation that creates additional deep traps. Collectively, these effects raise defect and impurity levels, reduce mobility, and limit the achievable n-type conductivity [3]. Delta-doping improves donor incorporation but does not fully restore activation, so redesigning the Al profile and layer thicknesses is needed to balance optical confinement with electrically active doping.

Acknowledge

This work is based on results obtained during the ongoing Ph.D. thesis of Gamze YOLCU, titled "Development of GaAs-based pump laser diode structure (λ=88x nm)". Gamze YOLCU is supported by the YOK (Council of Higher Education) 100/2000 Ph.D. Scholarship Program and The Scientific and Technological Research Council of Turkey (TUBITAK) 2211/A Program. The authors acknowledge the usage of the Sivas Cumhuriyet University Nanophotonics Application and Research Center-CÜNAM facilities. This study supported by The Scientific Research Project Fund of Sivas Cumhuriyet University, Turkey under the Project number M-2023-857.

References

[1] Watanabe, Miyoko Oku, et al. "Donor levels in Si-doped AlGaAs grown by MBE." Japanese journal of applied physics 23.2A (1984): L103.

[2] Nanometrics. ECVPro: Electrochemical C-V Profiler User Manual. P/N: 9PROF-UM01 Rev. B.

[3] Pfeffer, T. L., et al. "The use of diethylsulphide for the doping of $Al_xGa_{1-x}As$ grown by chemical beam epitaxy." Journal of crystal growth 146.1-4 (1995): 399-403

Bandstructure and Material Engineering of InGaAs/InAlAs Quantum Cascade Lasers for Mid-IR Applications

Merve Nur Koçak[1,3], İzel Perkitel [1,2], and İsmail Altuntaş and İlkay Demir [1,2*]

[1]*Sivas Cumhuriyet University Nanophotonics Application and Research Center-CÜNAM, 58140 Sivas, Turkey*
[2] *Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University,58140 Sivas, Turkey*
[3] *Department of Metallurgy and Materials Science, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Turkey*

[*]**Corresponding e-mail:**idemir@cumhuriyet.edu.tr

Quantum cascade lasers (QCLs) represent a powerful class of semiconductor lasers for the mid-infrared (mid-IR) range, enabling compact, high-power, and spectrally selective sources for applications in defense, spectroscopy, sensing, and environmental monitoring. In particular, their capability to deliver high optical power in the mid-IR makes them indispensable for infrared countermeasure (IRCM) systems, where reliable and wavelength-selective laser emission is required to counter heat-seeking threats [1]. Among various material types, InGaAs/InAlAs on InP has emerged as the most widely adopted system, owing to its superior electron mobility, favorable band alignment, and strong carrier confinement [2,3]. These attributes make it particularly suitable for achieving high-performance QCL active regions with controlled tunneling rates and efficient transport, which are essential for stable mid-IR lasing.

In this work, we present a novel QCL active region design operating at 4.6 µm, realized in the InGaAs/InAlAs material system. The structure incorporates a two-phonon resonant depopulation scheme, which ensures efficient emptying of the lower laser level, thereby enhancing population inversion and optical gain under high injection conditions. Bandstructure and gain simulations demonstrate that the proposed design supports stable lasing at 4.6 µm, offering performance characteristics suitable for high-power IRCM systems as well as broader mid-IR applications.This study introduces a new active region structure that emphasizes the decisive role of bandstructure engineering and material optimization in advancing mid-IR QCLs. The results highlight the potential of two-phonon resonant schemes in developing compact, reliable, and high-power QCLs relevant for both scientific and applied mid-IR photonics.

Acknowledgments

This work is based on results obtained during the ongoing Ph.D. thesis of Merve Nur Koçak, titled "Development of Short- and Mid-Wavelength Quantum Cascade Lasers". Merve Nur Koçak is supported by the YÖK (Council of Higher Education) 100/2000 Ph.D. Scholarship Program and The Scientific and Technological Research Council of Turkey (TÜBİTAK) 2211/A Program. This study supported by The Scientific Research Project Fund of Sivas Cumhuriyet University, Turkey under the project number MRK-2024-004 and The Scientific and Technological Research Council of Turkey (TUBITAK) under the project number 22AG074.

References

[1] Razeghi, Manijeh. "Quantum cascade lasers ready for IRCM applications." Technologies for Optical Countermeasures IX. Vol. 8543. SPIE, 2012.

[2] I. Perkitel and I. Demir, Effect of Si-doped and undoped inter-layer transition time on the strain-compensated InGaAs/InAlAs QCL active region grown with MOVPE, Journal of Molecular Structure, 1272, 134203 (2023).

[3] M. N. Koçak and I. Demir, Superlattice Structure of Quantum Cascade Lasers: Structural and Morphological Effects of AsH_3 Flow, Cumhuriyet Science Journal, 46, 384-389 (2025).

Modified Polyol Route for Synthesis of PtCuNi Nanocatalysts with Excellent HER Activity Across pH Conditions

I. Baldan Isik[1*], H.H. Isik[1], F. Karadag[1], A. Ekicibil[1], D. Kaya[1,2]

[1]Department of Physics, Faculty of Art and Sciences, Cukurova University, Adana, Türkiye
[2]Department of of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Çukurova University Adana, Türkiye.

[*]**Corresponding e-mail:** ibaldan@cu.edu.tr

Ternary PtCuNi nanocatalysts with varying elemental compositions were synthesized via a one-step modified polyol approach, aiming to evaluate their performance in the hydrogen evolution reaction (HER) [1, 2]. Structural characterization using X-ray diffraction and Rietveld refinement confirmed the formation of a face-centered cubic structure (space group of Fm-3m), where higher Pt content led to an expansion in lattice constant up to 3.712 Å and a reduction in crystallite size to 1.59 ± 0.39 nm. Transmission electron microscopy revealed uniformly dispersed spherical nanoparticles ranging from 3 to 9 nm. Among all samples, the $Pt_{58}Cu_{15}Ni_{27}$ composition, with a mean particle diameter of 3.62 nm, demonstrated superior HER activity, showing the lowest Tafel slopes of 40 mV dec^{-1} in alkaline and 62 mV dec^{-1} in acidic media. Long-term electrochemical stability was confirmed by chronoamperometric measurements at -0.3 V vs. RHE in both environments. The remarkable HER performance is attributed to synergistic electronic effects, where charge transfer from Cu and Ni atoms to Pt enhances catalytic efficiency and facilitates water dissociation kinetics.

Acknowledgements

This work was financially supported by Cukurova University, Adana, Turkey, under Scientific Research Funding Grand No: FDK-2021-14176.

References

[1] Y. Jiang, X., Wu, Y. Yan, S., Luo, X., Li, J., Huang, H., Zhang, D., Yang, Coupling PtNi Ultrathin Nanowires with MXenes for Boosting Electrocatalytic Hydrogen Evolution in Both Acidic and Alkaline Solutions, Small, 15(12), 1805474 (2019).

[2] I. Baldan Isik, D., Kaya, A., Ekicibil, F. Karadag, One-pot synthesis of multifunctional ternary PtCuNi alloys: Magnetic properties and efficient hydrogen evolution reaction in alkaline media, Electrochim. Acta, 477, 143794 (2024).

Enhanced Visible-Light Photocatalytic Activity of La-Doped Cd$_{1-x}$Zn$_x$S Solid Solutions: Structural and Optical Characterization

İpek Balnan[1], Sabit Horoz[1,2]

[1] *Department of Engineering Fundamental Sciences, Faculty of Engineering and Natural Sciences, Sivas University of Science and Technology, Sivas, Turkey*

[2] *Nanophotonics Application and Research Center, Sivas Cumhuriyet University, 58140, Sivas, Turkey*

In this study, La-doped Cd$_{1-x}$Zn$_x$S ($0 \leq x \leq 1$) solid-solution photocatalysts were successfully synthesized and systematically characterized using X-ray diffraction (XRD), UV–Vis spectroscopy, and scanning electron microscopy (SEM). XRD analysis confirmed the formation of single-phase solid solutions and revealed structural modifications induced by La incorporation. UV–Vis spectra indicated that La doping effectively narrowed the band gap, thereby enhancing visible-light absorption. SEM observations showed homogeneous particle morphologies with improved surface texturing, which contributed to better charge separation and active site availability.

The photocatalytic performance was evaluated through the degradation of Congo Red (CR) dye under visible-light irradiation. The results demonstrated that the optimum Zn substitution ratio was x = 0.5, achieving ~96% degradation after 60 minutes. Moreover, La doping further enhanced the photocatalytic efficiency, with 6% La-doped Cd$_{0.5}$Zn$_{0.5}$S reaching a maximum removal rate of 99%. The improvement is attributed to band structure tuning, enhanced light harvesting, and suppression of electron–hole recombination.

Overall, these findings highlight that La incorporation into CdZnS solid solutions represents an effective strategy to boost photocatalytic activity, offering promising potential for wastewater treatment and environmental remediation applications.

Keywords: Cd$_{1-x}$Zn$_x$S solid solution, La doping, photocatalysis, Congo Red degradation

Fast and selective polymer membrane potentiometric sensors based on 5-arylidene rhodanine derivatives for the determination of Nd(III) ions

I. M. Eski[1,*], O. N. Aslan[2], O. C. Altunoluk[3], O. Özbek[1], E. Kalay[4]

[1]Tokat Gaziosmanpaşa University, Faculty of Science and Arts, Department of Molecular Biology and Genetics, 60250 Tokat, Türkiye
[2]Atatürk University, Eastern Anatolia High Technology Application and Research Center, Erzurum 25240, Türkiye
[3]Tokat Gaziosmanpaşa University, Faculty of Science and Arts, Department of Chemistry, 60250 Tokat, Türkiye
[4]Kafkas University, Kars Vocational School, Department of Material and Material Processing Technologies, 36100 Kars, Türkiye

[*]**Corresponding e-mail:** isaamerteski@gmail.com

Potentiometric methods, one of the electrochemical analysis techniques, offer unique advantages such as a wide concentration range, low cost, low detection limit, high selectivity, high sensitivity, simple preparation, and ease of use [1]. Ionophores, which are included in potentiometric ion-selective sensors and can interact directly with the analyte ion, are the most important sensor components [2]. Studies in the literature have demonstrated that molecules containing different functional groups that facilitate complexation with metals possess ionophore properties [3]. In this study, we investigated the synthesis, characterization, and usability of two new molecules derived from 5-arylidene rhodanine as sensor materials. For this purpose, the newly synthesized 5-arylidene rhodanine derivative molecules were characterized by various spectroscopic methods, and then polymer membrane potentiometric sensors were prepared using these novel molecules. Our results indicate that the newly developed 5-arylidene rhodanine based sensors have a wide concentration range, low detection limit, good selectivity, good reproducibility, low cost, and easy producibility. The sensors prepared in this study were able to detect Nd^{3+} ions in various samples with high recoveries.

References

[1] O. C. Altunoluk, O. Özbek, H. Akbas, Ö. Isildak, Highly selective potentiometric detection of arsenate ions based on newly synthesized protic alkanolammonium ionic liquid, Microchem. J. 213, 113784 (2025).

[2] E. Kalay, O. Özbek, M. Elik, C. Berkel, O. N. Aslan, The synthesis, sensor and biological properties of two novel rhodanine derivative molecules. J. Indian Chem. Soc, 102, 101591 (2025).

[3] M. E. Cakmak, O. Özbek, K. Berkil Akar, M. B. Gürdere, Selective and fast potentiometric sensors based on thiosemicarbazone with low detection limit for the determination of Cu^{2+} ions, Microchem. J. 209, 112894 (2025).

Layered V/III Ratio Optimization for Sandwich-Structured AlN/PSS Films

F. K. Özbakır [1,2] and İ. Altuntaş[1,2*]

[1]Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University, Sivas, Türkiye
[2] Sivas Cumhuriyet University Nanophotonic Application and Research Center, Sivas Cumhuriyet University, Sivas, Türkiye

[*]**Corresponding e-mail:** ialtuntas@cumhuriyet.edu.tr

This study examines the impact of layer-by-layer V/III ratio optimization on the growth behavior and quality of aluminum nitride (AlN) films deposited on patterned sapphire substrates (PSS). To achieve improved crystalline and surface properties, a sandwich growth strategy was employed by alternating low and high ammonia flow conditions. Three types of samples were prepared for comparison. Sample A, grown as a single layer with a low V/III ratio, successfully retained the underlying substrate pattern but showed considerable structural irregularities, primarily due to the restriction of vertical growth. Sample B, designed as a two-layer structure beginning with a low V/III ratio followed by a high one, achieved the best crystalline quality, as evidenced by the narrowest full width at half maximum (FWHM) values in rocking curve analyses. In contrast, Sample C, despite its sandwich configuration, displayed poorer morphological features. The initiation of growth under low ammonia flow resulted in insufficient crystalline alignment and rougher surface boundaries [1]. Optical reflectance measurements indicated no meaningful shifts in band edge positions, confirming that all samples possessed nearly identical bandgap energies. Nevertheless, Sample C exhibited slightly enhanced ultraviolet scattering, which was attributed to its less uniform surface morphology. The findings demonstrate that appropriate sequencing of the V/III ratio, particularly in terms of layer order and interface stability, plays a decisive role in achieving superior crystalline and morphological characteristics in AlN/PSS heterostructures. This approach provides an effective route to optimize AlN film growth for future optoelectronic and ultraviolet device applications.

References

[1] Demir, I., Li, H., Robin, Y., McClintock, R., Elagoz, S., & Razeghi, M. (2018). Sandwich method to grow high quality AlN by MOCVD. Journal of Physics D: Applied Physics, 51(8), 085104.

Optimizing Ammonia Flow to Achieve High Structural and Optical Quality in AlN Thin Films on Patterned Sapphire Substrates

F. K. Özbakır [1,2] and İ. Altuntaş[1,2*]

[1]*Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University, Sivas, Türkiye*
[2] *Sivas Cumhuriyet University Nanophotonic Application and Research Center, Sivas Cumhuriyet University, Sivas, Türkiye*

***Corresponding e-mail:** ialtuntas@cumhuriyet.edu.tr

Aluminum nitride (AlN) thin films, which hold significant potential for applications in the ultraviolet (UV) spectral region, were grown on patterned sapphire substrates (PSS) using different V/III ratios by metal-organic chemical vapor deposition (MOCVD). This method was selected due to its advantages, such as surface uniformity, high growth rate, and the ability to grow multilayer structures. In this study, the effects of varying V/III ratios on the structural quality, optical characteristics, and growth behavior of AlN films were systematically investigated. Ammonia flow rates were set at 590 sccm for the low V/III ratio and 1180 sccm for the high V/III ratio.

The structural and morphological properties of the films were analyzed using high-resolution X-ray diffraction (HR-XRD) and scanning electron microscopy (SEM), while optical reflectance across the UV–Vis–NIR region was measured to assess optical performance and surface uniformity. The results demonstrated that films grown with a high V/III ratio exhibited narrower full width at half maximum (FWHM) values in HR-XRD, indicating improved crystalline quality. These samples also showed higher total and diffuse reflectance, smoother surface morphology, and enhanced optical performance. In contrast, films grown with a low V/III ratio displayed more pronounced lateral growth, which increased surface roughness and decreased both structural and optical quality.

Furthermore, in multilayer structures, initiating the growth with a high V/III ratio facilitated the formation of larger and more uniform nucleation islands, leading to more stable and higher-quality crystal growth. These findings underscore the critical role of controlling the V/III ratio in achieving high-quality AlN thin films, particularly for advanced optoelectronic applications requiring precise material properties [1].

References

[1] Wang, T. Y., Liang, J. H., Fu, G. W., & Wuu, D. S. (2016). Defect annihilation mechanism of AlN buffer structures with alternating high and low V/III ratios grown by MOCVD. CrystEngComm, 18(47), 9152-9159.

Development of High-Quality CTS Thin Films on Flexible Mo-Foil Through Two-Stage Processing

M. Çam[1*], Y. Atasoy[2], R. Zan[1] and **M.A. Olgar**[1*]

[1]*Department of Physics, Niğde Ömer Halisdemir University, Niğde, Türkiye*
[2]*Niğde Zübeyde Hanım Vocational School of Health Services, Niğde Ömer Halisdemir University, Niğde, Türkiye*

[*]**Corresponding e-mail:** mehmetaliolgar@ohu.edu.tr

Cu_2SnS_3 (CTS) is a promising p-type semiconductor material for thin film photovoltaic and optoelectronic applications due to its earth-abundant, non-toxic constituents, suitable band gap (~0.9–1.6 eV), and high absorption coefficient ($>10^4$ cm^{-1}) [1]. However, challenges such as secondary phase formation, non-stoichiometry, and Sn volatility during high-temperature processing limit its device performance. Therefore, controlling sulfurization conditions is critical for achieving phase-pure, high-quality CTS films. In this study, we aim to produce high-quality CTS thin films by optimizing sulfurization parameters using an alternative approach. Unlike conventional studies that employ tube furnaces with slow heating rates (~25 °C/min), this work utilizes Rapid Thermal Processing (RTP) to achieve rapid heating and controlled sulfurization. The influence of heating rates of 0.25-1.0 °C/s on the structural and morphological properties of CTS films will be systematically investigated. In the second phase, short sulfurization durations of 1-90 seconds will be applied in the RTP system to minimize Sn loss and suppress secondary phase formation, aiming to obtain phase-pure monoclinic CTS films. This work demonstrates a pathway to tailor CTS thin films through precise control of heating rates and sulfurization durations, offering valuable insights for developing stable and efficient CTS-based solar absorbers.

Acknowledgement

The authors gratefully acknowledge the financial support of the Scientific and Technological Research Council of Türkiye (TÜBİTAK) under project grant 122F217.

References

[1] He et al., Influence of Sulfurization Temperature on Photovoltaic Properties of Ge Alloyed Cu2SnS3 (CTGS) Thin Film Solar Cells, Solar Energy Materials and Solar Cells. 174, 94-101 (2018).

The Electrical and Magnetic Properties of Sodium and Large-Scale Nano-Sized Europium Co-Substituted Bi,Pb-2223 Superconducting Materials

Mehmet Ersin AYTEKİN[1*], Mustafa AKYOL[2]

[1] *Department of Electronics and Automation, Vocational School of Technical Sciences at Mersin Tarsus Organized Industrial Zone, Mersin, Türkiye*
[2] *Department of Materials Science and Engineering, Faculty of Engineering, Adana Alparslan Türkeş Science and Technology University, Adana, Türkiye*

*__Corresponding e-mail:__ mehmetaytekin@tarsus.edu.tr

In our previous study, low nano-sized europium substitution to the strontium sites and sodium substitution of 0.2 ratio to the copper sites were carried out in the Bi,Pb-2223 superconductor system. Enhancing the morphological structure, phase formations, and flux pinning characteristics of nano-sized evopium particles at a ratio of x = 0.1 was shown to improve their electrical and magnetic properties [1].

In this study, the effect of sodium and different amount nano-sized europium substituting in Bi,Pb-2223 superconductor system was investigated. Ceramic superconductor materials were produced using the solid-state reaction method, with an initial composition of $Bi_{1.7}Pb_{0.3}Sr_2Ca_2Cu_{2.75}Na_{0.25}O_y$ and doping ratios of x = 0, 0.2, 0.25 and 0.3. Scanning electron microscopy (SEM), X-ray diffraction (XRD), resistivity-temperature measurements, and magnetization measurements were used to characterize the morphological, phase formation, electrical, and magnetic characteristics. In X-ray diffraction measurements, the formation of some impurity phases, as well as the Bi-2223 high temperature phase and Bi-2212 low temperature superconducting phases, are observed in all samples. Although changes to the Bi-2223 phase structure are observed with increasing substitution of europium substituting at the nano-sized, the main phase structure in all samples is the Bi-2223 phase. Microstructure analysis of the samples, performed using a scanning electron microscope (SEM), revealed the presence of plate-like grains, indicating the formation of both B-2212 and Bi-2223 grain structures. In the electrical measurement results, metallic behavior was observed on the onset temperature value up to a contribution ratio of x>30, and superconductivity behavior was exhibited. M-H measurements were performed to characterize the magnetic properties of the samples. In M-H measurements, while the hysteresis behavior, which is a characteristic feature of Bi-2223 superconductors, occurs in a regular geometry in the sample without europium at nano-sized, the hysteresis behavior weakens with increasing substituting, indicating that the magnetic properties deteriorate. The best results in terms of electrical properties were observed in the sample containing europium substituting at x = 0.20

References

[1] M.E., Aytekin and M. Akyol. Modification of Magnetic and Electrical Properties of Bi,Pb-2223 Superconductors by Nano-Sized Eu Substitution. J Supercond Nov Magn 38, 156 (2025)

Analysis of the magnetocaloric properties of $La_{0.7}Ca_{0.1}Ba_{0.2}MnO_3$ perovskite

M.S. Aslan[1*], G. Akca[1], S. Kılıc Cetin[1] and A. Ekicibil[1]

[1]*Cukurova University, Faculty of Arts and Sciences, Physics Department, Adana, Turkey*

***Corresponding e-mail:** mehmetselimaslan34@gmail.com

The principle of magnetic cooling technology is the magnetocaloric effect (MCE), where a material undergoes a reversible temperature change when subjected to an adiabatic change in the magnetic field [1]. They have attracted great interest due to their interesting physical properties such as the colossal magnetoresistance effect and MCE in the last two decades [2]. In this study, the structural, magnetic and magnetocaloric properties of $La_{0.7}Ca_{0.1}Ba_{0.2}MnO_3$ manganite were investigated. Sol-gel method was used during the production of the material, and X-Ray Diffraction (XRD), Scanning Electron Microscope (SEM) and Energy Dispersive X-Ray Spectrometer (EDS) measurements were carried out to examine the crystal structures and surface morphologies. From XRD measurements, it was determined that the crystal structure of $La_{0.7}Ca_{0.1}Ba_{0.2}MnO_3$ manganite is hexagonal. Atomic percentage values were determined from the EDS analysis for each compound. Temperature dependent magnetization measurements were carried out to determine the Curie temperature (T_C). As a result of the measurements, the T_C value of $La_{0.7}Ca_{0.1}Ba_{0.2}MnO_3$ manganite was determined as 306 K. The maximum magnetic entropy change value of the sample was determined as 4.66 $Jkg^{-1}K^{-1}$ in an applied magnetic field of 5T.

This work is supported by the Cukurova University Scientific Research Projects under grant contract no: FDK-2021-13983

References

[1] E. Brück, Developments in magnetocaloric refrigeration, Journal of Physics D: Applied Physics, 38 R381-R391 (2005).

[2] A.M. Tishin, Chapter 4 Magnetocaloric effect in the vicinity of phase transitions, in: Handbook of Magnetic Materials, Elsevier, pp. 395-524 (1999).

Biocorrosion Behaviour of Laser Beam Welded AISI 2205 Duplex Stainless Steel in Simulated Body Fluid

C. Köse[1], **M. Gündüz[2,*]**, H. B. Mutu[1], E. İlhan[3], O. Gündüz[3,4], and S. Durdu[5,6]

[1]*Department of Mechanical Engineering, Faculty of Engineering and Architecture, Tokat Gaziosmanpaşa University, Tokat, Türkiye*
[2]*Department of Mechanical Engineering, Graduate Education Institute, Tokat Gaziosmanpaşa University, Tokat, Türkiye*
[3]*Center for Nonotechnologyand Biomaterials Application and Research (NBUAM), Marmara University, Istanbul, Türkiye*
[4]*Department of Metallurgical and Materials Engineering, Faculty of Technology, Marmara University, Istanbul, Türkiye*
[5]*The department of Industrial Engineering, Engineering Faculty, Giresun University, Giresun, Türkiye*
[6]*The department of Genetics and Bioengineering, Engineering Faculty, Giresun, Giresun University, Türkiye*

***Corresponding e-mail:** mervegunduzz.mg@gmail.com

In stainless steel bioimplant material selection, mechanical properties, biocorrosion resistance, biocompatibility, and surface hydrophilicity are important criteria [1]. An increase in the austenite phase in the microstructure increases the material's resistance to corrosive environments [2]. Laser welded is known to minimize changes in the microstructure of the heat-affected zone and contribute to increased biocorrosion resistance [3]. High laser energy also affects surface hydrophilicity [4]. In this study, the microstructure, contact angle, and biocorrosion behavior of the base metal and laser-welded samples were investigated. The volume percentages of the δ-ferrite and γ-austenite phases in the microstructures of the samples were analyzed. The base material contained 53% ferrite and 47% austenite, while the ferrite and austenite ratios in the welded sample were 86% and 14%, respectively. Contact angle measurements revealed that the laser-welded 2205 duplex stainless steel and the base material had a hydrophilic surface. As a result of electrochemical corrosion tests carried out in a simulated body fluid (SBF) environment, the corrosion rates of the base material and the laser-welded sample were determined as 0.0072 and 0.0110 mm/year, respectively. The high austenite content in the microstructure of the base material and the greater contact angle compared to the laser-welded sample are consistent with the low corrosion rate.

Keywords: Duplex Stainless Steel, Laser Welding, Microstructure, Contact Angle, Biocorrosion

References

[1] Murr, L. E. (2019). Strategies for creating living, additively manufactured, open-cellular metal and alloy implants by promoting osseointegration, osteoinduction and vascularization: An overview. *Journal of Materials Science & Technology*, 35(2), 231-241. https://doi.org/10.1016/j.jmst.2018.09.003

[2] Zhang, Y., Wu, S., & Cheng, F. (2022). A specially-designed super duplex stainless steel with balanced ferrite: austenite ratio fabricated via flux-cored wire arc additive manufacturing: Microstructure evolution, mechanical properties and corrosion resistance. *Materials Science and Engineering: A,* 854, 143809. https://doi.org/10.1016/j.msea.2022.143809

[3] C. Köse Effect of post-weld heat treatment on microstructure, crystallography, and mechanical properties of laser beam welded AISI 904L super austenitic stainless steel. *Eng. Fail. Anal.*, 158 (2024), https://doi.org/10.1016/j.engfailanal.2024.108025

[4] Dong, J., Liu, Y. & Pacella, M. (2024). Surface Texturing and Wettability Modification by Nanosecond Pulse Laser Ablation of Stainless Steels. Coatings, 14(4), 467. https://doi.org/10.3390/coatings14040467

Biocompatibility Properties and Bacterial Attachment of Laser Beam Welded AISI 2205 Duplex Stainless Steel

C. Köse[1], **M. Gündüz[2]**, H. B. Mutu[1], E. İlhan[3], O. Gündüz[3,4,*], and S. Durdu[5,6]

[1]Department of Mechanical Engineering, Faculty of Engineering and Architecture, Tokat Gaziosmanpaşa University, Tokat, Türkiye
[2]Department of Mechanical Engineering, Graduate Education Institute, Tokat Gaziosmanpaşa University, Tokat, Türkiye
[3]Center for Nonotechnologyand Biomaterials Application and Research (NBUAM), Marmara University, Istanbul, Türkiye
[4]Department of Metallurgical and Materials Engineering, Faculty of Technology, Marmara University, Istanbul, Türkiye
[5]The department of Industrial Engineering, Engineering Faculty, Giresun University, Giresun, Türkiye
[6]The department of Genetics and Bioengineering, Engineering Faculty, Giresun, Giresun University, Türkiye

[*]**Corresponding e-mail:** mervegunduzz.mg@gmail.com

Stainless steels are widely used engineering materials in bioimplant production due to their low cost, easy availability, and high magnetic stent-grafts [1,2]. The laser welding process reduces metal ion transfer from the surface of the duplex stainless steel material and increases biocompatibility [3]. In this study, in vitro biocompatibility analysis of the base material and laser-welded 2205 duplex stainless steel was performed using the MTT method on the human fetal osteoblast hFOB cell line. Results of biocompatibility. While austenitic stainless steels are generally preferred for bioimplant production, recent studies indicate that duplex stainless steels are more advantageous due to their high biocompatibility and biocorrosion resistance. Studies have shown that duplex stainless steels can be used in the production of orthodontic wires and obtained on days 7, 14, 21, and 28 of incubation, indicating that cell viability was acceptable in both the base material and the welded sample. Additionally, metals released from the base material and the laser-welded sample into the hFOB medium were measured by ICP-MS, and the effect of the welding process on the release of Cr, Fe, Ni, Mn, and Mo was investigated. The amount of Escherichia coli that could adhere to the samples was examined, and it was determined that laser welding affected bacterial adhesion. The increase in bacterial adhesion is thought to be due to surface roughness in the welding area.

Keywords: 2205 Duplex Stainless Steel, Laser Welding, Human fetal osteoblast cell line, *Escherichia coli*

References

[1] Murr, L. E. (2019). Strategies for creating living, additively manufactured, open-cellular metal and alloy implants by promoting osseointegration, osteoinduction and vascularization: An overview. Journal of Materials Science & Technology, 35(2), 231-241. https://doi.org/10.1016/j.jmst.2018.09.003
[2] Tefft, B. J., Uthamaraj, S., Harburn, J. J., Hlinomaz, O., Lerman, A., Dragomir-Daescu, D., & Sandhu, G. S. (2017). Magnetizable stent-grafts enable endothelial cell capture. Journal of magnetism and magnetic materials, 427, 100-104. https://doi.org/10.1016/j.jmmm.2016.11.007
[3] Köse, C., Kaçar, R., Zorba, A.P., Bağırova, M. & Allahverdiyev, A.M. (2016). The effect of CO_2 laser beam welded AISI 316L austenitic stainless steel on the viability of fibroblast cells, in vitro. Materials Science and Engineering C, 60, 211–218. https://doi.org/10.1016/j.msec.2015.11.035

Electron and Hole Mobilities of Monolayer ZrS_2: ab initio Calculation

B. Özdemir[1], N.T. Yıldız[2], H.C. Çekil[1], M. A. Sabaner[2], Ü. Dömekeli[2], F. İşık[2], S. Şengül[2], **M. Özdemir[1]**

[1]Department of Physics, Faculty of Arts and Sciences, Çukurova University, 01330 Adana
[2]Department of Physics, Faculty of Sciences, Trakya University, 22100 Edirne

[*]**Corresponding e-mail:** metoz@cu.edu.tr

Two-dimensional (2D) material-based structures are attracting growing attention due to their remarkable properties and strong potential for optoelectronic and sensor applications among others [1]. Monolayer zirconium disulfide (ZrS_2), a two dimensional transition metal dichalcogenide, is a semiconducting material with an indirect band gap [2]. The crystal structure, energy band dispersion and phonon frequency spectrum of ZrS2 are studied with first principles calculations. Electron and hole scattering rates are obtained as a function of energy and are resolved with respect individual phonon oscillation modes. Only intrinsic phonon scatterings are considered, ionic scatterings and substrate and polarization effects are neglected. Carrier mobilities are then obtained through the solution of Boltzmann Transport Equation (BTE) for a wide range of temperatures (100-500 K). The room temperature mobilities of both electrons and holes are found to be relatively low which might be attributed to large and strongly anisotropic effective masses.

References

[1] S. Manzeli, D. Ovchinnikov, D. Pasquier, *et al.*, 2D transition metal dichalcogenides. *Nat Rev Mater* **2**, 17033 (2017). https://doi.org/10.1038/natrevmats.2017.33

[2] A. Nandhakumar, S. Subashchandrabose, P.L. Silvestrelli, *et al.*, A review of zirconium disulfide: Structural characterization, properties, applications, and prospects of dichalcogenide materials, Solid State Communications, 404 (2025).

Analysis of Experimental Data of Schottky Diode Characteristics in Wide Temperature Range Using Artificial Neural Network Modeling

M. Koç[1*], N. Yıldırım[2], M. Göndük[3], S. Koçkanat[4], H. Doğan[5]

[1] Sivas Cumhuriyet University, Electrical and Electronics Engineering Department, Sivas, Turkey
[2] Bingöl University, Institute of Science, Department of Physics, 12000, Bingöl, Türkiye,
[3] Bingöl University, Institute of Science, Department of Physics, 12000, Bingöl, Türkiye,
[4] Sivas Cumhuriyet University, Electrical and Electronics Engineering Department, Sivas, Turkey
[5] Sivas Cumhuriyet University, Electrical and Electronics Engineering Department, Sivas, Turkey

***Corresponding e-mail:** mevludekoc58@outlook.com

In this study, Artificial Neural Network Modeling, which is a common machine learning method, was used to model the I-V characteristics of the unannealed Au/n-Si/Al Schottky diode. Experimental current values for the diode terminal of a previously produced Au/n-Si/Al Schottky diode, where the temperature was applied from 60 K to 400 K in 20 K steps, were measured for the unannealed Schottky diode. Models were created using the Artificial Neural Network technique using experimental data comprising a total of 1800 samples. The voltage value was varied from -1 V to +1 V for each temperature. Modeling performance was evaluated depending on the number of neurons in the hidden layer, ranging from 5 to 30 neurons, and the optimum number of neurons was obtained for the unannealed ANN. Minimum Mean Square Error (MSE), Root Mean Square Error (RMSE), and Mean Absolute Error (MAE) index values for the unannealed Schottky diodes were obtained with 25 neurons for both training and testing stages. The results obtained from the ANN were found to be in good agreement with the experimental data of the unannealed Schottky diode. Therefore, it is proposed as a powerful tool for modeling I–V characteristics at all temperature values between 60K and 400K.

References

[1] H. Doğan ve ark.Au/Ni/n-GaN/katkılanmamış GaN yapılarının kapasitans-iletkenlik-frekans özellikleriFizik B Yoğunlaşır. Madde(2015)

[2] T. Güzel ve ark. Sıcaklık ve voltaja dayalı polimer arayüz Schottky diyotunun akım değerlerini tahmin etmeye yönelik yapay zeka yaklaşımı: deneysel bir çalışmaSüper kafes. Mikrost.(2021)

The optical, structural, and morphological properties of SnS/ITO thin film obtained by chemical bath deposition

Mohamed El Moustapha Abd Dayem[1*], Sevda İldan Özmen[2,3], Hülya Metin Gübür[1]

[1]*Department of Physics, Mersin University, Mersin, Türkiye*

[2]*Advanced Technology Education Research and Application Centre, Mersin University, Mersin, Türkiye*

[3]*Technical Science Vocational School, Department of Chemistry and Chemical Processing Technologies, Mersin, Türkiye*

***Corresponding e-mail:** moustap790@gmail.com

This study aims to synthesize and characterize tin sulfide (SnS) thin films on indium tin Oxide (ITO) substrates using the chemical bath deposition (CBD) method. ITO is widely used in photovoltaic and optoelectronic applications due to its excellent electrical conductivity and optical transparency. SnS, a non-toxic and earth-abundant semiconductor with a suitable band gap (~1.3–1.5 eV), is considered a promising absorber material for thin-film solar cells.

This research investigates the effects of deposition parameters and post-deposition annealing on the structural, optical, and electrical properties of SnS films on ITO. Characterization techniques include X-ray diffraction (XRD), scanning electron microscopy (SEM), UV–Vis spectrophotometry, and Hall-effect measurements. XRD analysis revealed that annealing enhanced the crystallinity of the films, increasing the average crystallite size and reducing the lattice strain. SEM analysis showed that the as-deposited SnS thin films consist of nanoparticles; after annealing at 200 °C, the nanowalls start to form between the nanoparticles, and at 400 °C, the structure is completely transformed into interconnected nanowalls. It was seen by the UV-vis measurements that as a result of annealing, the optical band gap increased from 1.73 eV to 1.78 eV. Hall measurement results indicate that the as-deposited and 200 °C-annealed SnS films exhibit n-type conductivity, whereas the SnS film annealed at 400 °C has transformed into a p-type conductor.

Keywords: SnS, chemical bath deposition, optical properties, structural properties, Hall-affect, photovoltaic.

Acknowledgments: This study was supported by the Research Fund of Mersin University in Turkey with Project Number 2025-TP2-5284.

References

[1] Chowdhury, M. I., Rahman, K. S., Alghamdi, S., & Alam, M. M. (2016). Synthesis and characterization of SnS thin films by chemical bath deposition for photovoltaic application. Materials Science in Semiconductor Processing, 56, 49–54. https://doi.org/10.1016/j.mssp.2016.07.024

[2] Mahapatra, A., Paramanik, D., & Mohapatra, S. (2015). Optical and structural properties of SnS thin films prepared by chemical bath deposition. Applied Surface Science, 353, 492–500. https://doi.org/10.1016/j.apsusc.2015.06.096

A highly selective potentiometric sensor for the rapid and reliable detection of etodolac

O. Özbek and **M. Elik***

Tokat Gaziosmanpaşa University, Faculty of Science and Arts, Department of Molecular Biology and Genetics, 60250 Tokat, Türkiye

***Corresponding e-mail:** elikmuhammed60@gmail.com

Etodolac, an indole derivative non-steroidal anti-inflammatory drugs, is used in the treatment of rheumatoid arthritis, acute gouty arthritis, osteoarthritis and acute musculoskeletal pain [1]. Etodolac exhibits anti-inflammatory, analgesic and antipyretic properties. Different analytical methods such as HPLC, LC-MS/MS, GC and spectrophotometric methods have been proposed for the determination of etodolac in various pharmaceutical and biological samples [2, 3]. However, these analytical methods are not particularly suitable for on–site analysis, not easy to use, time-consuming, costly, and require experienced lab personnel and a well–equipped laboratory setting [4]. Therefore, potentiometric methods come to the fore with their versatile advantages in the analysis of different drug samples. Potentiometric devices have particular advantages including low cost, easy use, low limit of detection, short response time, low–energy consumption, wide concentration range, good selectivity and repeatability [5]. In this study, a potentiometric sensor was developed for the determination of etodolac in pharmaceutical samples. For this purpose, the etodolac–phosphotungstic acid ion pair was synthesized. Then, polymer membrane sensors were prepared using the synthesized ion pair as the ionophore. The prepared etodolac selective sensors had a low detection limit and good reproducibility in a wide concentration range. At the same time, the developed sensor had good selectivity, good reproducibility and short response time. Finally, the produced drug sensors were applied in pharmaceutical samples containing etodolac, and high recoveries were obtained.

Acknowledgments: This work was supported by the Tokat Gaziosmanpaşa University, Scientific Research Projects Commission (Project Number: 2024/51).

References

[1] S. Lynch and R. N. Brogden, Etodolac: a preliminary review of its pharmacodynamic activity andtherapeutic use. Drugs, 31, 288-300 (1986).

[2] M. I. Helmy, S. S. Saad, M. A. Hegazy, A. S. Fayed, Sensitive and selective LC-MS/MS for thedetermination of tolperisone and etodolac in human plasma and application to a pharmacokinetic study. J. Sep. Sci. 45, 1646-1655 (2022).

[3] S. Siddiraju, V. Boga, HPLC method development and validation for rapid estimation of Etodolacrelated impurity-H in pharmaceutical dosage form. Pharm. Methods 4, 52-55 (2013).

[4] O. Özbek, O. C. Altunoluk, Potentiometric determination of the local anesthetic procaine in pharmaceutical samples. Anal. Biochem, 695, 115657 (2024).

[5] E. Kalay, O. Özbek, M. Elik, C. Berkel, O. N. Aslan, The synthesis, sensor and biological properties of two novel rhodanine derivative molecules. J. Indian Chem. Soc, 102, 101591 (2025).

Analysis of Current-Voltage and Capacitance-Voltage Characteristics in Inhomogeneous *n*-Si/Mo Schottky Diodes

S.Tokmanav[1*], H. Doğan[1]

[1]*Sivas Cumhuriyet University, Faculty of Engineering, Department of Electrical and Electronics Engineering, Sivas, Türkiye*

[*]**Corresponding e-mail:** tokmanavseda@gmail.com

In this study, *n*-Si/Mo metal-semiconductor contact was obtained by sputtering using the DC sputtering method. The characteristic parameters of the *n*-Si/Mo Schottky diode were calculated using the current-voltage (I-V) and capacitance-voltage (C-V) measurements. Using thermionic emission theory, the barrier height (Φ_{b0}) and ideality factor (n) of the diode were calculated as 1.88 and 0.771 eV, respectively. It was observed that the obtained I-V curves deviated from linearity under forward voltage. The series resistance was calculated and compared using Cheung and Norde functions. The barrier height (Φ_{b0}) and doping density (N_d) values were also determined from the (C-V) measurements of the diode in the 1 kHz-1 MHz frequency range. The (Φ_{b0}) values obtained from (I-V) and (C-V) measurements were compared. The differences in the barrier height values obtained from both methods were attributed to the inhomogeneity of the barrier height and the differences between the I-V and (C-V) methods. These differences clearly demonstrate that electron transport at the metal-semiconductor interface is significantly affected by low-barrier regions (patches). It was concluded that when the experimental data are described by thermionic emission theory of inhomogeneous Schottky contacts, both the experimental forward and reverse I-V characteristics and the difference between the experimental *(I-V)* and *(C-V)* barrier height values must be taken into account.

Fabrication of potentiometric sensors based on newly synthesized rhodanine derivatives for the direct determination of copper(II) ions in environmental samples

O. C. Altunoluk[1,*], O. Özbek[2], E. Kalay[3], C. Berkel[2] and Ö. Isildak[1]

[1]*Tokat Gaziosmanpaşa University, Faculty of Science and Arts, Department of Chemistry, 60250 Tokat, Türkiye*
[2]*Tokat Gaziosmanpaşa University, Faculty of Science and Arts, Department of Molecular Biology and Genetics, 60250 Tokat, Türkiye*
[3]*Kafkas University, Kars Vocational School, Department of Material and Material Processing Technologies, 36100 Kars, Türkiye*

[*]**Corresponding e-mail:** altunolukonurcem@gmail.com

Rhodanine is a five–membered ring compound containing heteroatoms such as sulfur and nitrogen, and rhodanine derivative compounds have found important applications especially in photochemistry, medicinal chemistry, biochemistry and industry [1]. Thanks to the –NH group in the structure of rhodanine compounds, they can form hydrophobic interactions, hydrogen bonds and complexes with metal ions. This interaction with metals makes it possible to use them as ionophore, especially in potentiometric sensors. Recently, we have extensively investigated the ionophore properties of rhodanine derivative compounds. Potentiometric ion-selective sensors offer significant advantages over known analytical techniques due to their properties such as wide linear working range, very short response time, low energy consumption, low detection limit, low cost, ease of preparation, high sensitivity and high selectivity against various ionic species [2, 3]. In this study, we synthesized new rhodanine derivative molecules and investigated their use as ionophores in the design of ion–selective potentiometric sensors. The prepared sensors exhibited very high selectivity towards copper(II) ions. The developed copper(II)–selective sensors exhibited a low detection limit in a wide concentration range. They had a fast response time, wide pH working range, good reproducibility, and Nernstian response. The new rhodanine–based sensors were successfully applied in various environmental samples and the results obtained were compared with atomic absorption spectroscopy (AAS).

Acknowledgements

The authors are indebted to the The Scientific and Technological Research Council of Turkey (TUBITAK) (Project Number: 124Z600). Onur Cem Altunoluk was supported by TUBITAK–BIDEB 2210/A Scholarship Programs for MSc students. Authors thank to TUBITAK for their support.

References

[1] T. Mendgen, C. Steuer, C.D. Klein, Privileged scaffolds or promiscuous binders: a comparative study on rhodanines and related heterocycles in medicinal chemistry, J. Med. Chem. 55, 743–753 (2012).

[2] O. Özbek, O. C. Altunoluk, Potentiometric determination of the local anesthetic procaine in pharmaceutical samples. Anal. Biochem, 695, 115657 (2024).

[3] E. Kalay, O. Özbek, M. Elik, C. Berkel, O. N. Aslan, The synthesis, sensor and biological properties of two novel rhodanine derivative molecules. J. Indian Chem. Soc, 102, 101591 (2025).

Precision Engineering of Dental Aligners: The Role of Additive Manufacturing Materials and Techniques

O. Er[1,*], D.A. Bircan[2]

[1]Çukurova University, Division of Advanced Materials and Nanotechnology, Adana, Türkiye. dtosmaner@gmail.com*

[1,2]Çukurova University, Department of Mechanical Engineering, Adana, Türkiye. abircan@cu.edu.tr

[*]**Corresponding e-mail:** dtosmaner@gmail.com

Additive manufacturing (AM) has transformed the fabrication of dental aligners, offering significant advantages over conventional methods in precision, customization, and efficiency. This study examines AM techniques and materials essential to aligner production, emphasizing their mechanical and clinical implications. Stereolithography (SLA), digital light processing (DLP), and liquid crystal display (LCD)-based vat photopolymerization are identified as dominant techniques, enabling micron-level accuracy essential for patient-specific geometries. In contrast, fused deposition modeling (FDM) remains limited due to inadequate resolution for direct aligner fabrication. Two primary manufacturing paradigms are evaluated: indirect thermoforming using AM-produced molds and emerging direct printing of aligners. For indirect methods, photopolymer resins (e.g., dental model resins) serve as mold substrates, over which medical-grade thermoplastics like polyurethane or polyethylene terephthalate glycol (PETG) are thermoformed. Direct printing employs biocompatible photopolymer resins, such as flexible, shape-memory formulations, which allow intricate control over pressure zones and variable wall thicknesses. Key benefits include accelerated production timelines, reduced material waste, and enhanced personalization; however, challenges persist in material biocompatibility validation, long-term wear resistance, and economic scalability for direct methods. Innovations in additive materials, such as antimicrobial nanoparticles, UV stabilizers, and plasticizers, further enhance functional performance. This study underscores the potential of AM to advance orthodontic solutions through precision-engineered materials while highlighting critical research directions for mechanical robustness and regulatory compliance.

References

[1] Tartaglia, G. M., Mapelli, A., Maspero, C., Santaniello, T., Serafin, M., Farronato, M., & Caprioglio, A. (2021). Direct 3D Printing of Clear Orthodontic Aligners: Current State and Future Possibilities. *MATERIALS*, *14*(7), 1799. https://doi.org/10.3390/ma14071799

The Evolution of Digital Workflows and Biomaterials in Dental Implantology: A Clinical Protocol from Planning to Restoration

O. Er[1,*], D.A. Bircan[2]

[1*]*Çukurova University, Division of Advanced Materials and Nanotechnology, Adana, Türkiye. dtosmaner@gmail.com*

[1,2]*Çukurova University, Department of Mechanical Engineering, Adana, Türkiye. abircan@cu.edu.tr*

[*]**Corresponding e-mail:** dtosmaner@gmail.com

The advent of digital dentistry has catalyzed a paradigm shift in implantology, steering therapeutic protocols toward integrated workflows that combine advanced manufacturing with innovations in biomaterials. This study describes an integrated digital protocol, emphasizing the critical contribution of novel material science in enhancing each stage of implant therapy, from surgical planning to definitive restoration. A patient-specific digital treatment plan was developed through the use of Cone-Beam Computed Tomography (CBCT) and intraoral scanning data. This virtual blueprint directed the Additive Manufacturing (AM) of a surgical guide, fabricated from a photopolymer resin selected for its dimensional stability and biocompatibility. This guide facilitated precise osteotomy preparation and implant placement. During the immediate postoperative phase, an interim prosthesis was additively manufactured from a composite resin. This prosthesis provided immediate function and promoted optimal soft tissue healing, attributable to its polished, biofilm-resistant surface. Subsequently, the definitive restoration was produced using a Computer-Aided Design and Computer-Aided Manufacturing (CAD/CAM) workflow, milling it from an advanced zirconia ceramic. This high-performance polycrystalline material was chosen for its exceptional fracture resistance, low thermal conductivity, and superior biocompatibility.

The incorporation of these advanced materials within a cohesive digital framework yielded a notable reduction in production time, enhanced the mechanical and aesthetic properties of the prostheses, and improved patient satisfaction. This research demonstrates that the integration of digital workflows and material science advancements is critical for developing next-generation implant solutions, offering elevated standards of precision, functionality, and long-term clinical success.

References

[1] Arpit Sikri, & Jyotsana Sikri. (2022). Digital dental implantology – The cutting edge implantology: A comprehensive review. IP Annals of Prosthodontics and Restorative Dentistry, 8, 3–9. https://doi.org/10.18231/j.aprd.2022.002

[2] Flügge, T., Kramer, J., Nelson, K., Nahles, S., & Kernen, F. (2022). Digital implantology—a review of virtual planning software for guided implant surgery. Part II: Prosthetic set-up and virtual implant planning. BMC Oral Health, 22(1). https://doi.org/10.1186/s12903-022-02057-w

Fabrication of Polymeric Artificial Cornea Using a Dual Electrospinning Technique

G. Bozdoğan[1], M.C. Karaaslan[1,2], **Ö. Eğri**[1,3*]

[1] Institute of Graduate Studies, Bioengineering Division, Tokat Gaziosmanpasa University, 60250 Tokat, Türkiye
[2] Tokat Gaziosmanpasa University Faculty of Art and Sciences, Molecular Biology and Genetics Department, 60250 Tokat, Türkiye
[3] Gaziosmanpasa University, Faculty of Engineering and Architecture, Mechanical Engineering Department, 60250 Tokat, Türkiye

[*]**Corresponding e-mail:** ozlm.gnrl@gmail.com

The cornea, optically composed of three transparent cellular layers and two membranes, serves as the eye's primary lens. Its essential role is to transmit incoming light while protecting the ocular surface from chemical and mechanical damage, infections, and ultraviolet radiation. Corneal dysfunctions arise from congenital abnormalities or acquired structural and/or functional impairments due to trauma and other causes. Conventional corneal transplantation is limited by donor shortages and postoperative complications. Therefore, the development of bioinspired artificial corneas with biocompatibility, transparency, and adequate mechanical properties has gained increasing importance, particularly through studies utilizing polymeric materials. In this study, polymeric membranes intended for artificial corneal applications were fabricated using FDA-approved, biocompatible, and biodegradable polymers, polycaprolactone (PCL) and polyethylene glycol (PEG), via a dual-electrospinning technique. This approach enabled the simultaneous deposition of PEG and PCL fibers in opposite directions onto a rotating drum collector, resulting in non-woven polymeric fibrous membranes. A 15% (w/v) PCL solution was prepared using a 5:1 chloroform/methanol solvent mixture, while a 10% (w/v) PEG solution was prepared using chloroform as the solvent. The solutions were loaded into separate syringes and positioned on independent micropumps, which were aligned on opposite sides of the rotating collector. After a series of optimization experiments, the process parameters were established as a flow rate of 2 mL/h and a tip-to-collector distance of 14–15 cm for the PCL solution, and 2 mL/h with a distance of 13 cm for the PEG solution. Electrospinning was carried out for three hours under a potential difference of 14 kV, resulting in the deposition of PEG/PCL membranes on the rotating drum collector. The obtained membranes were left overnight to ensure complete solvent evaporation, followed by packaging and storage under ambient conditions. PCL fibers were intended to impart flexibility and mechanical strength to the membranes, whereas PEG fibers were designed to dissolve upon contact with tear fluid, enabling the controlled ocular release of therapeutic agents. The fabricated PEG/PCL polymeric membranes will be subjected to in vitro chemical (FTIR), physical (SEM, UV–Vis, contact angle, water uptake capacity, controlled release, mass loss, density and porosity), and biological (antimicrobial activity and cell culture) characterizations to evaluate their potential use as artificial corneal substitutes

References

[1] Mahmoud Salehi AO, Heidari Keshel S, Sefat T, Tayebi L. (2021). Use of polycaprolactone in corneal tissue engineering: a review. Mater Today Commun, 27:102402.
[2] Avadhanam, V. S., Smith, H. E., Liu, C. (2015). Keratoprostheses for corneal blindness: a review of contemporary devices. Clinical Ophthalmology, 9, 697–720.

Fabrication and characterization of three-dimensional PCL/PEG artificial nerve conduits loaded with cobalt (II) oxide and *H.perforatum* oil

Mustafa Caner KARAASLAN[1,3], **Özlem EĞRİ**[2,3*] and E. Çaçan[1]

[1] *Tokat Gaziosmanpasa University Faculty of Art and Sciences, Molecular Biology and Genetics Department, 60250 Tokat, Türkiye*
[2] *Gaziosmanpasa University, Faculty of Engineering and Architecture, Mechanical Engineering Department, 60250 Tokat, Türkiye*
[3] *Institute of Graduate Studies, Bioengineering Division, Tokat Gaziosmanpasa University, 60250 Tokat, Türkiye*

[*]**Corresponding e-mail:** ozlm.gnrl@gmail.com

Peripheral nerve injuries are a serious problem that reduces the quality of life of patients and often cause lifelong pain, resulting in a huge socioeconomic burden. Currently, different surgical procedures are used to treat peripheral nerve injuries, including direct suturing, autograft and synthetic conduits. For gaps smaller than 5 mm, a direct suture method known as end-to-end suture is used. For gaps larger than 5 mm, the use of three-dimensional nerve conduits made of biodegradable synthetic polymers has become widespread in recent years. Since the need for a second surgery due to the non-biodegradability of silicone-based synthetic nerve conduits negatively affects patients financially and psychologically, it was aimed to produce synthetic nerve conduits with biodegradable materials. A peripheral nerve conduit should be mechanically durable, elastic, functional, biocompatible, not require a duplicate operation, biodegradable, non-toxic, non-tumorigenic, apoptotic and non-necrotic, electrically conductive, hydrophilic, non-narrowing of the nerve tube lumen when swollen with water, easy to implant and economical. The fabrication of three-dimensional peripheral nerve conduits for this purpose was carried out by coaxial electrospinning technique. *H.perforatum* oil (HPO), a wound healing herbal oil, was integrated into PEG (Polyethylene glycol) and CoO nanoparticles were integrated in PCL (Polycaprolactone) and coaxial-electrospinning was performed and three-dimensional peripheral nerve conduits were fabricated. The chemical structure (FTIR), surface morphology (SEM), wettability (% swelling ratio), hydrophilic/hydrophobic properties (water contact angle), time-dependent mass loss, controlled release of HPO and nanoparticles from the conduits were determined by performing various in-vitro characterization studies and the performance of the three-dimensional peripheral nerve conduits was evaluated.

References

[1] Gu X, Ding F, Williams DF (2014) Neural tissue engineering options for peripheral nerve regeneration. Biomaterials 35(24):6143–6156.

[2] Zhang X, Wu Y, Tan L, et al. (2024) Evolution of natural polymer nerve conduit technology in peripheral nerve repair: a narrative review. Adv Technol Neurosci 1(2):229–243.

Fabrication and characterization of dual electrospun polymeric dental membranes

M.C. Karaaslan[1,4], A. Bülbül[4], **Ö. Eğri**[2,3*] and S. Eğri[3,4]

[1] Tokat Gaziosmanpasa University Faculty of Art and Sciences, Molecular Biology and Genetics Department, 60250 Tokat, Türkiye
[2] Gaziosmanpasa University, Faculty of Engineering and Architecture, Mechanical Engineering Department, 60250 Tokat, Türkiye
[3] Tokat Gaziosmanpasa University Faculty of Art and Sciences, Chemistry Department, Tokat Gaziosmanpasa University, 60250 Tokat, Türkiye
[4] Institute of Graduate Studies, Bioengineering Division, Tokat Gaziosmanpasa University, 60250 Tokat, Türkiye

*Corresponding e-mail:** ozlm.gnrl@gmail.com

Tumors, congenital diseases, inflammatory (periodontal) diseases affecting the gums and other tissues supporting the teeth, traumas due to accidents or problems caused by surgical operations can cause defects in the alveolar bone. The most popular methods for the treatment of these defects are guided tissue regeneration (GTR) and guided bone regeneration (GBR) methods. The aim of these treatments is to fill the damaged bone with bone grafts and to create a barrier between the damaged hard tissue and soft tissue with the help of dental membranes, thus ensuring the regeneration and healing of the tissues. Dental membranes used in GBR and GTR techniques should have properties such as good biocompatibility, coverage and tissue integration. The aim of the present study is to produce PCL-PEG membranes loaded with vitamin D_3, known for its effect on wound healing and bone regeneration, and *Hypericum perforatum* oil, which has a healing property in wound healing. The membranes are produced in a non-woven structure consisting of interwoven fibers by mutual electrospinning of PEG and PCL solutions. *H. perforatum* oil and vitamin D_3 were encapsulated in PEG fibers and their controlled release was achieved depending on the dissolution of the PEG polymer. Membranes were produced by co-electrospinning method PCL solution and PEG solution with D_3 and *H. perforatum* oil in it. To see the surface morphology and physical properties of the membranes, Scanning Electron Microscopy (SEM), standard tensile test and Fourier Transform Infrared Spectroscopy (FTIR) measurements were performed. Swelling test, contact angle measurement, mass loss and controlled release tests were carried out to measure the water retention capacity of the membranes, determine their hydrophilicity, find the degradation rate over time and calculate the release of the therapeutic agents over time.

References

[1] Belgheisi, G., Nazarpak, M. H., & Hashjin, M. S. (2020). Bone tissue engineering electrospun scaffolds based on layered double hydroxides with the ability to release vitamin D3: Fabrication, characterization and in vitro study. Applied Clay Science, 185, 105434.

[2] Garg, K.A. (2004). Bone Biology, Harwesting, Grafting for Dental Implants. Quisntessence Publising, 57-89.

Investigation of the Therapeutic Potential of *Rosmarinus officinalis* Derivative Exosomes in Regenerative Hair Mesotherapy

R. B. Taşdemir [1], S. Dayan [1,2*]

[1]Department of Drug Research, Development and Applications, Erciyes University Institute of Health Science, Talas, Kayseri, Türkiye
[2]Department of Basic Sciences, Erciyes University Faculty of Pharmacy, Talas, Kayseri, Türkiye

***Corresponding e-mail:** serkandayan@erciyes.edu.tr, serkandayan7@gmail.com, rumeysabeyan@gmail.com

Hair loss is a prevalent health condition among men and women, resulting in aesthetic and psychological consequences, thereby diminishing quality of life. Current treatment methods are typically chemical-based, have limited efficacy, and can cause adverse effects. The need for novel, naturally biocompatible, and effective approaches is rising. Plant-derived exosome delivery systems are positioned to emerge as the next generation of bioactive delivery systems. Exosomes, defined as nanoscopic vesicles secreted from cells, have been demonstrated to fulfill critical functions in various biological processes, including cell renewal and immune modulation. Plant-derived exosomes' antioxidant, anti-inflammatory, and regenerative properties have increased their utilization in biotechnology and medicine. Exosomes have been demonstrated to promote cell regeneration and possess the capacity to repair damaged tissues. This property can be attributed to the composition of protein, RNA, lipids, and antioxidant components. This project aims to formulate an innovative hair mesotherapy solution using exosomes derived from the medicinal plant *Rosmarinus officinalis* (rosemary). The treatment is hypothesized to be effective in halting hair loss and promoting hair growth due to its ability to stimulate the growth cycle, thereby promoting healthier hair growth. The primary objective of this project is the isolation and characterization of rosemary-derived exosome samples. The exosome samples were purified using the aqueous two-phase system (ATPS) technique and characterized by a variety of analytical methods, including scanning electron microscopy (SEM), STEM, Fourier-transform infrared spectroscopy (FTIR), nanoparticle tracking analysis (NTA), dynamic light scattering (DLS), and zeta potential analysis. The biocompatibility and efficacy of the developed formulations containing rosemary-derived exosomes will be evaluated *in vitro* on human dermal papilla cells. This pioneering biotechnological system was designed to address the global demand for organic and biotechnological cosmetics, offering a safer and more effective alternative to chemical and animal-based products.

References

[1] D. Liu, Q. Xu, X. Meng, X. Liu, and J. Liu, Status of research on the development and regeneration of hair follicles. International Journal of Medical Sciences, 21(1), 80 (2024).
[2] G. N. Alzhrani, S. T. Alanazi, S. Y. Alsharif, A. M. Albalawi, A. A. Alsharif, M. S. Abdel-Maksoud, and N. Elsherbiny, Exosomes: Isolation, characterization, and biomedical applications. Cell Biology International, 45(9), 1807-1831 (2021).
[3] F. Li Pomi, V. Papa, F. Borgia, M. Vaccaro, A. Allegra, N. Cicero, and S. Gangemi, Rosmarinus officinalis and skin: antioxidant activity and possible therapeutic role in cutaneous diseases. Antioxidants. 12(3), 680 (2023).

The Tuning the Magnetocaloric Properties of $La_{0.7}Nd_{0.1}Na_{0.2}MnO_3$ by Mn-Site Bi Substitution

S. Kılıç Çetin[1*], M. S. Aslan[1], G. Akça[1], F. Karadağ[1] and A. Ekicibil[1]

[1]*Department of Physics, Faculty of Sciences and Letters, Adana, Türkiye*

*__Corresponding e-mail:__ kilics@cu.edu.tr

With the acceleration of technological advancements and the growth of the global population, the demand for energy is increasing daily. As a result, traditional cooling technologies, particularly used for comfort and industrial processes, are being reevaluated in terms of both energy efficiency and environmental sustainability. In this context, magnetic cooling systems are attracting increasing interest in the search for environmentally friendly and highly efficient cooling systems to replace gas compression systems [1]. These systems are based on the principle of the magnetocaloric effect (MCE), which describes the reversible temperature change a material exhibits when exposed to a changing magnetic field [2]. Two parameters are used to express the magnetocaloric effect: magnetic entropy change and adiabatic temperature change. For a material to be considered an effective magnetocaloric cooler, it must meet various criteria such as exhibiting high magnetic entropy change even at low field changes, having a transition temperature suitable for the application range, having a controllable nature of the magnetic phase transition, and structural stability.

In this context, the design of magnetocaloric compounds with high and broad refrigerant capacity near room temperature is of significant importance for the development of materials suitable for magnetic refrigeration technology. In the present study, the effect of substituting element Bi at the Mn site of $La_{0.7}Nd_{0.1}Na_{0.2}MnO_3$ on the magnetocaloric properties has been investigated. The temperature dependence of magnetization measurements revealed a ferromagnetic-to-paramagnetic phase transition. The Curie temperature (T_C), which was 281K for the pure sample, decreased to 276 K after the substitution of element Bi at the Mn site with a concentration of $x = 0.01$. For the parent material, the maximum magnetic entropy change was 6.18 $Jkg^{-1}K^{-1}$, whereas the introduction of Bi in place of Mn increased this value to 6.49 $Jkg^{-1}K^{-1}$. The results indicate that the addition of Bi to the Mn site leads to a decreasing trend in T_C. However, an increase in the magnetic entropy change value was also observed. This can be considered a positive indicator for the development of magnetic refrigerant materials with enhanced performance.

Acknowledgments: This study is supported by the Research Fund of Çukurova University, Adana, Türkiye, under grant contract no: FBA-2023-16332.

References

[1] Pecharsky, V. K., & Gschneidner, K. A. (1999). Magnetocaloric effect and magnetic refrigeration. Journal of Magnetism and Magnetic Materials, 200(1–3), 44–56.

[2] Tishin, A. M., & Spichkin, Y. I. (2003). The Magnetocaloric Effect and its Applications. Institute of Physics Publishing.

Production of Ion-Doped Novel Bioactive Glass-Containing Polymeric Membranes and Evaluation of Their Bioactivity Properties

Gözde Keleş[1], Tülay Merve Temel-Soylu[1], Kübra Özkan Güner[1], Yeşim Ayık[1,2], Bilge Sema Tekerek[3], Mine Kucak[4,6], İlkay Turhan Kara[5], Cem Özel[1,6], Ali Can Özarslan[6,7], **Sevil Yücel[1,6*]**

[1]Department of Bioengineering, Yildiz Technical University, İstanbul, Türkiye
[2] Department of Bioengineering, Üsküdar University, İstanbul,, Türkiye
[3] Department of Mechanical Engineering, Nişantaşı University, İstanbul, Türkiye
[4] Department of Moleculer Biology and Genetics, Yildiz Technical University, İstanbul, Türkiye
[5] Department of Nutrition and Dietetics, Istanbul Arel University, İstanbul, Türkiye
[6] Health Biotechnology Joint Research and Application Center of Excellence, Istanbul, Türkiye
[7] Department of Metallurgical and Materials Engineering, Istanbul University-Cerrahpasa, İstanbul, Türkiye

[*]**Corresponding e-mail:** yuce.sevil@gmail.com

The treatment process for diabetic chronic wounds is generally long, and current treatment methods are unable to sufficiently remedy impaired angiogenesis. Additionally, the tendency of diabetic wounds to become infected necessitates the use of wound dressings with antibacterial properties. At this point, biomaterials that support angiogenesis, prevent infection, and promote tissue regeneration come to the forefront. Unlike traditional bio-inert materials, bioactive glasses (BGs) developed in recent years have attracted attention due to their ability to form strong bonds with both hard and soft tissues, interact with physiological fluids to support new tissue formation, and exhibit positive effects on angiogenesis through their dissolution products. These properties of BGs make them effective not only in bone tissue engineering but also in soft tissue repair. In particular, various studies have shown that BGs promote angiogenesis in the wound area, thereby increasing oxygen and nutrient transport and accelerating the healing process, especially in the treatment of diabetic wounds. In this regard, bioactive glasses represent a promising alternative for the development of multifunctional wound dressing systems that combine both biocompatibility and functional properties. In this study, various ions selected were added to traditional BGs; the resulting glasses were incorporated into a specified polymer mixture at different ratios and used to produce polymeric membranes via the electrospinning method, and the effects of these membranes on soft tissue were investigated. The structural characterizations of polymeric membranes were performed using SEM-EDS, FTIR, XRD, TG-DTA, and porosity analyses. Within the scope of biological evaluations, swelling, biodegradability, and ICP-OES tests were performed, and antibacterial tests were conducted using *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas aeruginosa* bacterial strains to determine their antibacterial effects. Additionally, to evaluate their effects on cell viability, an indirect MTT cytotoxicity test was applied on the L929 mouse fibroblast cell line in accordance with the ISO 10993-5:2009 standard. In general, it has been determined that the developed bioactive glass-containing nanofiber membranes have a homogeneous structure, and their fibre diameter, porosity, and thermal properties vary depending on the glass content. These membranes have shown promising results in terms of antibacterial activity, biodegradability, angiogenic ion release, and cell viability. Based on the findings, these polymeric nanofiber membranes containing metal ion- incorporated BGs are potential biomaterials for wound dressing systems and bone tissue engineering applications.

This work was supported by the Presidency of Turkish Health Institutes (TUSEB) within the scope of the 2022-B-03/B Group R&D Projects Call (Project Code 24239). We thank TUSEB for their support.

Effect of Low Cu Doping on Optical and Electrical Properties of ZnO Thin Films

S. Gürakar[1*]

[1]*Ankara University, Department of Physics Engineering, Ankara, 06100, Türkiye*

*[*]**Corresponding e-mail:** sgurakar@eng.ankara.edu.tr

Cu doped ZnO thin films with different doping ratios of 0, 1, 2, and 3 at % are grown by sol-gel dip coating method on microscope glass substrates using a one-day aged solution. The deposition voltage and temperature for 8 cycles of dipping are chosen as 24 V and 500 °C, respectively. The effect of low Cu doping on the optical properties of ZnO thin films are analyzed from the optical transmittances measured with UV-Vis-NIR spectrometer in the 300−1600 nm wavelength range. A simple analysis according to Swanepoel's method [1] is applied to determine the thickness and refraction index values. The optical band gap, E_g values of the films are obtained using the Tauc relation [2]. The effect of low Cu doping on the electrical properties of ZnO thin films are investigated using Van der Pauw method at room temperature. As a result of Hall effect measurements, the resistivity and carrier density values are determined.

References

[1] R. Swanepoel, Determination of the thickness and optical constants of amorphous silicon, J. Phys. E: Sci. Instrum. 16, 1214 (1983).

[2] J. C. Tauc, Optical Properties of Solids, North-Holland Publ. 8, 279 (1972).

Effect of Some Organic Inhibitors on General Corrosion of Variously Surface AA 2024 and AA 7075 Alloys Using Electrochemical Methods

Ş.Yılmaz[1*], A.Yılmaz[2]

[1]Sivas Cumhuriyet University, Faculty of Engineering, Department of Nanotechnology Engineering, Sivas, Turkey
[2]Sivas Science and Technology University, Faculty of Aviation and Space Sciences, Department of Space Engineering Sivas, Turkey

[*]**Corresponding e-mail:** gumus5858@hotmail.com

The corrosion inhibition effect of the penicillin group antibiotic Largopen and the topical antifungal drug Oceral on aluminum 2024 and aluminum 7075 alloys in well water environments has been investigated. Additionally, the influence of surface treatments (heat treatment and sanding) on the corrosion behavior of the alloys have been examined. Corrosion parameters obtained by potentiodynamic polarization (PD) and electrochemical impedance spectroscopy (EIS) techniques are utilized to determine both the influence of surface treatments and organic inhibitors on corrosion. The results have shown that all applied surface treatments have improved corrosion resistance as compared to the untreated samples. The organic inhibitors used in the study have been found to significantly effective on the corrosion rate of both treated and untreated samples.

Keywords: Aluminum, inhibitor, sanding, heat treatment, potentiodynamic polarization, impedance spectroscopy.

References

[1] Wallace, W., Hoeppner, D.W. ve Kandachar, P.V., Agard Corrosion Handbook Volume1 Aircraft Corrosion: Causes And Case Histories, AGARD, (1985).

[2] J. Orlikowski, A. Jazdzewska, R. Mazur, K. Darowicki, Determination of pitting corrosion stage of stainless steel by galvanodynamic impedance spectroscopy, Electrochim. Acta. 253 (2017) 403–412. doi:10,1016/j.electacta.2017.09.047.

[3] El Haleem, S.M.A., El Wanees, S.A., El Aal, E.E.A., Farouk, A., 2013. Factors affecting the corrosion behaviour of aluminium in acid solutions. I. Nitrogen and/or sulphur-containing organic compounds as corrosion inhibitors for Al in HCl solutions. Corrosion Science, 68, 1-13.

Frequency-dependent capacitance-conductance-voltage characteristics and dielectric properties of the Al/(GO:PTCDA)/p-Si structures

Şükrü KARATAŞ[a,b], Niyazi BERK[b],

[a]*Department of Physics, Faculty of Sciences, Kahramanmaraş Sütçü İmam University, 46100-Kahramanmaraş, Turkey*
[b]*Department of Materials Science and Engineering, Kahramanmaras Sutcu Imam University, Kahramanmaraş 46100, Turkey*

[*]**Corresponding e-mail:** skaratas@ksu.edu.tr

In this study, the capacitance-voltage (C-V) and conductance-voltage (G/□-V) characteristics and very important parameters such as dielectric constant (ε'), dielectric loss (ε"), dielectric loss tangent (tan□), ac electrical conductivity ($\square_{ac}$), electrical modulus (M′, M″) and complex impedance values (Z′, Z″) of the Al/p-Si semiconductor structures with GO:PTCDA interlayer were investigated in a wide frequency (from 0.1 MHz to 1.0 MHz by 0.1 MHz steps) and voltage range (in the range of ±4.0 V with 0.03 V steps). While the C and G/□ values decreased with increasing frequency, the same C and G values increased with increasing voltage. The observation of a peak in the C–V curves in the voltage region (1.52 V ≤ V ≤ 2.72 V) for each frequency value can be attributed to the presence of reconstructed and reordering charges in the interface layer. However, G/□-values always increase depending on the voltage. Furthermore, experimental results showed that dielectric values such as ε', ε", tan□□□$\square_{ac}$, ln$\square_{ac}$, M″ and Z′ generally decreased with increasing frequency, while dielectric values such as M′ and at low frequencies Z″ increase with increasing frequency. This means that frequency and voltage have a strong effect on C, G/□ and dielectric properties. Thus, this study showed that Al/p-Si semiconductor structures with GO and PTCDA interlayer have the potential to be used in many optoelectronic devices such as integrated circuit elements and electronic applications.

Keywords: C-V; G/□-V; Frequency; Dielectric; Conductivity

Modification of YBCO Superconductors with 2D Graphene: Effects on Transition Temperature and Morphology

V. Guckan[1*], S. Karavul[1], F. Aslan[1], A.O. Ayas[2], F. Karadag[1], M. Akyol[3] and A. Ekicibil[1]

[1]*Department of Physics, Art and Sciences Faculty, Cukurova University, Adana, TURKEY*
[2]*Department of Physics, Faculty of Science and Letters, Adıyaman University, Adıyaman, Turkey*
[3]*Department of Materials Science and Engineering, Faculty of Engineering, Adana Alparslan Türkeş Science and Technology University, Adana, TURKEY*

[*]**Corresponding e-mail:** veysiguckan@gmail.com

$YBa_2Cu_3O_{7-x}$ (YBCO) was one of the first cuprate compounds to exhibit superconductivity at liquid nitrogen temperatures. Its high T_c value and strong magnetic properties make it a preferred material for many technological applications [1-3].

In this study, YBCO, a high-temperature superconductor, was synthesized via the sol-gel method and the effects of graphene doping at different rates *(0.5, 1, 2, and 3 wt%)* on the structural, morphological, and superconductivity properties were investigated. The crystal structure of the YBCO samples were characterized by X-ray diffraction (XRD), and their surface morphologies were evaluated by Scanning Electron Microscopy (SEM). In addition, superconductivity transition temperatures and magnetic properties were determined by R-T (resistance-temperature) and M-T (magnetization-temperature) analyses, respectively.

The results show that graphene doping improves the transition temperature *(T_c)* value and interparticle connectivity at low rates, but this effect decreases as the doping rate increases. These results reveal that graphene doping can increase the superconductivity performance of YBCO when used at appropriate rates and contribute to advanced material designs in this field.

References

[1] Larbalestier, D., et al., High-T c superconducting materials for electric power applications. 2001. 414(6861): p. 368-377.

[2] Lanzara, A., et al., Evidence for ubiquitous strong electron–phonon coupling in high-temperature superconductors. 2001. 412(6846): p. 510-514.

[3] Wu, M.-K., et al., Superconductivity at 93 K in a new mixed-phase Y-Ba-Cu-O compound system at ambient pressure. 1987. 58(9): p. 908.

$CaAl_{12}O_{19}$:Tm,Be Ceramics for Optically Stimulated Luminescence Dosimetry

V. Altunal[1*], and Z. Yegingil[2]

[1]Cukurova University, Physics Department 01250, Saricam, Adana, TÜRKİYE
[2]Toros University, Engineering Faculty, Electrical and Electronic Engineering Department, Mersin, TÜRKİYE

[*]**Corresponding e-mail:** valtunal@cu.edu.tr

In this study, $CaAl_{12}O_{19}$ (hexaaluminate) ceramics doped with Tm^{3+} and Be^{2+} were synthesized using the sol-gel method and sintered at high temperatures to obtain dense ceramic phases. The effects of the additives on the material were systematically investigated from both a structural and optical perspective. X-ray diffraction (XRD) analyses revealed that the synthesized ceramics crystallized in the desired phase and were free of impurity phases. SEM examinations confirmed the homogeneous microstructure, compact grain distribution, and high density properties. Thermoluminescence (TL), optically stimulated luminescence (OSL), and radioluminescence (RL) measurements performed as part of the optical characterization revealed the contributions of the additives to the luminescence performance of the material. Tm^{3+} ions produce characteristic emissions, particularly related to the $^1D_2 \rightarrow {}^3F_4$ and $^1G_4 \rightarrow {}^3H_6$ transitions; The additional trap centres created by the Be^{2+} doping supported charge trapping and release processes, thus significantly increasing both the intensity and stability of the TL and OSL signals. The low fading behaviour observed in OSL measurements, in particular, demonstrates the material's ability to retain information for long periods. Furthermore, no significant degradation in signal intensity was observed during repeated dosing and readout cycles, demonstrating that the material can be considered a reusable and reliable dosimetry sensor [1]. The multiple trap structures observed in the TL curves indicate the interaction between deep and shallow trap levels created by the doping. This interaction supports the existence of long-lived charge traps, particularly those induced by radiation, and is associated with the material's persistent OSL (POSL) properties. In conclusion, $CaAl_{12}O_{19}$ ceramics doped with Tm^{3+} and Be^{2+} stand out as strong candidates for next-generation radiation dosimetry applications thanks to their structural integrity, characteristic emission bands, high TL/OSL intensities, low fading behaviour, and reproducible signal stability. These results support the usability of these ceramics in the fields of medical imaging, nuclear safety, radiation occupational health and environmental dosimetry.

References

[1] V. Altunal, A. Ozdemir, K. Kurt, O. Yigit, V. Guckan, B. Isik, Z. Yegingil, Luminescence properties of Ce and Be-doped CaAl12O19 for dosimetric and light-emitting applications, J. Alloys Compd., 985 (2024) 174081.

Field-Tunable Optical Response of a Planar Liquid Crystal Cell: A Monte Carlo and Mueller Matrix Approach with RGB-Based Visualization

Y. Emül[1*]

[1]*Department of Physics, Faculty Science, Sivas Cumhuriyet University, Sivas, Türkiye*

[*]**Corresponding e-mail:** yakupemul@cumhuriyet.edu.tr

In this study, we present a simulation-based investigation of the polarization-resolved optical behavior of a planar nematic liquid crystal (LC) cell under varying electric field strengths and polarizer azimuthal angles (see Figure 1). A hybrid methodology combining Monte Carlo simulations with the Mueller matrix formalism is employed to statistically model the molecular orientation of the LC system, incorporating surface anchoring and electric field effects via a Lebwohl–Lasher-type lattice model [1]. The optical response is computed across the visible spectrum using red (700 nm), green (546.1 nm), and blue (435.8 nm) wavelengths, forming RGB-based transmittance maps. These maps serve as intuitive visualizations of birefringence-induced color shifts and intensity modulations, directly linking LC molecular alignment to observed Newton colors. We explore the influence of polarizer rotation angles (0°, −22.5°, and −45°), revealing how angular birefringence and director reorientation govern the emergence of interference colors and field-induced extinction. Our findings offer practical insight into the design of tunable liquid crystal optical devices, such as electro-optic filters, adaptive lenses, and display elements. This approach also provides a pedagogically rich tool for visualizing LC physics and polarization optics through color-mapped simulations.

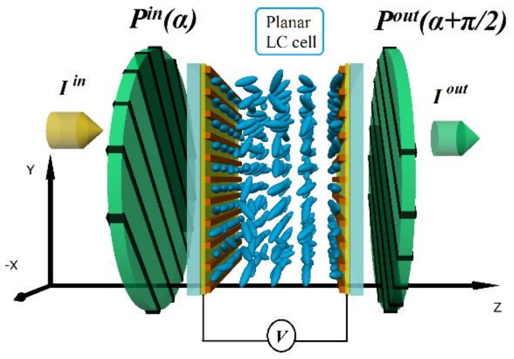

Figure 1. Schematic of the voltage controlled planar LC retarder system under crossed polarizer geometry.

References

[1] Y. Emül, Monte Carlo simulations for tuning optical properties in a two-stage liquid crystal retarder system via Mueller matrix method, Liquid Crystals, 52(3–4), 212–219 (2024).

Properties of Polypropylene-Based Micro Synthetic Fiber Reinforced Mortars Containing Calcined Marl Blended Cement

Y. Akgün[1*] and C. Özdem Baş[2]

[1]Department of Construction Technologies, Ordu University, Ordu, Türkiye
[2]Institute of Science, Renewable Energy Department, Ordu University, Ordu, Türkiye

[*]**Corresponding e-mail:** ysmakgun@gmail.com

Pozzolanic mineral additives, used in appropriate proportions, help to reduce energy consumption and CO2 emissions by reducing the amount of clinker in cement production. Concrete is brittle and has poor ductility under compression. Therefore, concretes exposed to fixed and live loads should be strengthened using fiber. In this work, it was investigated effects on physical and mechanical properties of mortars produced by using both calcined marl blended cement that is an alternative novel pozzolan and polypropylene-based micro synthetic fiber. Calcined marl was replaced with klinker at 0, 10, 20 and 30 wt.% ratios. The polypropylene-based micro synthetic fiber was mixed at different ratios (0.3-0.6 kg/m3) to the mortars. According to results of tests, it was observed that there were positive improvements in the mechanical properties of mortars containing with up 0.6 kg/m3 polypropylene-based micro synthetic fiber and calcined marl blended cement up to 30% replacement ratio. And, the using calcined marl blended cement will contribute to cement production sector in terms of low-emission, energy-saving, low-cost and sustainability.

Keywords: Calsined Marl, Blended Cement, Polypropylene-Based Micro Synthetic Fiber, Mortar

References

[1] Rakhimova, N., Rakhimov, R., Morozov, V., Potapova, L., & Osin, Y., Marl as a supplementary material to alkali-activated blended cements. European Journal of Environmental and Civil Engineering, 25(13), 2491-2508, (2021).

[2] Akgün Y., Thermal performance of mortars/concretes containing calcined marl as alternative pozzolan. Emerging Materials Research, 10, (3), 246-256, (2021).

Enhanced Optoelectronic Performance of Chemically Synthesized Al–Graphene Co-Doped ZnO Thin Films: A Promising TCO Approach for Thin-Film Photovoltaics

Y. Atasoy[1*], D. Özbek[2], A. Altuntepe[3], M.A. Olğar[2], and R.Zan[2]

[1] *Niğde Ömer Halisdemir University, Niğde Zübeyde Hanım Vocational School of Health Services, Niğde, Türkiye*
[2] *Niğde Ömer Halisdemir University, Department of Physics, Niğde, Türkiye*
[3] *Sivas University of Science and Technology Optical Excellence Application and Research Center, Sivas, Türkiye*

[*]**Corresponding e-mail:** yavuzatasoy@ohu.edu.tr

Chemically synthesized transparent conductive oxide (TCO) offers several advantages compared to vacuum-based deposition methods, including lower production cost, scalability for large-area coatings, and the potential for low-temperature processing, which is compatible with flexible substrates [1]. The sol–gel approach also provides fine control over dopant incorporation and microstructural tuning, enabling targeted improvements in TCO performance [1]. Although chemically deposited TCO layers have been explored in thin-film solar cell technologies such as CIGS and CZTS, the literature remains relatively limited, and the optimization of chemical processing parameters for high-performance devices is still an ongoing challenge [2-3]. This study investigates pristine and doped ZnO thin films fabricated via the sol–gel technique, focusing on enhancing their suitability as TCO layers in optoelectronic applications. ZnO was first doped with aluminum (Al) and subsequently with both Al and graphene (Gr) to evaluate the individual and synergistic effects of these dopants. Al doping was optimized at a ratio of Al/(Al+Zn) = 0.2, followed by optimization of the graphene content at 1.5 wt%. In this context, the structural, optical, and electrical properties of pristine ZnO, Al-doped ZnO, and Al–Gr co-doped ZnO (Gr-AZO) thin films were systematically investigated.

Incorporation of graphene into AZO further enhances the electrical performance by introducing additional conductive pathways, reducing grain boundary scattering, while maintaining high optical transparency. This co-doping strategy also contributes to enhanced mechanical stability and potentially improved environmental durability of the films. The synergistic improvements achieved through Al and Gr co-doping in solution-processed ZnO films demonstrate a substantial enhancement in optoelectronic properties compared to pristine or singly doped ZnO. These findings, coupled with the inherent advantages of chemical synthesis, position co-doped ZnO films as a strong candidate for next-generation TCO layers, with significant potential for integration into thin-film solar cells and other advanced optoelectronic applications.

Keywords: CZTS, RTA, Al doping, Al-Gr co-doping

Acknowledgement: This study was supported by the Scientific and Technological Research Council of Türkiye with the project number of 122F217

References

[1] Tabassum, S., et al., Damp heat stability of AZO transparent electrode and influence of thin metal film for enhancing the stability. Journal of Materials Science: Materials in Electronics, 2014. 25(7): p. 3203-3208.

[2] Perlikowski, I., et al., Structural properties and electrical characteristics of pn junctions based on kesterite cu2znsns4 layers for thin-film solar cells. Energies, 2021. 14(16): p. 5182.

[3] Albiss, B. and M. Al-Widyan, Numerical simulation, preparation, and evaluation of Cu (In, Ga) Se2 (CIGS) thin-film solar cells. ChemEngineering, 2023. **7**(5): p. 87.

Evaluation of Morphological and Structural Properties of Silicate-Based Bioactive Glass Nanoparticles as a Function of Production Conditions and Sodium Content

Y. Ayik[1,2*], A. Alizadeh[1], C. Ozel[1,3], A. C. Ozarslan[3,4], and S. Yucel[1,3]
[1]Department of Bioengineering, Faculty of Chemical and Metallurgical Engineering, Yıldız Technical University, İstanbul, Türkiye
[2]Department of Bioengineering, Faculty of Engineering and Natural Sciences, Üsküdar University, İstanbul, Türkiye
[3]Health Biotechnology Joint Research and Application Center of Excellence, İstanbul, Türkiye
[4]Department of Metallurgical and Materials Engineering, Faculty of Engineering, İstanbul University-Cerrahpaşa, İstanbul, Türkiye

[*]**Corresponding e-mail:** yesim.ayik@uskudar.edu.tr

Bioactive glasses (BGs) are biomaterials found nearly 60 years ago, that interact with body tissues with a strong bond, and release of therapeutically active ions when they contact with physiological fluids [1, 2]. BGs can be doped with several ions which have significant properties to bring in activities such as osteogenic, pro-angiogenic, antibacterial, and antioxidant [3]. BGs can be produced by 2 main methods as melting the precursors at high temperatures or polycondensation reaction from organic precursors (sol-gel method) [2]. There is an opportunity to control several characteristics such as size, distribution, and morphology of BG particles by changing reaction parameters and ingredients when mostly using sol-gel methods [4].

In this study, it was aimed to produce and evaluate morphological and structural properties of silicate-based BG nanoparticles (BGNs) under different production conditions. In this direction, a modified Stöber method (a base catalyzed sol-gel method) was used to produce BGNs with standard composition (SiO_2, CaO, Na_2O, and P_2O_5) [5]. Ammonium hydroxide (28%) was chosen as an alkaline catalyst. Chemical composition, crystallization, and morphological properties of the produced BGNs were characterized by X-Ray Fluorescence Spectroscopy (XRF), X-Ray Diffraction Analysis (XRD), and Scanning Electron Microscopy-Energy Dispersive X-Ray Spectrometry (SEM-EDS). In conclusion, the characterization results revealed that production conditions affect shape, monodispersity, and chemical properties of BGNs, produced by Stöber method. BGNs with desired monodispersity and shape can be produced by controlling production method and conditions.

This work has been supported by The Scientific and Technological Research Council of Türkiye (TÜBİTAK) under project number 224M333.

References

[1] Abodunrin, O. D., Semlali, A., El Mabrouk, K., & Bricha, M. (2024). The effect of borate on acellular bioactivity of novel mesoporous borosilicate bioactive glasses for tissue engineering. *Ceramics International*, 50(1), 2303-2318.

[2] Brauer, D. S. (2015). Bioactive glasses—structure and properties. *Angewandte Chemie International Edition*, *54*(14), 4160-4181.

[3] Miola, M., Piatti, E., Iorio, F., Boccaccini, A. R., & Verné, E. (2025). Electrospun Polymeric Composite Fibers Containing Te-Doped Bioactive Glass Powders. *Polymers*, *17*(15), 2057.

[4] Greasley, S. L., Page, S. J., Sirovica, S., Chen, S., Martin, R. A., Riveiro, A., ... & Jones, J. R. (2016). Controlling particle size in the Stöber process and incorporation of calcium. *Journal of colloid and interface science*, 469, 213-223.

[5] Miola, M., Piatti, E., Sartori, P., & Verné, E. (2023). Sol-gel synthesis of spherical monodispersed bioactive glass nanoparticles co-doped with boron and copper. *Journal of non-crystalline solids*, 622, 122653.

Negative dielectric constant controlling in nanostructure CdO material by heat treatment

Y. Orman[1*], F.Yakuphanoglu[1]

[1] *Department of Physics, Firat University, Elazig, 23119, Turkey*

[*] **Corresponding e-mail:** y.orman12@hotmail.com

In this study, cadmium oxide(CdO) was synthesized by hydrothermal method. The synthesized CdO was heat treated at different temperatures (350 oC -400 oC -450 oC -500 oC). The characterization properties depending on the heat treatment temperature were investigated using X-ray diffraction XRD, Fourier Transform Infrared Spectroscopy (FTIR), scanning electron microscopy (SEM), UV-Vis spectrophotometer and impedance spectrometer. FTIR and XRD results confim the formation of CdO samples. SEM analysis indicates that the crystallite sizes are increased from 45 nm to 52 nm with increasing heat treatment temperature [1]. The band gap energy of the samples was obtained with the (F(R)hν)2 (m-1eV)2 - hν (eV) graph using the UV-Vis spectrophotometer. It is observed that the optical band gap of the samples is changed with the heat treatment. The dielectric properties of the samples have been investigated by depending on the heat treatment temperature. The CdO exhibits negative dielectric behavior. This behavior was analyzed by Drude model. The negative dielectric constant of CdO was increased with the heat treatment temperature [2]. The obtained results indicate that the negative dielectric constant of CdO can be controlled by heat treatment.

References

[1] N.M. Al-Hada, E.B. Saion, A.H. Shaari, M.A. Kamarudin, M.H. Flaifel, S.H. Ahmad, A. Gene, A facile thermal-treatment route to synthesize the semiconductor CdO nanoparticles and effect of calcination, Mater Sci Semicond Process 26 (2014) 460–466. https://doi.org/10.1016/j.mssp.2014.05.032.

[2] K. Demirelli, C. Ercan, A. Dere, F. Yakuphanoglu, Transition from negative dielectric constant to positive dielectric constant of MXene by ZnO nanoparticles produced by Fytronix hydrothermal method, J Alloys Compd (2025). https://doi.org/10.1016/j.jallcom.2024.178414.

POSTER PRESENTATIONS

Optimization and Characterization of Fabrication Parameters of YBCO Superconducting Nanofibers Produced by Electrospinning

A. Ekicibil[1*],_V. Guckan[1], F. Aslan[1], S. Karavul[1], A.O. Ayaş[2], F. Karadağ[1], M. Akyol[3]

[1]*Department of Physics, Art and Sciences Faculty, Cukurova University, Adana, TURKEY*
[2]*Department of Physics, Faculty of Science and Letters, Adıyaman University, Adıyaman, Turkey*
[3]*Department of Materials Science and Engineering, Faculty of Engineering, Adana Alparslan Türkeş Science and Technology University, Adana, TURKEY*

[*]**Corresponding e-mail:** ahmetcan@cu.edu.tr

$YBa_2Cu_3O_{7-x}$ (YBCO), a high-temperature superconductor, has a wide range of applications from energy transmission to magnetic sensors due to its low electrical resistivity and strong magnetic flux retention properties [1,2]. This study has a guiding role in determining the optimum parameters to produce high-quality YBCO nanofibers with bead-free structures using the electrospinning method and enhancing their superconductivity performance.

In this study, optimization of process parameters and structural characterization of the produced YBCO precursor nanofibers were carried out in the production of electrospinning. Precursor solutions were prepared using polyvinylpyrrolidone (PVP) with a molecular weight of 40,000 g/mol at 25%, 30% and 35% by weight (wt%). Electrospinning processes were carried out at voltages of 16, 18 and 20 kV, flow rates of 0.4 and 0.6 mL/h, and a constant needle-collector distance of 12.5 cm. The morphology and composition of the produced nanofibers were investigated using scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS), while the crystal structure was investigated using X-ray diffraction (XRD). The results show that polymer concentration and applied voltage play a decisive role in fiber morphology; increasing viscosity results in fibers homogeneous diameter distribution, and production avoids beaded structures which it is a major problem for nanofibers [1,3].

As a result of this study, ıt was showed that a significant improvement in the bead-free nanofiber structure of the 35 wt% solution. Although it was not significantly observed, increasing the flow rate resulted in an increase in nanofiber diameters, and increasing the voltage resulted in more irregular nanofiber structures.

References

[1] Ma, Y., Wang, H., Zhang, H., Wu, J., & Lin, C. (2015). Fabrication of $YBa_2Cu_3O_{7-x}$ nanofibers by electrospinning and their superconducting properties. Journal of Alloys and Compounds, 618, 389–393.

[2] Solovev, A. A., Ivanov, S. A., & Antipov, E. V. (2020). Electrospinning: A versatile method for the fabrication of ceramic and ceramic composite nanofibers for functional applications. Journal of Materials Chemistry A, 8(5), 2363–2390.

[3] Zahra, F. T., Zhang, Y., Ajayi, A. O., Quick, Q., & Mu, R. (2024). Optimization of electrospinning parameters for lower molecular weight polymers: A case study on polyvinylpyrrolidone. Polymers, 16(9), 1217.

Potentiometric detection of copper(II) ions based on a newly synthesized thiosemicarbazone derivative molecule

M. Elik[1], **A. A. Kogu[2,*]**, O. Özbek[1] and M. B. Gürdere[2]

[1]*Tokat Gaziosmanpaşa University, Faculty of Science and Arts, Department of Molecular Biology and Genetics, 60250 Tokat, Türkiye*
[2]*Tokat Gaziosmanpaşa University, Faculty of Science and Arts, Department of Chemistry, 60250 Tokat, Türkiye*

***Corresponding e-mail:** koguali4@gmail.com

Today's rapid industrialization is leading to increased concentrations of particularly toxic heavy metals in environmental samples. Copper, one of the toxic heavy metals, can cause serious health problems for humans when ingested in various forms, especially at high concentrations [1]. Therefore, copper determination is very important especially for human and environmental health. Although many analytical methods have been proposed for the determination of copper in various samples, potentiometric ion–selective sensors have a special importance among these methods due to the advantages they provide [2, 3]. Ionophores, the most important component of ion-selective electrodes, exhibit a high interaction with analyte ions [4]. In this study, a thiosemicarbazone derivative molecule was synthesized and its ionophore properties were investigated. The developed potentiometric sensors exhibited very high selectivity towards copper(II) ions over different cationic species. The proposed sensor had a wide concentration range, low detection limit and Nernstian behavior. In addition, developed sensor had a wide pH working range, good reproducibility and fast response time. Finally, the fabricated sensor was able to determine copper(II) ions in various samples with very high recoveries.

References

[1] H.I. Ulusoy, R. Gürkan, M. Akcay, Kinetic spectrophotometric determination of trace copper (II) ions by their catalytic effect on the reduction of brilliant cresyl blue by ascorbic acid, Turk. J. Chem. 35 599–612 (2011).

[2] O. Özbek, A. Ölcenoglu, The use of bis–thiadiazole and bis–oxadiazol derivatives as ionophores: A novel copper (II)–selective potentiometric electrodes, Microchem. J. 190, 108679 (2023).

[3] O. Özbek, O. C. Altunoluk, Potentiometric determination of the local anesthetic procaine in pharmaceutical samples. Anal. Biochem, 695, 115657 (2024).

[4] M.E. Cakmak, O. Özbek, K. Berkil Akar, M.B. Gürdere, Selective and fast potentiometric sensors based on thiosemicarbazone with low detection limit for the determination of Cu^{2+} ions, Microchem. J. 209, 112894 (2025).

Development of One-Dimensional Photonic Structures Containing Metal-Organic Framework and Metal Oxide-Based Hybrid Materials for Volatile Organic Compound, Gas, and Humidity Sensing Applications

A. Bagcivan[1*], M. Erkartal[2] and M. Caglar[1]

[1]*Department of Physics, Faculty of Science, Eskisehir Technical University, Yunus Emre Campus, Eskisehir, 26470, Turkey*
[2]*Department of Basic Sciences, Engineering, Architecture and Design, Bartın University, Bartın, 74100, Turkey*

[*]**Corresponding e-mail:** aybikebagcivan@ogr.eskisehir.edu.tr

In this study, Metal Organic Framework (MOF)/Metal oxide (MO)-based hybrid sensor systems were developed by integrating them into one-dimensional photonic crystal (1DPC) structures for volatile organic compound (VOC), gas, and humidity sensing applications [1]. The multilayered structures were fabricated on p-type Si substrates via the sol–gel-based spin coating technique by sequentially depositing metal oxide and MOF precursor solutions. These alternating high and low refractive index layers form photonic structures capable of generating strong optical responses against environmental changes [2]. X-ray diffraction (XRD) analysis was conducted to examine the crystalline structure of the layers and identify any phase formations. Scanning electron microscopy (SEM) was employed to investigate the surface morphology and assess the quality and uniformity of the deposited layers. Optical microscopy was used to visually confirm the photonic nature of the structures, particularly through observable color changes in the multilayer configuration. The synergistic effect of the MOF and MO components in these hybrid materials enables a highly responsive detection mechanism by inducing shifts in the optical band gap upon exposure to target gases. The developed systems demonstrate high selectivity and sensitivity, as well as repeatability and low-cost fabrication, making them promising candidates for advanced optical sensor platforms.

This study was supported by The Scientific and Technological Research Council of Türkiye (TÜBİTAK) within the scope of the 1001 Scientific and Technological Research Projects Support Program, under the project titled “Development of One-Dimensional Photonic Structures Containing Metal-Organic Framework and Metal Oxide-Based Hybrid Materials for Volatile Organic Compound, Gas, and Humidity Sensing Applications” (Project No: 122M312).

References

[1] Z. Hu, C.-A. Tao, F. Wang, X. Zou, J. Wang. Flexible metal–organic framework-based one-dimensional photonic crystals, J. Mater. Chem. C 3, 211-216 (2015).
[2] J. Wei, Z. Yi, L. Yang, L. Zhang, J. Yang, M. Qin and S. Cao, Photonic crystal gas sensors based on metal–organic frameworks and polymers, Anal. Methods 16, 4901–4916 (2024).

Combination Therapy of Primary Canine Mammary Adenocarcinoma with Mo_2C-MXene Nanosheets

Ayça Tunçel[1*], Selin Güleç[2], Gül Kaya[1], Derya Ozel[3], Korhan Altunbaş[4], Özlem Özden Akkaya[4], Kasim Ocakoglu[1], Fatma Yurt[3]

[1] *Tarsus University, Faculty of Engineering, Department of Engineering Fundamental Sciences, 33400 Tarsus, Türkiye*
[2] *Ege University, Institute of Natural and Applied Sciences, Department of Biotechnology, 35100, Izmir, Turkey*
[3] *Ege University, Institute Nuclear Science, Department of Nuclear Applications, 35100, Bornova, Izmir, Türkiye*
[4] *Afyon Kocatepe University, Faculty of Veterinary Medicine, Department of Histology and Embryology, Afyon, Türkiye*

***Corresponding e-mail:** nuk.ayca.tuncel@gmail.com

Canine mammary adenocarcinoma is among the most challenging tumors in veterinary oncology, often demonstrating high recurrence rates and poor responsiveness to standard therapies. Photothermal therapy (PTT) and photodynamic therapy (PDT) utilizing two-dimensional nanomaterials such as MXene nanosheets offer a promising minimally invasive approach for tumor ablation in veterinary medicine.

In this study, Mo_2C-MXene nanosheets were synthesized and evaluated for their therapeutic efficacy on primary canine mammary adenocarcinoma cells. A combination therapy approach involving both PTT and PDT was applied: cells were incubated with 100 μg/mL MXene nanosheets and exposed to near-infrared (NIR, 808 nm) laser irradiation. According to MTT assay results, cell viability decreased from 69% (NIR−) to 44% (NIR+), demonstrating a 25% additional reduction attributable to the photothermal and photodynamic effects induced by the laser-activated MXene nanosheets. Live/dead and ROS assays further confirmed increased oxidative stress and tumor cell death following the combination therapy.

These results indicate that Mo_2C-MXene nanosheets can induce potent cytotoxicity in primary canine mammary adenocarcinoma cells through synergistic photothermal and photodynamic mechanisms, supporting their potential as a selective and minimally invasive treatment strategy in veterinary oncology.

Acknowledge: We would like to thank the Therapy Animal hospital for providing the canine mammary tumor tissue diagnosed as adenocarcinoma

Keywords: Mo_2C-MXene nanosheets, Photothermal therapy, Photodynamic therapy, Canine mammary adenocarcinoma, Primary cell culture, Near-infrared irradiation, Veterinary oncology

References

[1] A. Tunçel et al., Photothermal and photodynamic responses of core-shell Mo_2C@C@Fucoidan nanospheres, Mater. Chem. Phys. 329, 130088 (2025).

[2] G. Kaya et al., Assessment of Mo_2C@C@Fuc/Mo_2C-MXene@Fuc hybrid structures: Potential for photothermal and photodynamic applications, Surf. Interfaces 66, 106554 (2025).

[3] F. Yurt et al., Synthesis, characterization and evaluation of the photochemical properties and photothermal conversion capacities of Mo_2CT_x-MXene@Fuc nanohybrids, Diam. Relat. Mater. 153, 112025 (2025).

[4] V. Jain et al., A review of nanotechnology-based approaches for breast cancer and triple-negative breast cancer, J. Control. Release 326, 628–647 (2020).

Green-Synthesized ZnO Nanoplates *via sustainable DES* as Photoanodes: Characterization and Irradiance-Dependent Performance in DSSCs

Batuhan Atay[1], Lorenzo Gontrani[2], Yasemin Caglar[1], Ozgur Polat[3], Mujdat Caglar[1], Marilena Carbone[2]

[1]Department of Physics, Faculty of Science, Eskisehir Technical University, Eskisehir, 26470, Türkiye
[2]STARTNETICS - Department of Chemical Science and Technologies, University of Rome Tor Vergata, Via della Ricerca Scientifica 1, 00133 Rome, Italy
[3]Department of Physics and Astronomy, California State Polytechnic University, 3801 West Temple Ave, Pomona, CA 91768, USA

[*]**Corresponding e-mail:** ataybatu200@gmail.com

In this study, ZnO photoanode material for use in DSSCs was synthesized using a deep eutectic solvent (DES) containing zinc nitrate and urea, non-toxic alternative to conventional synthesis routes. The green synthesis and systematic evaluation of the synthesized ZnO nanostructures were performed, and the ZnO nanoparticles were characterized by XRD and SEM as having a wurtzite crystal structure and a vertically aligned nanoplate morphology with enhanced surface area [1]. DSSCs produced with ZnO photoanodes created using the doctor blade technique achieved a maximum power conversion efficiency of 1.79%, outperforming many green-synthesized ZnO-based devices reported in the literature. Photovoltaic characterization revealed a nearly linear increase in short-circuit current density with light intensity. Photovoltaic characterization results revealed that light intensity and short-circuit current density are almost linearly related. Electrochemical impedance spectroscopy showed that charge transfer resistance at the photoanode/electrolyte interface decreased under illumination, indicating increased carrier transport. A high light ideality factor ($n = 6.57$) indicates trap-assisted recombination, likely associated with structural defects. Overall, this study demonstrates that combining environmentally sensitive synthesis with scalable deposition methods enables the production of ZnO photoanodes with competitive photovoltaic performance, advancing the development of sustainable solar technologies.

M. Carbone and L. Gontrani would like to acknowledge the project PRIN2022 Grant number 2022F4YZP9 “GREEN3”

References

[1] M. Bonomo, L. Gontrani, A. Capocefalo, A. Sarra, A. Nucara, M. Carbone, P. Postorino, D. Dini, A combined electrochemical, infrared and EDXD tool to disclose Deep Eutectic Solvents formation when one precursor is liquid: Glyceline as case study, J Mol Liq 319 (2020) 114292. https://doi.org/10.1016/J.MOLLIQ.2020.114292

Green Synthesis of Pd Nanoparticles Using Olives Leaves Extract: Investigation of Structural and Catalytic Properties

Nurhan Kaya[1*], **Batuhan Berk Sahin**[1], Emre Can Tayfun[1], Faruk Karadag[1], Ahmet Ekicibil[1] and Dogan Kaya[1,2]

[1]Department of Physics, Faculty of Art and Sciences, Cukurova University, Adana, Türkiye
[2]Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Cukurova University, Adana, Türkiye

[*]**Corresponding e-mail:** nurhanxkaya@outlook.com

Hydrogen technology stands out as one of the most promising future energy solutions due to its zero carbon emissions, potential to reduce fossil fuel dependence, ability to store energy for long periods, transport it over long distances, and enable the production of more efficient and cleaner vehicles, thereby decreasing external dependency. In this context, the development of environmentally friendly catalysts for clean and efficient energy systems is of great importance. This study aims to produce palladium (Pd)-based nanoparticles (NPs) via a green synthesis method. Initially, olive leaves were dried and boiled at approximately 45 °C in ethanol for 5 hours to obtain an extract containing *Olea europaea* compounds. The plant extract was employed as a reducing agent for the reduction of $Pd(acac)_2$ metal salt. The structural characterization of the synthesized Pd NPs was performed using X-ray diffraction, revealing a face-centered cubic (fcc) structure belonging to the Fm-3m space group. Scanning electron microscopy analysis indicated an average particle size of approximately 3–4 nm. Energy-dispersive X-ray spectroscopy analysis confirmed the absence of impurities. The results demonstrate that low-cost, environmentally friendly, and high-purity Pd NPs can be successfully synthesized via green synthesis, with strong potential for application as catalysts in hydrogen technologies.

Aknowledgement: This work was supported by the Scientific and Technological Research Council of Türkiye (TÜBİTAK) under the 2209-A Program, Project No: 1919B012403219

References

[1] Dogan Kaya, Idris Adanur, Mustafa Akyol, Faruk Karadag, Ahmet Ekicibil, Synthesis of monodisperse CoPt nanoparticles Structural and magnetic properties, Journal of Molecular Structure Volume 1224, 12899 (2021)

[2] Fasih Ullah Haider, Usman Zulfiqar and Noor ul Ain Ecotoxicology and Enviromental Safety 281, 116620 (2024)

[3] Imtiyaz Hussain, N.B.Singh, Ajey Singh, Himani Sinhg& S.C. Singh, Green synthesis of nanoparticles and its potetial application, Volume 38, pages 545-560 (2016)

The Fabrication of Novel Hydrogels for Controlled Molecule Delivery Applications in Agriculture

B. Özcan[1], F. Özdemir Güney[1], M. Küçükoflaz Korkmaz[1], A. Özgür Göksu[2], E. Çömlekçi[2], Ö.F. Gürkan[2], M. Sezen[2], H. Bülbül[2], S. Dayan[1,3]*

[1]*Erciyes University, Drug Application and Research Center, Molecular Synthesis and Industrial Application Laboratory (MSIA-Lab), Kayseri, Turkey*
[2]*Kayseri Sugar Factory R&D Center, Kayseri, Turkey*
[3]*Erciyes University, Faculty of Pharmacy, Department of Pharmaceutical Basic Sciences, Kayseri, Turkey*

***Corresponding e-mail:** serkandayan@erciyes.edu.tr

Hydrogels, an essential class of polymer-based multifunctional materials, are widely recognized in controlled and targeted drug delivery systems owing to their high-water absorption capacity, biocompatibility, and tunable structures. These materials, typically obtained by combining natural and synthetic polymers, acquire a porous architecture through cross-linking [1,2]. Silica nanoparticles (SiNPs), on the other hand, are known to enhance soil water retention and possess the potential to protect plants against pathogens due to their high adsorption capacity [3]. Within this context, integrating SiNPs with hydrogel-based systems for agricultural drug delivery represents a promising area of research. In this study, the novel silica nanoparticles were synthesized and subsequently incorporated into newly developed silicon-based hydrogels. The chemical, crystalline, and morphological properties of the resulting hydrogels were characterized using Fourier Transform Infrared Spectroscopy (FTIR), X-ray Diffraction (XRD), Field Emission Scanning Electron Microscopy (FESEM), Energy-Dispersive X-ray Spectroscopy (EDX), and elemental mapping. The findings indicate that these silicon-based hydrogel systems hold strong potential for application in agriculture as controlled-release drug delivery platforms.

Keywords: Silicon, hydrogel, drug delivery systems.

Acknowledgments: This work is supported by the TÜBİTAK-1004 Center of Excellence Support Program under project number 22AG012. We want to express our sincere gratitude to TÜBİTAK for their support.

References

[1] P., Kesharwani, A., Bisht, A., Alexander, V., Dave, & S., Sharma, Biomedical applications of hydrogels in drug delivery systems: An update, J. Drug Deliv. Sci. Technol. 66, 102914 (2021).
[2] K., Pal, A. K., Banthia, & D. K., Majumdar, Polymeric hydrogels: characterization and biomedical applications, Des. Monomers Polym. 12(3), 197-220 (2009).
[3] G., Bapat, S., Zinjarde, & V., Tamhane, Evaluation of silica nanoparticle-mediated delivery of protease inhibitor in tomato plants and its effect on insect pest Helicoverpa armigera, Colloids Surf. B Biointerfaces. 193, 111079 (2020).

Topological Spin Textures in Chiral Magnetism: Skyrmions and Their Role in Spintronics

Çağatay Yalçın[1*], Doğan Kaya[1], Ahmet Ekicibil[1], Faruk Karadağ[1]

[1]*Cukurova University, Faculty of Arts and Sciences, Physics Department, Adana, Turkey*

***Corresponding e-mail:** yalcincagatay20@gmail.com

Magnetic skyrmions are topologically protected, nanoscale spin textures that have emerged as promising candidates for next-generation spintronic applications. This study investigates the fundamental physics and application potential of skyrmions, which arise from the interplay of exchange interactions and the Dzyaloshinskii–Moriya interaction (DMI) in chiral magnets[1]. Advanced manipulation techniques, specifically spin-transfer torque (STT) and spin-orbit torque (SOT), are examined as low-power methods for controlling skyrmion movement. The work highlights the potential of skyrmion-based devices such as racetrack memories, logic gates, and neuromorphic architectures as a compelling alternative to traditional CMOS technologies[2].

References

[1] Skyrme THR. A unified field theory of mesons and baryons.Nucl Phys. 1962;31:556-569.

[2] Al Khawaja U, Stoof H. Skyrmions in a ferromagnetic Bose-Einstein condensate. Nature. 2001;411(6840):918-920.

In Vitro Evaluation of Radiolabeled Trastuzumab-Conjugated Manganese–Iron Oxide Nanoplatform for Targeted PET/MR Imaging for HER2 Positive Breast Cancer

Derya Özel[1,2*], Fatma Yurt[1]

[1]*Ege University, Institute Nuclear Science, Department of Nuclear Applications, 35100, Bornova, Izmir, Türkiye*
[2]*İzmir Kavram Vocational School, Medical Services and Techniques Programme, 35230, Konak, Izmir, Türkiye*

[*]**Corresponding e-mail:** deryaozel01@gmail.com

HER2-positive breast cancer is characterized by rapid progression and high metastatic potential, requiring highly specific and sensitive diagnostic strategies. In this study, we evaluated the cellular targeting specificity, Pozitron Emission Tomography (PET) Imaging and magnetic resonance (MR) imaging performance of a trastuzumab-functionalized, manganese–iron oxide-based nanoparticle platform (Fe_3O_4-mSiO_2-NH_2-Mn-Tra), previously synthesized and radiolabeled with ^{89}Zr for imaging applications.

In vitro cell uptake experiments using ^{89}Zr-labeled nanoparticles demonstrated a 65.25% uptake rate in HER2-positive SKBR-3 cells after a 2-hour incubation period. Following HER2 receptor blockade, the uptake rate decreased to 54.65%, thereby confirming that internalization occurs via a receptor-specific mechanism. Conversely, no substantial uptake was observed in HER2-negative MDA-MB-231 cells, thereby further substantiating the HER2-dependent targeting specificity of the nanoplatform MR imaging studies performed on nanoparticle suspensions and HER2-positive cell pellets revealed pronounced signal enhancement in both T_1- and T_2-weighted sequences. The bimodal contrast effect is the result of the combined influence of manganese's paramagnetic properties and the superparamagnetic nature of the iron oxide core. The observed dual-mode imaging capability suggests that the Fe_3O_4-mSiO_2-NH_2-Mn-Tra nanoplatform has the potential to serve as an effective T1/T2 MR contrast agent, with the capability to enable high-sensitivity tumor visualization that is adaptable to diverse clinical imaging requirements. The findings indicate that the Fe_3O_4-mSi-NH_2-Mn-Tra nanoplatform has the potential to serve as an effective agent for the high-specificity and hybrid imaging of HER2+ tumors, thereby supporting its further development for diagnostic applications.

Keywords: Magnetic Nanoparticles, HER2+ breast cancer, ^{89}Zr Radiolabeling, PET/MR.

Acknowledgment: This study was supported by Ege University Scientific Research Project (BAP) no FDK-2021-22568 and TUBITAK 2211-C Doctoral Fellowship Program

Tuning the Properties of ZnO Thin Films Through pH Control

D.Özbek[1*], Y. Atasoy[2], M.A. Olgar[1] and R. Zan[1*]

[1]*Department of PhysicsNiğde Ömer Halisdemir University, Niğde, Türkiye*
[2] *Zübeyde Hanım Vocational School of Health Services, Niğde Ömer Halisdemir University, Niğde, Türkiye*

*__Corresponding e-mail:__ done_ozbek@mail.ohu.edu.tr

The constituent elements of ZnO, which belongs to the II–VI group of compounds, are abundant in the earth, inexpensive, and environmentally friendly [1]. ZnO is an n-type semiconductor material with a wide band gap of 3.37 eV and a high exciton binding energy of 60 meV [2]. The n-type conductivity of this structure is attributed to zinc interstitials and oxygen vacancies [3]. When a solution-based method is employed for the fabrication of ZnO thin films, one of the factors influencing the properties and performance of the films is the pH value of the prepared solution. The grain size, morphology, and density of the films can be controlled through the pH of the solution [4]. In this context, optimizing the pH value leads to improved film quality and enhanced performance.

In this study, ZnO thin films will be fabricated using the spin-coating method at different pH values (pH 2, 7, 9, and 12) to investigate the influence of pH on the properties of ZnO films. The aim is to determine the optimal pH range for obtaining ZnO films with superior crystal quality, optical transmittance, homogeneity, and a band gap consistent with the literature. This work demonstrates that the properties of ZnO thin films can vary significantly depending on the control of the solution's pH value.

Acknowledgement

The authors gratefully acknowledge the financial support of the Scientific and Technological Research Council of Türkiye (TÜBİTAK) under project grant 122F217.

References

[1] Altuntepe, A., et al., Performance of Si-based solar cell utilizing optimized Al-doped ZnO films as TCO layer. Journal of Materials Science: Materials in Electronics, 2023. 34(1): p. 75.
[2] Nosidlak, N., et al., The thermo-optical and optical properties of thin ZnO and AZO films produced using the atomic layer deposition technology. Journal of Alloys and Compounds, 2022. 900: p. 163313.
[3] Lin, Y.-S., et al., Effect of oxygen to argon flow ratio on the properties of Al-doped ZnO films for amorphous silicon thin film solar cell applications. Thin solid films, 2013. 529: p. 50-53.
[4] Wahab, R., et al., The role of pH variation on the growth of zinc oxide nanostructures. Applied Surface Science, 2009. 255(9): p. 4891-4896.

Structural and Optical Properties of ZnO Compound Synthesized via Polyol Method

Emine Eslem Bulut[1*], Mehmet Selim Aslan[1], Hasan Huseyin Isik[1], Faruk Karadag[1], Dogan Kaya[1,2] and Ahmet Ekicibil[1]

[1]*Department of Physics, Faculty of Arts and Sciences, Cukurova University, Adana, Türkiye*
[2]*Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Cukurova University, Adana, Türkiye*

[*]**Corresponding e-mail:** emineeslemblt@gmail.com

Zinc oxide (ZnO) nanoparticles have attracted significant attention due to their unique optical, electronic, and catalytic properties, making them promising for applications in optoelectronics, sensors, photocatalysis, and biomedical fields [1, 2]. In this study, ZnO was successfully synthesized using the polyol method, and its structural and optical properties were systematically investigated. Structural characterization was performed using X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDS). Optical properties were examined using UV–Vis spectroscopy. XRD results revealed that the synthesized ZnO exhibits a hexagonal wurtzite crystal structure and belongs to the $P6_3mc$ space group. SEM analysis indicated a homogeneous particle distribution with an average size of approximately 150 nm. UV-Vis absorption and transmittance measurements were used to determine the optical band gap via the Tauc method, yielding a value of 2.8 eV.

References

[1] Noua, A.E., Kaya, D., Sigircik, G. T. Tuken, F. Karadag & A. Ekicibil. Enhanced photocatalytic activity in AgCu-decorated ZnO nanoparticles under UV and sunlight. J Mater Sci: Mater Electron **35**, 1220 (2024).

[2] P. Cheng, Y. Wang, L. Xu, P. Sun, Z. Su, F. Jin, F. Liu, Y. Sun, G. Lu. High specific surface area urchin-like hierarchical ZnO-TiO2 architectures: Hydrothermal synthesis and photocatalytic properties, Materials Letters,175, 52-55 (2016).

Au-Pt Nanostructures: Morphology-Driven Enhancement of HER Performance in Alkaline Media

Emre Can Tayfun[1], Ilknur Baldan Isik[1], Hasan Huseyin Isik[1], Idrıs Adanur[1], Mustafa Akyol[2], Dogan Kaya[1,3], Faruk Karadag[1], Ahmet Ekicibil[1]

[1]Department of Physics, Faculty of Art and Sciences, Cukurova University, Adana, Türkiye
[2]Department of Materials Science and Engineering, Faculty of Engineering, Adana Alparslan Türkeş Science and Technology University, Adana, Türkiye
[3]Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Cukurova University Adana, Türkiye.

*__Corresponding e-mail:__ emrecntayfun@gmail.com

Bimetallic Au-Pt nanoparticles (NPs) are of significant interest for energy conversion and sensing technologies due to their unique combination of high catalytic activity, corrosion resistance, and tunable surface chemistry [1]. In particular, equiatomic Au-Pt compositions can leverage synergistic effects between the two metals, offering enhanced performance in electrochemical reactions such as the hydrogen evolution reaction (HER) [2]. In this work, Au-Pt NPs were synthesized via a modified polyol method, yielding well-defined Au-rich cores decorated with ultrasmall Pt domains, as confirmed by SEM images and EDS mapping. X-ray diffraction with Rietveld refinement revealed coexisting *fcc* Au and Pt phases, consistent with partial phase separation. The observed morphology-Au centers with Pt concentrated at particle edges-suggests a bull-cup or side-decorated structure, known to maximize active site exposure and electronic coupling. Electrochemical measurements in alkaline media demonstrated the combined redox signatures of Au and Pt, alongside markedly improved HER performance compared to monometallic Au. The Au-Pt catalyst exhibited a favorable onset potential, low overpotential at practical current densities, and enhanced specific and mass activities, indicating efficient Pt utilization. Furthermore, the catalyst maintained its activity after extended cycling, underscoring its structural and electrochemical stability.

Acknowledgement: This work was financially supported by Cukurova University, Adana, Turkey, under Scientific Research Funding Grand No: FBA-2023-15712.

References

[1] P.S. Cappellari, A.M. Baena-Moncada, R. Coneo-Rodríguez, M.S. Moreno, C.A. Barbero, G.A. Planes, Catalytic enhancement of formic acid electro-oxidation through surface modifications with gold on supported Pt nanoparticles, Int. J. Hydrogen Energy, 44 (2019) 1967-1972.
[2] M. Khalid, X. Zarate, M. Saavedra-Torres, E. Schott, A. Maria Borges Honorato, M. Rafe Hatshan, H. Varela, Electro-reduced graphene oxide nanosheets coupled with RuAu bimetallic nanoparticles for efficient hydrogen evolution electrocatalysis, Chem. Eng. J. (Lausanne), 421 (2021) 129987.

2D Borophene-Doped YBCO Superconductors Produced Using Sol-Gel Method: Production and Characterization

F. Aslan[1*], V. Guckan[1], A.O. Ayaş[2], F. Karadağ[1], M. Akyol[3] and A. Ekicibil[1]

[1]*Department of Physics, Art and Sciences Faculty, Cukurova University, Adana, TURKEY*
[2]*Department of Physics, Faculty of Science and Letters, Adıyaman University, Adıyaman, Turkey*
[3]*Department of Materials Science and Engineering, Faculty of Engineering, Adana Alparslan Türkeş Science and Technology University, Adana, TURKEY*

[*]**Corresponding e-mail:** farukasln22@gmail.com

$YBa_2Cu_3O_{7-x}$ (YBCO) is a copper oxide-based high-temperature superconductor, notable for its sensitive electrical and magnetic properties that vary with oxygen content, and its high current-carrying capacity [1,2].

In this study, the impact of varying 2D borofen dopant concentrations (0.5, 1, 2, and 3 %wt) on the structural and morphological properties of YBCO that was produced using the sol-gel synthesis process were examined. 2D borophene used for borophene doping was obtained using a sonicator. Transmitting sound waves with frequencies higher than 20,000 Hz which generated cavitational pressure waves that caused shock waves to break down the 3D borophene. X-ray diffraction (XRD) was used to analyse the crystal structure of the synthesized YBCO samples and compared each other. Morphological analyses were checked using scanning electron microscope (SEM).

The results of this study showed that the borophene doping did not disrupt the YBCO primary structure and overlapped with the characteristic peaks of Y-123 superconductors. No impurities or new peaks were observed with increasing borophene doping. This indicates that the samples have an orthorhombic YBCO-123 structure and that the doped borophene was successfully incorporated into the YBCO matrix. The obtained results will guide future studies for the production of 2D borophene-doped YBCO superconductor in suitable forms and its appropriate use.

References

[1] Habermeier, H. U. (2016). Science and technology of cuprate-based high temperature superconductor thin films, heterostructures and superlattices—the first 30 years. Low temperature physics, 42(10), 840-862.
[2] Lee, S. H., & Choi, Y. (2009). Effect of oxide dopants on the superconducting properties of YBCO superconductor. Physica B: Condensed Matter, 404(5-7), 734-736.

Structural and Characterization of Pd-Ni Nanoparticles Shyntesized by Modified Polyol Process

Faruk Karadag[1,*], Emre Can Tayfun[1], Zafer Eroğlu[2], Ruveyda Uguz[1*], Onder Metin[2,3], Ahmet Ekicibil[1], Dogan Kaya[1,4]

[1]Department of Physics, Faculty of Art and Sciences, Cukurova University, Adana, Türkiye
[2]Department of Chemistry, Faculty of Sciences, Koc University, Istanbul, Türkiye
[3]Koç University Surface Science and Technology Center (KUYTAM), Sarıyer, Istanbul, Türkiye
[4]Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Cukurova University, Adana, Türkiye

[*]Corresponding e-mail: fkaradag@cu.edu.tr

Pd-Ni bimetallic nanoparticles (NPs) have gained significant attention as efficient and cost-effective alternatives to pure Pd catalysts in energy conversion, fuel cells, and environmental remediation [1, 2]. In this work, Pd-Ni NPs were synthesized through a modified polyol process and comprehensively characterized to evaluate their crystal structure, morphology, and surface chemistry. X-ray diffraction and Rietveld refinement confirmed the formation of a single-phase face-centered cubic (fcc) solid solution across the synthesized samples. Incorporation of Pd into the Ni lattice expanded the unit cell due to its larger atomic radius, while also enhancing crystallinity and reducing microstructural defects at intermediate Pd contents. Optimal compositions exhibited crystallite sizes in the 4–6 nm range, low dislocation densities, and minimal microstrain, consistent with literature criteria for stable alloy nanoparticles. Scanning and transmission electron microscopy revealed well-dispersed, predominantly spherical nanoparticles with average sizes between 5–10 nm and reduced agglomeration compared to monometallic Ni. Elemental analysis by EDS and ICP confirmed homogeneous alloying and close agreement with nominal Pd/Ni ratios. X-ray photoelectron spectroscopy indicated the coexistence of metallic Pd^0 and oxidized Ni^{2+} species, suggesting a synergistic surface chemistry that combines high conductivity with catalytically active oxide sites.

Acknowledgement: This work was supported by the Scientific and Technological Research Council of Türkiye (TÜBİTAK) under the 1001 – Scientific and Technological Research Projects Funding Program, Grand No: 123F475.

References

[1] L. Zhang, L. Zhou, K. Yang, D. Gao, C. Huang, Y. Chen, F. Zhang, X. Xiong, L. Li, Q. Xia, PdNi nanoparticles supported on MIL-101 as high-performance catalysts for hydrogen generation from ammonia borane, J. Alloys Compd., 677 (2016) 87-95.

[2] V. Abdelsayed, G. Glaspell, M. Nguyen, J.M. Howe, M. Samy El-Shall, Laser synthesis of bimetallic nanoalloys in the vapor and liquid phases and the magnetic properties of PdM and PtM nanoparticles (M = Fe, Co and Ni), Faraday Discuss., 138 (2008) 163-180.

Tumor-Specific Fucoidan-Functionalized Mo_2C-MXene Hybrid Nanostructures for Efficient Synergistic Multitherapy of Triple-Negative Breast Cancer

Fatma Yurt[1]*, Ayça Tunçel[2], Derya Ozel[1], Gül Kaya[2], Ozde Gokbayrak[3], Efsun Kolatan[4], Osman Yilmaz[4], Safiye Aktas[3], Kasim Ocakoglu[2]

[1]Ege University, Institute Nuclear Science, Department of Nuclear Applications, 35100, Bornova, Izmir, Türkiye
[2]Tarsus University, Faculty of Engineering, Department of Engineering Fundamental Sciences, 33400 Tarsus, Türkiye
[3]Dokuz Eylül University, Institute of Health Sciences, Department of Laboratory Animals, İzmir, Türkiye
[4]Dokuz Eylul University, Institute of Oncology, Department of Basic Oncology, 35000, Izmir, Türkiye

***Corresponding e-mail:** fatma.yurt.lambrecht@ege.edu.tr

In this study, a multifunctional hybrid nanosystem (PTX/Mo_2C@C@Fuc/Mo_2CTx-MXene@Fuc) was synthesized by integrating Mo_2C@C@Fuc nanospheres with Mo_2CTx-MXene@Fuc nanosheets. After paclitaxel (PTX) loading, the hybrid system exhibited high drug loading efficiency, strong NIR-triggered photothermal and photodynamic effects [1-3], and dual pH/NIR-responsive drug release. This advanced platform was specifically developed to provide targeted and synergistic therapy against triple-negative breast cancer (TNBC) [4]. Comprehensive *in vivo* studies were conducted using a 4T1 murine breast cancer xenograft model to assess the therapeutic performance of the PTX-loaded Mo_2C@C@Fuc/Mo_2C-MXene@Fuc nanohybrid. Mice treated with the hybrid nanostructure followed by NIR laser irradiation exhibited remarkable tumor regression, with 82% necrosis and 12.5% apoptosis detected in tumor tissues. Complete macroscopic disappearance of tumors was observed, indicating efficient eradication of malignant cells. Biodistribution analysis revealed significant accumulation of the nanohybrid in tumor tissue, further enhanced by NIR-induced hyperthermia, while minimal off-target toxicity and only mild, transient hepatic effects were observed. No pathological damage was detected in critical organs, confirming the high biocompatibility and safety of the system. Overall, the engineered Mo_2C-MXene-based hybrid nanostructure provides a highly efficient platform for combined chemo-, photothermal-, and photodynamic therapy, enabling rapid, selective, and minimally toxic treatment of aggressive triple-negative breast cancer *in vivo*. This work highlights the potential of advanced two-dimensional nanomaterial systems for next-generation cancer nanotheranostics.

Keywords: Mo_2C@C@Fuc/Mo_2CTx-MXene@Fuc hybrid, MXene nanostructures, Fucoidan functionalization, Photothermal therapy, Photodynamic therapy, Triple-negative breast cancer.

Acknowledgement

This work was supported by the Scientific and Technological Research Council of Türkiye (TÜBİTAK, Grant No: 122Z055).

References

[1] A. Tunçel et al., Photothermal and photodynamic responses of core-shell Mo_2C@C@Fucoidan nanospheres, Mater. Chem. Phys. 329, 130088 (2025).

[2] G. Kaya et al., Assessment of Mo_2C@C@Fuc/Mo_2C-MXene@Fuc hybrid structures: Potential for photothermal and photodynamic applications, Surf. Interfaces 66, 106554 (2025).

[3] F. Yurt et al., Synthesis, characterization and evaluation of the photochemical properties and photothermal conversion capacities of Mo_2CTx-MXene@Fuc nanohybrids, Diam. Relat. Mater. 153, 112025 (2025).

[4] V. Jain et al., A review of nanotechnology-based approaches for breast cancer and triple-negative breast cancer, J. Control. Release 326, 628–647 (2020).

Development of Surface-Modified Mesoporous Silica Nano-Carriers for Enhanced Drug Delivery

F.Uyan[1], S.Dayan[1,2*]
[1]*Drug Application and Research Center, Molecular Synthesis & Industrial Application Research Laboratory, Erciyes University, 38039 Kayseri, Türkiye*
[2]*Faculty of Pharmacy, Department of Pharmaceutical Sciences, Kayseri, Türkiye*

[*]**Corresponding e-mail:** fatmanuruyan99@gmail.com and serkandayan@erciyes.edu.tr

Mesoporous silica nanospheres (MSNs) have emerged as versatile nanocarriers in drug delivery research owing to their high surface-to-volume ratio, controlled pore size, structural stability, adsorption capacity, and excellent biocompatibility. These unique properties enable efficient drug loading and allow sustained and controlled release, thereby improving therapeutic efficacy compared to conventional formulations [1]. Herein, the surface-modified MSNs were synthesized via a core particle preparation and growth method, resulting in highly porous and size-controlled structures. The nanoparticles were extensively characterized by SEM, EDX, XRD, DLS, and FT-IR analyses, confirming the successful fabrication of uniform and structurally stable silica nanospheres. Doxorubicin (DOX) was subsequently selected as a model anticancer drug and successfully incorporated into the MSNs, as illustrated in **Fig. 1.** Drug release studies were performed using a dialysis membrane method, and preliminary results demonstrated controlled release behaviour. In future stages, high-performance liquid chromatography (HPLC) will be employed to evaluate detailed release profiles quantitatively. The DOX-loaded MSNs represent promising nanocarrier platforms for drug delivery applications. Their tunable morphology, surface functionality, and ability to achieve controlled release highlight their potential in the design of next-generation therapeutic systems.

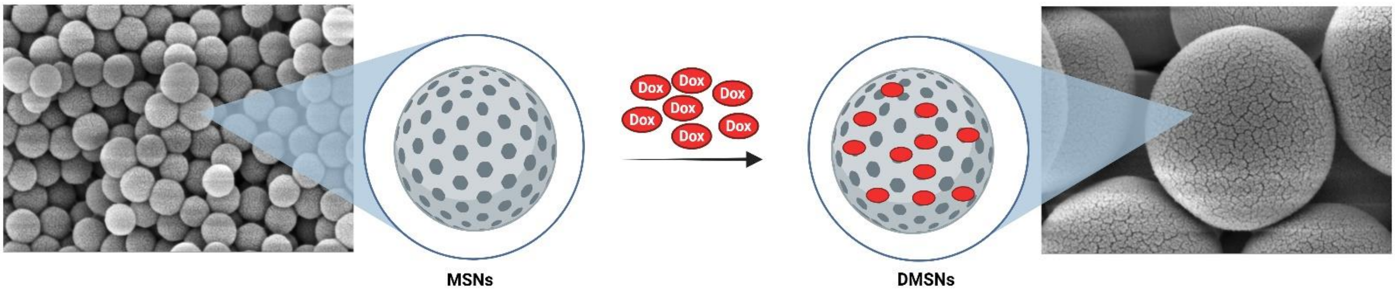

Fig. 1. SEM image of DOX-loaded MSNs

Acknowledgements: This study was supported by TÜBİTAK 2210-C National Scholarship Program for MSc Students and is part of the author's master's thesis, which will be presented at this conference.

References

[1] N. Nik, H. Zare, S. Razavi, H. Mohammadi, P. T. Ahmadi, N. Yazdani, M. Bayandori, N. Rabiee, and J. Izadi Mobarakeh, Smart drug delivery: Capping strategies for mesoporous silica nanoparticles, Microporous Mesoporous Mater. 299, 10115 (2020).

Effects of Substrate Temperature on the Crystal Structure, Optical Properties, and Thickness of NiO Thin Films

Hafize Seda Aydınoğlu[1,2] Hicret Hopoğlu[2,3], Ebru Şenadım Tüzemen[2,3]

[1] *Sivas Cumhuriyet University, Vocational School of Health Services, Sivas, Turkey*
[2] *Sivas Cumhuriyet University, Nanophotonics Research and Application Center, Sivas, Turkey*
[3] *Sivas Cumhuriyet University, Department of Physics, Faculty of Science, Sivas, Turkey*

***Corresponding e-mail:** hsaydinoglu@cumhuriyet.edu.tr

In this study, NiO thin films were grown on glass substrates using the RF magnetron sputtering method at room temperature and at a substrate temperature of 250 °C. The films were examined and compared in terms of their crystal structure, optical properties, and thickness, both before and after annealing. XRD results showed that the films grown at room temperature exhibited distinct diffraction peaks corresponding to the (111), (200), and (220) planes, and that annealing led to the sharpening of the (200) and (220) peaks, indicating an increase in crystallinity. The films grown at 250 °C already exhibited a more intense and ordered crystal structure before annealing, with a notable increase in the intensity of the (111) peak. This indicates that a higher substrate temperature positively affects crystal quality. Optical transmittance measurements revealed that the unannealed film grown at room temperature had the highest transmittance value. In the analysis of the band gap, a slight increase was observed after annealing in the films grown at room temperature, while the change in the films grown at 250 °C remained quite limited. Cross-sectional images also showed differences in film thickness. While the thickness remained nearly constant in the films grown at room temperature, a noticeable increase was observed in the films grown at 250 °C after annealing. This increase is attributed to structural reorganization and densification occurring during the annealing process. The results indicate that the crystal structure, optical properties, and thickness of NiO thin films vary significantly depending on the substrate temperature and the applied annealing process [1].

This study is supported by Sivas Cumhuriyet University Scientific Research Project Fund under the project number F-2024-727.

References

[1] Hopoğlu, H., KAYA, D., Maslov, M. M., KAYA, S., DEMİR, İ., ALTUNTAŞ, İ., ... UNGAN, F.(2023). Investigating the optical, electronic, magnetic properties and DFT of NiO films prepared using RF sputtering with various argon pressures. Physica B: Condensed Matter , vol.661.

Production and Characterization of Dye-Sensitized Solar Cells Using Natural Dyes Extracted from Local Fruits and Vegetables

H.K. Acik[1,*], M. Caglar[1]

[1] *Department of Physics, Faculty of Science, Eskisehir, Tepebasi, TURKEY*

[*] **Corresponding e-mail:** merhababenhkn@gmail.com

In this study, the usability of naturally derived dyes in dye-sensitized solar cells (DSSCs) was investigated. Natural dyes were extracted from locally grown fruits and vegetables specific to the Eskişehir region, including blackberry, purple cabbage, red beet, and pomegranate. These dyes were evaluated in comparison with commercial dyes N719 and N749. As photoanode materials, ZnO nanoparticles synthesized via the hydrothermal method at 180 °C and pH 11, as well as commercial TiO_2, were employed. ZnO photoanodes were deposited onto FTO glass substrates using the doctor blade method, followed by immersion in natural dye solutions to enable dye adsorption. The photoanodes were then assembled with platinum-coated counter electrodes, and the electrolyte was injected into the cells to complete DSSC fabrication.

The fabricated cells were characterized using X-ray diffraction (XRD), UV-Vis spectroscopy, scanning electron microscopy (SEM), and photovoltaic performance measurements. SEM images revealed notable differences in the grain structure and particle size between ZnO and TiO_2 photoanodes. Among the devices sensitized with natural dyes and based on TiO_2 photoanodes, the highest power conversion efficiency (PCE) was achieved using purple cabbage dye, with a value of 0.026%. This was followed by blackberry (0.017%), red beet (0.016%), and pomegranate (0.0036%), respectively. Among the commercial dyes, N719 exhibited the best performance when combined with the ZnO photoanode, achieving a PCE of 1.048% and a short-circuit current density (Isc) of 1.9318 mA/cm^2. Among the natural dye-sensitized cells, those using purple cabbage and blackberry demonstrated the highest open-circuit voltage (Voc) of 0.43 V and high fill factors (FF) of 55% and 52%, respectively.

These results indicate that ZnO, with its favorable morphological properties and promising photovoltaic potential, is a suitable photoanode material for DSSC applications. This study aims to contribute to the advancement of renewable energy technologies by utilizing local and sustainable natural resources.

This work was supported by TÜBİTAK under the 2209A – Undergraduate Students Research Projects Funding Program. We gratefully acknowledge TÜBİTAK for their valuable contributions and support.

References

[1] Eşgin, Halil. "ZnO: Cu ve ZnO: Mn tabanlı boya duyarlı güneş pillerinin fabrikasyonu ve karakterizasyonu." (2021).

[2] Yaka, Pekuslu Armagan. Caglar, Mujdat. Caglar, Yasemin. Electrical performance of dye-sensitized solar cells based nanostructured ZnO synthesized by addition CTAB with hydrothermal method. (2024)

Investigation of Morphological and Chemical Analyses of Ga_2O_3 Thin Films Grown on Sapphire Substrates

Hicret Hopoğlu[1,2*], Hafize Seda Aydınoğlu[2,3] Ebru Şenadım Tüzemen[1,2]

[1] *Sivas Cumhuriyet University, Department of Physics, Faculty of Science, Sivas, Turkey*
[2] *Sivas Cumhuriyet University, Nanophotonics Research and Application Center, Sivas, Turkey*
[3] *Sivas Cumhuriyet University, Vocational School of Health Services, Sivas, Turkey*

[*]**Corresponding e-mail:** akalan23@hotmail.com

In this study, Ga_2O_3 (gallium oxide) thin films were deposited on sapphire (Al_2O_3) substrates using the RF magnetron sputtering technique at powers of 60 W, 90 W, and 120 W. The films were evaluated under both unannealed conditions and after being annealed in air at 850 °C for 1.5 hours. The effects of annealing and applied RF power on the surface morphology and chemical structure of the films were investigated. The surface properties of the films were characterized using Atomic Force Microscopy (AFM), and the obtained average roughness (Ra) and root mean square (Rq) roughness values were evaluated according to the RF power and annealing conditions. The chemical bonding structure was analyzed using Fourier Transform Infrared Spectroscopy (FTIR). The findings indicate that the RF sputtering power significantly influences the morphological and chemical characteristics of Ga_2O_3 films. These results highlight the potential of Ga_2O_3 films as a promising material platform for optoelectronic applications such as UV photodetectors[1].

This work was supported by the Scientific Research Project Fund of Sivas Cumhuriyet University, Turkey, under the project number F-2025-736

References

[1] L. Messeddek, F. Amraoui, L. Arab, and N. Sengouga, Effect of different substrates on the structural, morphological, electrical, and optical properties of β-Ga_2O_3 thin films deposited by the sol-gel spin coating method, J. Sol-Gel Sci. Technol. 113, 159 (2025).

Organic Inorganic Hybrid Nanomaterial bearing HAP, Carbon Dots, and Pr (III): Methotrexate Release and *in vitro* Cytotoxic Activity

İlayda KÖSE[1], Rümeysa BEYAN TAŞDEMİR[1], Hatice BEKCİ[2], Kasım BÜYÜKBEZİRCİ[3], Funda GÜNEY[1], M. Betül YERER AYCAN[4], Serkan DAYAN[1, 2]*

[1]Department of Drug Research, Development and Applications, Erciyes University Institute of Health Science, Talas, Kayseri, Türkiye
[2]Kayseri Unıversity, Develi Hüseyin Şahin MYO, Kayseri, Türkiye
[3]Drug Application and Research Center, Erciyes University, Kayseri, Türkiye
[4]Department of Pharmacology, Erciyes University, Kayseri, Türkiye
[5]Department of Basic Sciences, Erciyes University Faculty of Pharmacy, Talas, Kayseri, Türkiye

***Corresponding e-mail:** ilaydakse6@gmail.com and serkandayan@erciyes.edu.tr

Lung cancer is a significant cause of cancer-related mortality worldwide, and chemotherapy is a prevalent treatment method. Nevertheless, the deleterious effects of chemotherapy agents on healthy cells necessitate limiting their dosage. Methotrexate (MTX) is a drug that inhibits folate-related enzymes, halting the cell cycle and selectively targeting cancer cells. Herein, a novel nanocarrier system was developed using fluorescent carbon dots (CD) obtained from blueberry extract, hydroxyapatite nanoparticles (nHAP), and praseodymium (Pr) ion by a hydrothermal method. This study loaded MTX onto the fabricated nanocarrier, and *in vitro* tests were conducted on the A549 lung cancer cell line. The results demonstrated that the drug release commenced after 24 hours and persisted with regularity. Furthermore, MTX-loaded nanomaterials exert a significant cytotoxic effect on A549 cells. In summary, this plant-derived, fluorescent nanocarrier has the potential to offer a practical alternative in lung cancer treatment by reducing toxicity.

Keywords: Nanocarriers, carbon dots, cancer cells

References

[1] Hano, C., & Abbasi, B. H. (2021). Plant-Based Green Synthesis of Nanoparticles: Production, Characterization, and Applications. *Biomolecules*, *12*(1), 31. https://doi.org/10.3390/biom12010031
[2] [Jia, B., Mei, Y., Cheng, L., Zhou, J., & Zhang, L. (2012). Preparation of copper nanoparticles coated cellulose films with antibacterial properties through one-step reduction. *ACS applied materials & interfaces*, *4*(6), 2897–2902. https://doi.org/10.1021/am3007609, https://pubs.acs.org/doi/full/10.1021/cr400135

Influence of AsH_3 Flow on the Structural, Optical, and Electrical Properties of InAlAs/InP Layers for QCLs

Ömer SÜR[1,2], Abdulrhman ALKRDY[1,2], Merve Nur KOÇAK[1,3], İlkay DEMİR[1,2,*]

[1] Sivas Cumhuriyet University Nanophotonics Application and Research Center-CUNAM, Sivas, 58140, Turkey
[2] Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Turkey
[3] Department of Metallurgy and Materials Science, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Turkey

[*]**Corresponding e-mail:** idemir@cumhuriyet.edu.tr

Quantum cascade lasers (QCLs) function as unipolar semiconductor lasers employing intersubband transitions in engineered multiple quantum-well heterostructures, enabling precise wavelength engineering through layer thickness and composition design [1]. Their performance strongly depends on interface sharpness and barrier quality, since carrier transport and tunneling rates are highly sensitive to growth conditions [2][3]. In InGaAs/InAlAs QCLs on InP, InAlAs serves as the barrier material, and its crystalline quality is directly influenced by arsine (AsH_3) flow during growth. Even slight variations in AsH_3 flow can alter the V/III ratio, affect indium incorporation, and modify interface smoothness, thereby impacting carrier confinement and optical gain, and thus directly determining the overall QCL performance [4].

In this study, the effect of arsine (AsH_3) flow rate on lattice-matched InAlAs layers grown on InP substrates by metal–organic vapor phase epitaxy (MOVPE) was investigated. To analyze the influence of AsH_3 variation, atomic force microscopy (AFM) was used to assess morphological changes, Hall measurements were performed to determine electrical properties, Raman spectroscopy was employed for optical characterization, and high-resolution X-ray diffraction (HRXRD) was conducted to evaluate structural quality. The results highlight the importance of precise growth parameter control in achieving InAlAs layers with properties suitable for high-performance QCL applications.

Acknowledgments

This work is based on results obtained during the ongoing Ph.D. thesis of Merve Nur Koçak, titled “Development of Short- and Mid-Wavelength Quantum Cascade Lasers”. Merve Nur Koçak is supported by the YÖK (Council of Higher Education) 100/2000 Ph.D. Scholarship Program and The Scientific and Technological Research Council of Turkey (TÜBİTAK) 2211/A Program. This study supported by The Scientific Research Project Fund of Sivas Cumhuriyet University, Turkey under the project number MRK-2024-004 and The Scientific and Technological Research Council of Turkey (TUBITAK) under the project number 22AG074.

References

[1] C. Jirauschek and T. Kubis, Modelin Techniques for Quantum Cascade Lasers, Appl. Phys. Rev. 1, 011307 (2014).
[2] G. Scalari and J. Faist, 30 Years of The Quantum Cascade Laser, Communication Physics, 7, 394 (2024).
[3] I. Perkitel and I. Demir, Effect of Si-doped and undoped inter-layer transition time on the strain-compensated InGaAs/InAlAs QCL active region grown with MOVPE, Journal of Molecular Structure, 1272, 134203 (2023).
[4] M. N. Koçak and I. Demir, Superlattice Structure of Quantum Cascade Lasers: Structural and Morphological Effects of AsH_3 Flow, Cumhuriyet Science Journal, 46, 384-389 (2025).

SiH_4 Flow–Dependent Doping Dynamics in MOVPE-Grown InGaAs for Mid-Infrared Quantum Cascade Lasers

Riska Delvia[1, 2], Abdlrahman Alkdry[2,3], Merve Nur Koçak[2,4], Murat Köksal[1, 2], and İlkay Demir[2,3*]

[1] Department of Physics, Faculty of Sciences, Sivas Cumhuriyet University, 58140 Sivas, Türkiye
[2] Sivas Cumhuriyet University Nanophotonics Application and Research Center-CÜNAM, 58140 Sivas, Türkiye
[3] Department of Nanotechnology Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye
[4]Department of Metallurgical and Materials Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye

[*]**Corresponding e-mail:** idemir@cumhuriyet.edu.tr

Indium gallium arsenide is a ternary III–V semiconductor valued for its tunable direct bandgap, high electron mobility, and excellent lattice compatibility with InP substrates. These characteristics make InGaAs highly versatile for optoelectronic applications, including infrared detectors, high-speed communication devices, and mid-wave infrared (MWIR) quantum cascade lasers (QCLs) [1]. In QCL structures, InGaAs is widely employed as the quantum well material in combination with InAlAs barriers, owing not only to their lattice compatibility with InP substrates [2] but also to the favorable band alignment that provides a sufficient conduction band offset to support efficient intersubband transitions and ensure low-resistance electron transport [3]. The crystalline quality of InGaAs layers plays a decisive role in determining QCL efficiency and reproducibility, as even minor deviations in composition, thickness, or interface sharpness can severely impact device performance [4]. Furthermore, doping is another critical factor for QCL operation, as it directly influences carrier concentration, conductivity, and overall gain. InGaAs is commonly doped with silicon (Si) to achieve controlled n-type conductivity [5], making the optimization of doping levels essential for balancing electrical performance with crystal integrity in active region design.

In this study, we specifically examine how SiH_4 flow, used as a silicon doping precursor, affects $In_{0.58}Ga_{0.42}As$ layers grown on InP substrates via metal–organic vapor phase epitaxy (MOVPE) under optimized growth conditions. The SiH_4 flow rate was systematically varied to investigate its influence on structural, electrical, and morphological properties. Characterization was performed using high-resolution X-ray diffraction (XRD) and Raman spectroscopy to evaluate crystal quality, atomic force microscopy (AFM) to analyze surface morphology and roughness, and Hall effect measurements to determine carrier concentration, mobility, and resistivity. The findings establish a clear correlation between SiH_4 flow and key material parameters, enabling identification of an optimal doping condition that enhances QCL active region design by balancing crystal quality, electrical performance, and surface smoothness.

Acknowledgments

This work is based on results obtained during the ongoing Ph.D. thesis of Merve Nur Koçak, titled "Development of Short- and Mid-Wavelength Quantum Cascade Lasers". Merve Nur Koçak is supported by the YÖK (Council of Higher Education) 100/2000 Ph.D. Scholarship Program and The Scientific and Technological Research Council of Turkey (TÜBİTAK) 2211/A Program. This study supported by The Scientific Research Project Fund of Sivas Cumhuriyet University, Turkey under the project number MRK-2024-004 and The Scientific and Technological Research Council of Turkey (TUBITAK) under the project number 22AG074.

References

[1] J. Faist, F. Capasso, D. L. Sivco, C. Sirtori, A. L. Hutchinson, and A. Y. Cho, “Quantum cascade laser,” Science, vol. 264, no. 5158, pp. 553–556 (1994).

[2] M. N. Koçak and İ. Demir, “Superlattice Structure of Quantum Cascade Lasers: Structural and Morphological Effects of AsH_3 Flow,” Cumhuriyet Science Journal, vol. 46, no. 2, pp. 384–389 (2025).

[3] D. Jung, S. Bank, M. L. Lee, and D. Wasserman, “Next-generation mid-infrared sources,” Journal of Optics, vol. 19, no. 12, p. 123001 (2017).

[4] C. A. Wang, B. Schwarz, D. F. Siriani, L. J. Missaggia, M. K. Connors, T. S. Mansuripur, … and F. Capasso, “MOVPE growth of LWIR AlInAs/GaInAs/InP quantum cascade lasers: Impact of growth and material quality on laser performance,” IEEE Journal of Selected Topics in Quantum Electronics, vol. 23, no. 6, pp. 1–13 (2017).

[5] İ. Demir, İ. Altuntaş, B. Bulut, M. Ezzedini, Y. Ergun, and S. Elagoz, “Comprehensive growth and characterization study on highly n-doped InGaAs as a contact layer for quantum cascade laser applications,” Semiconductor Science and Technology, vol. 33, no. 5, p. 055005 (2018).

Improving the quality of AlN films with a gas flow sequence

D.H. Unal[1,2], I. Perkitel[1,3], G. Yolcu[1,4], and I. Demir[1,3]*

[1]Sivas Cumhuriyet University Nanophotonics Application and Research Centre-CÜNAM, 58140 Sivas, Türkiye
[2] Department of Optical Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye
[3] Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye
[4] Department of Metallurgy and Materials Science, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye

***Corresponding e-mail:** idemir@cumhuriyet.edu.tr

Aluminium nitride (AlN) is a critical semiconductor material for high-frequency electronics, ultraviolet (UV) optoelectronic devices, and power electronics circuits, thanks to its wide bandgap, high thermal conductivity, and strong piezoelectric properties [1, 2]. However, parasitic reactions resulting from the simultaneous supply of TMAl and NH_3 gases limit the quality of crystals produced by heteroepitaxial growth of high-quality AlN layers [3].

In this study, AlN films were grown on sapphire substrates using the metal-organic chemical vapour deposition (MOCVD) method. Two different growth approaches were applied by simply changing the order in which the silicon tetrachloride (SiH_4) dopant gas was supplied. In the first method, TMAl and SiH_4 were supplied simultaneously, followed by NH_3 flow. In the second method, NH_3 and SiH_4 were supplied simultaneously, followed by a flow of TMAl. The aim was to promote the participation of Si atoms in the lattice and reduce parasitic reactions.

The resulting films were characterised structurally using XRD and Raman spectroscopy, and morphologically using AFM. The results indicate that the flow sequence of the SiH_4 gas directly affects the crystal structure and surface defects. It was observed that the Si dopant integrated more efficiently into the AlN layers, and that the appropriate flow sequence reduced TMAl–NH_3 parasitic reactions. These findings reveal that the gas flow sequence is a critical parameter in Si-doped AlN growth, providing a powerful tool for controlling the films' structural and surface properties.

Acknowledgement

This study was supported by the TUBITAK-The Scientific and Technological Research Council of Turkey, under project numbers 118F425.

References

[1] K. M. Pürlü, et al., Growth and characterization of PALE Si-doped AlN on sapphire substrate by MOVPE, Mater. Sci. Semicond. Process. 142, 106464 (2022).
[2] G. Yolcu, M. N. Koçak, D. H. Ünal, I. Altuntaş, S. Horoz, and I. Demir, High-quality AlN growth: a detailed study on ammonia flow, J. Mater. Sci.: Mater. Electron. 34(4), 250 (2023).
[3] M. N. Koçak, K. M. Pürlü, I. Perkitel, İ. Altuntaş, and I. Demir, In-situ and ex-situ face-to-face annealing of epitaxial AlN, Vacuum 203, 111284 (2022).

Growth Control Strategies for Superlattice Structures in QCLs

Merve Nur Koçak[1,3], Aslı Bozkurt [1,2], Mohammad Alyosuf [1,2], Gamze Yolcu[1,3] and İlkay Demir [1,2*]

[1]Sivas Cumhuriyet University Nanophotonics Application and Research Center-CÜNAM, 58140 Sivas, Türkiye
[2] Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye
[3] Department of Metallurgy and Materials Science, Faculty of Engineering, Sivas Cumhuriyet University, 58140 Sivas, Türkiye

[*]**Corresponding e-mail:**idemir@cumhuriyet.edu.tr

Quantum cascade lasers (QCLs) are essential mid-wave infrared (MWIR) and long-wave infrared (LWIR) light sources, offering compact size, high output power, and wavelength tunability [1]. They are widely used in gas sensing, environmental monitoring, medical diagnostics, security, defense, and spectroscopic imaging. Unlike conventional semiconductor lasers that rely on band-to-band recombination, QCLs generate light through intersubband transitions within the conduction band, enabling a single electron to emit multiple photons while tunneling through a cascade of quantum wells and barriers. The emission wavelength is defined by nanometer-scale layer thicknesses rather than the material bandgap, allowing precise wavelength engineering. A typical QCL active region consists of 20–30 layers forming a single stage, which is then repeated 20–40 times to realize the cascade process. Consequently, interface sharpness and thickness control are critical for device performance, as even slight deviations can degrade optical gain and efficiency [2]. The successful fabrication of such multilayer structures requires strict control over interface quality, film uniformity, and surface morphology.

In this study, InGaAs/InAlAs QCL superlattices were grown by metal-organic vapor-phase epitaxy (MOVPE) with a focus on interface and film quality optimization. Two growth parameters were systematically varied: AsH_3 flow rate and interface interruption time to enhance atomic ordering during material transitions. Structural, optical, and morphological properties were characterized by high-resolution X-ray diffraction (HRXRD), photoluminescence (PL), and atomic force microscopy (AFM). Results demonstrate that both parameters strongly influence interface sharpness, layer periodicity, and overall film quality—providing practical guidelines for optimized QCL growth

Acknowledgments

This work is based on results obtained during the ongoing Ph.D. thesis of Merve Nur Koçak, titled "Development of Short- and Mid-Wavelength Quantum Cascade Lasers". Merve Nur Koçak is supported by the YÖK (Council of Higher Education) 100/2000 Ph.D. Scholarship Program and The Scientific and Technological Research Council of Turkey (TÜBİTAK) 2211/A Program. This study supported by The Scientific Research Project Fund of Sivas Cumhuriyet University, Turkey under the project number MRK-2024-004 and The Scientific and Technological Research Council of Turkey (TUBITAK) under the project number 22AG074.

References

[1] I. Perkitel and I. Demir, Effect of Si-doped and undoped inter-layer transition time on the strain-compensated InGaAs/InAlAs QCL active region grown with MOVPE, Journal of Molecular Structure, 1272, 134203 (2023).
[2] Demir, Ilkay, and Sezai Elagoz. "Interruption time effects on InGaAs/InAlAs superlattices of quantum cascade laser structures grown by MOCVD." Superlattices and Microstructures 100 (2016): 723-729.

Highly selective PVC–membrane potentiometric sensor for the determination of thiosulfate ions

I. M. Eski[1,*], O. C. Altunoluk[2] and O. Özbek[1]

[1] *Tokat Gaziosmanpaşa University, Faculty of Science and Arts, Department of Molecular Biology and Genetics, 60250 Tokat, Türkiye*
[2] *Tokat Gaziosmanpaşa University, Faculty of Science and Arts, Department of Chemistry, 60250 Tokat, Türkiye*

[*] **Corresponding e-mail:** isaamerteski@gmail.com

Sodium thiosulfate ($Na_2S_2O_3$) is an inorganic compound widely used in various industrial, medical, and environmental applications [1]. Thiosulfate reaches the environment and natural waters through industrial pollution [2]. Sulfite, sulfide and thiosulfate are formed as intermediate products by the oxidation of sulfur and are eventually oxidized to sulfuric acid, causing acidification of environmental water samples [3]. These sulfur species are highly reactive and unstable, making their determination in a variety of samples difficult [4]. There is increasing interest from researchers in the sensitive, simple and rapid determination of sulfur species. In this study, a thiosulfate–selective polymer membrane potentiometric sensor was developed. The proposed sensor exhibited a wide concentration range, low detection limit, fast response time, and good reproducibility. Furthermore, it was applied to various water samples with very high recoveries.

References

[1] P. L. McGeer, E. G. McGeer and M. J. Lee, Medical uses of Sodium thiosulfate, J Neurol Neuromedicine 1(3), 28–30 (2016).

[2] R. Gürkan, N. Altunay, N. Gürkan, Extraction, preconcentration and spectrophotometric determination of trace levels of thiosulfate in environmental waters, J Iran Chem. Soc. 14, 1033–1049 (2017).

[3] Y. Miura, K. Fukasawa, T. Koh, Determination of sulfur anions at the ppb level by ion chromatography utilizing their catalytic effects on the postcolumn reaction of iodine with azide, J. Chromatogr. A 804 (1-2), 143–150 (1998).

[4] A. A. Ensafi, H. A. Soleymani, E. Mirmomtaz, Determination of sulfur contents of SO_3^{2-}, $S_2O_3^{2-}$ and S^{2-} based on the electrocatalytic interaction with homogeneous mediator tris (2,2'-bipyridyl) Ru (II), Microchem. J. 89, 108–115 (2008).

Boosting AlN Thin Film Quality on Patterned Sapphire by Optimizing Temperature Profiles

F. K. Özbakır [1,2] and İ. Altuntaş[1,2*]

[1]*Department of Nanotechnology Engineering, Faculty of Engineering, Sivas Cumhuriyet University, Sivas, Türkiye*
[2] *Sivas Cumhuriyet University Nanophotonic Application and Research Center, Sivas Cumhuriyet University, Sivas, Türkiye*

[*]**Corresponding e-mail:** ialtuntas@cumhuriyet.edu.tr

This study investigates the influence of temperature modulation interfaces on the growth behavior and structural quality of aluminum nitride (AlN) thin films deposited on c-plane patterned sapphire substrates (PSS) using the Pulsed Atomic Layer Epitaxy (PALE) technique. The films were fabricated by metal-organic vapor-phase epitaxy (MOVPE), where all growth parameters were kept constant except for temperature. The high and low growth temperatures were set at 1440 °C and 1250 °C, respectively. Under these conditions, three types of samples were prepared: Sample A, grown with a high/low/high temperature sequence consisting of 1200 cycles for each layer; Sample B, grown with a high/low temperature sequence consisting of 1800 cycles per layer; and Sample C, grown entirely at the high temperature with a continuous 3600-cycle process.

All samples underwent extensive characterization using high-resolution X-ray diffraction (HR-XRD), UV–Vis-NIR spectrophotometry, and scanning electron microscopy (SEM). The analysis revealed that decreasing the number of temperature modulation interfaces significantly improves the crystalline quality of AlN films. Among the samples, Sample C, grown under a constant high-temperature condition, exhibited the smoothest surface morphology, the lowest dislocation density, and the best overall structural quality [1].

These results highlight the critical role of temperature modulation in the epitaxial growth of AlN thin films. Furthermore, the findings highlight that optimizing the temperature profile is essential to enhance both the structural and functional performance of AlN-based materials.

References

[1] Hagedorn, S., Knauer, A., Mogilatenko, A., Richter, E., & Weyers, M. (2016). AlN growth on nano-patterned sapphire: A route for cost efficient pseudo substrates for deep UV LEDs. physica status solidi (a), 213(12), 3178-3185.

Design and Synthesis of Carbazole–Thiophene Dyes for DSSC Applications

K.Görgün[1*], and K. Bozbal[2]

[1] Department of Chemistry, University of Eskisehir Osmangazi, Eskisehir, Turkey
[2] University of Eskisehir Osmangazi, Graduate School of Natural and Applied Science, Eskisehir, Turkey

[*]**Corresponding e-mail:** kgorgun@ogu.edu.tr

Carbazole-based donor–acceptor molecules are promising candidates for organic optoelectronic devices due to their thermal stability, photophysical tunability, and electron-donating character. This study focuses on novel carbazole derivatives functionalized with benzothiophene and thiophene for dye-sensitized solar cell (DSSC) applications. Carbazole derivatives are an important chemical used in organic transistors (OTFT), organic light emitting diodes (OLED) and organic solar cells. So carbazole units can also affect the HOMO level, leading to better hole transporting properties of the materials [1-2]

In this study, we synthesized and designed carbazole based compound (compound IV) by Ullman and Suzuki Miyaura cross-coupling reaction (Figure 1). This synthesized novel molecule (compound IV) has high solubility, easy to purify. All synthesized compounds (III and IV) were characterized by using ^{1}H NMR, ^{13}C NMR, UV-Vis and thermal properties. TiO_2-DSSC's were fabricated using these molecule. To measure the photoelectrochemical properties of the obtained TiO_2-DSSC. The current–voltage characterization of fabricated DSSCs was performed by AM 1.5 simulated. The short current, open circuit voltage, conversion efficiency and fill factor of TiO_2-DSSCs were determined.

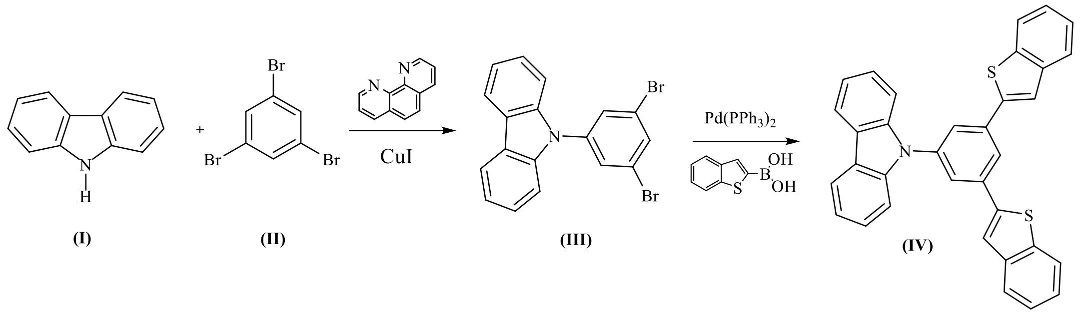

Figure 1 Synthetic route for the 9-(3,5-bis(benzo[b]thiophen-2-yl)phenyl)-9H-carbazole (IV)

References

[1] Tong, J., Guo, P., Zhang, H. et al. Synthesis of modified benzothiadiazole-thiophene-cored acceptor and carbazole/indolocarbazole alternating conjugated polymers and their photovoltaic applications. Polym. Bull. 72, 565–581 (2015). [2] Bozbal, K., Designed, synthesized and characterization of carbazole and thiophene derivative compounds for dye synthesized solar cell (DSSC) applications, Master, Thesis No: 897659, 2024.

GaInP/GaAs/Ge Semiconductor Cell Receiver for Fresnel Lens-Based Concentrated Photovoltaic Modules Developments and Performance Analysis

N. Demirtas Taylan[1], E. Kasapoglu[2], Y. Ozen[3,4], and **M.B. Yücel[1*]**

[1]*Department of Physics, Faculty of Science, Akdeniz University, Antalya, Türkiye*
[2]*Department of Physics, Faculty of Science, Sivas Cumhuriyet University, Sivas, Türkiye*
[3]*Department of Physics, Faculty of Science, Gazi University, Ankara, Türkiye*
[4]*Photonics Application and Research Center, Gazi University, Ankara, Türkiye*

*__Corresponding e-mail:__ myucel@akdeniz.edu.tr

In this study, a Fresnel lens-based concentrated photovoltaic (CPV) module employing GaInP/GaAs/Ge triple-junction semiconductor solar cells was designed and evaluated, with particular emphasis on the development of cell receivers. With the depletion of fossil fuels and the growing impact of environmental challenges, the efficient utilization of solar energy is regarded as a crucial step toward sustainable energy production [1]. Within this context, the development of high-efficiency semiconductor-based solar cells is considered highly significant [2]. Multi-junction III–V cells (GaInP/GaAs/Ge) show higher efficiencies than Si-based cells [3]. A 144-cell CPV panel was fabricated using Fresnel lenses, through which concentrated solar irradiation was directed onto the cells. Aluminum-based receivers were developed, and additional receivers coated with Au, Ag, and Ni were manufactured to assess oxidation under normal atmospheric conditions. Thermal simulations were carried out using SolidWorks, while spectral response and current–voltage measurements were performed experimentally. The triple-junction cells exhibited an open-circuit voltage of 3.1 V, a short-circuit current of 110 mA, and a fill factor exceeding 85%. Long-term outdoor testing indicated that the average panel efficiency remained at ~28%, with oxidation-related efficiency degradation under atmospheric exposure limited to 0.1% over four years. The Fresnel lens structure was found to ensure precise light concentration, while the developed receiver design provided effective passive cooling, preventing thermal losses and structural degradation. In conclusion, the integration of GaInP/GaAs/Ge semiconductor-based triple-junction cells with Fresnel lens concentrators and optimized cell receivers was shown to enable the efficient use of solar energy, while ensuring high efficiency, long-term stability, and cost-effectiveness in next-generation CPV applications.

References

[1] A. Erol and N. Balkan, Yarıiletkenler ve Optoelektronik Uygulamaları, Seçkin Yayıncılık, 2.Baskı, İstanbul, page: 347 (2015).

[2] N. Hui, T. Sanyal and R. Das, A Brief Review on Solar Photovoltaic: A Key to Sustainable Development © International Academic Publishing House (IAPH), N.R. Madhu, T. Sanyal et al. (eds.), A Basic Overview of Environment and Sustainable Development [Volume: 3], pp. 137-151 (2024).

[3] M.A. Green, E.D. Dunlop, J. Hohl-Ebinger, M. Yoshita, N. Kopidakis, A.W.Y. Ho-Baillie, Solar cell efficiency tables (Version 55). Prog. Photovoltaics Res. Appl., 28: 3–15 (2020).

Electrochemical Behaviour of the Ru1 Complex in Non-Enzymatic Glucose Sensors

M.Kucukoflaz Korkmaz [1], S.Dayan [*1,2], N.Ozdemir [3], D.Erdener [4], O.Dayan [4], B.Cetinkaya [5]

[1] *Drug Application and Research Center, Molecular Synthesis and Industrial Application Laboratory (MSIA-Lab), Kayseri, Türkiye.*

[2] *Erciyes University, Faculty of Pharmacy, Department of Pharmaceutical Basic Sciences, Kayseri, Türkiye.*

[3] *Ondokuz Mayıs University, Department of Physics, Faculty of Science, Samsun, Türkiye*

[4]*Osman Dayan, Çanakkale Onsekiz Mart University, Department of Chemistry, Faculty of Sciences, Çanakkale, Türkiye*

[4] *Ege University, Department of Chemistry, Faculty of Sciences, İzmir, Türkiye*

[*]**Corresponding e-mail:** kucukoflazmerve@gmail.com and serkandayan@erciyes.edu.tr

Transition metal complexes have significantly advanced in electrochemical sensor research in recent years due to their high electrocatalytic activity and selectivity [1, 2]. The ruthenium complexes are leading candidates for non-enzymatic glucose sensors due to their ability to catalyze the electrochemical oxidation of glucose [3] effectively. The new Ru1 complex was synthesized using 2,2'-bipyridine-4,4'-dicarboxylic acid (dcbpy) and p-cymene ligands; it has been comprehensively characterized using nuclear magnetic resonance (NMR), Fourier transform infrared spectroscopy (FTIR), ultraviolet-visible spectroscopy (UV-Vis), and single-crystal X-ray diffraction (XRD) methods. The Ru1 complex, whose structural properties were confirmed, was successfully applied to develop a non-enzymatic glucose sensor through strip electrode surface modification.

Electrochemical analyses revealed that the Ru1 complex exhibits high electrocatalytic activity and stability in glucose sensing. Cyclic voltammetry studies showed that increased activity over time, while chronoamperometry measurements provided a linear response ($R^2 = 0.9855$) and sensitivity of 0.00245 mA mM^{-1} cm^{-2} in the 0.1–0.8 mM concentration range. These results indicate that the Ru1 complex is a strong candidate for developing next-generation non-enzymatic glucose sensors.

Keywords: Glucose biosensor, ruthenium complex, strip electrode, potentiostat/galvanostat

References

[1] Lee, Lawrence Cho-Cheung, and Kenneth Kam-Wing Lo. Shining new light on biological systems: Luminescent transition metal complexes for bioimaging and biosensing applications, Chemical Reviews 124.15 8825-9014 (2024).

[2] Oiye, É. N., Ribeiro, M. F. M., Katayama, J. M. T., Tadini, M. C., Balbino, M. A., Eleotério, I. C., ... & de Oliveira, M. F. (2019). Electrochemical sensors containing Schiff bases and their transition metal complexes to detect analytes of forensic, pharmaceutical, and environmental interest. A review. Critical Reviews in Analytical Chemistry, 49(6), 488-509.

[3] Chmayssem, A., Nadolska, M., Tubbs, E., Sadowska, K., Vadgma, P., Shitanda, I., ... & Zebda, A. (2023). Insight into continuous glucose monitoring: from medical basics to commercialized devices. Microchimica Acta, 190(5), 177.

Design of Sc doped YRh intermetallic material: prediction of structural parameters and stability using density functional theory

Merve Ozcan*, Ali Kemal Havare and Cevher Ak

Department of Electric Electronic Engineering, Faculty of Engineering, Mersin, Türkiye

***Corresponding e-mail:** merve.ozcan@toros.edu.tr

In present study, first-principles calculations based on density functional theory (DFT) were employed to investigate the ground state structural parameters of YRh in its cubic phase (*space group* $Pm\bar{3}m$, *No. 221*) at ambient conditions. Furthermore, the structural parameters of the YRh supercell structure were systematically evaluated following Scandium (Sc) doping. Geometric optimization calculations allowed for the precise determination of the relaxed atomic positions of Y and Rh atoms situated within the crystallographic unit cell. The supercell structure was constructed utilizing the equilibrium atomic positions derived from the structural optimization of the unit cell of YRh. It was replaced one Rh atom in the supercell structure with one Sc atom, then this doping concentration corresponds to 6.25% in the $YRh_{1-x}Sc_x$ phase composition. The bond length of pristine and doped YRh calculation. First-principles calculations were conducted using the Generalized Gradient Approximation (GGA) in the Perdew Burke Ernzerhof (PBE) functional [1], as implemented in the Quantum ESPRESSO software package and code [2]. The obtained structural parameters are in close agreement available previously reported studies.

References

[1] Perdew J. P., Burke K., Ernzerhof M. Generalized gradient approximation made simple. Physical Review Letters, 77, 3865, (1996).

[2] Giannozzi, P. et al. QUANTUM ESPRESSO: a modular and open-source software project for quantum simulations of materials, Journal of Physics: Condensed Matter, 21, 395502, (2009).

Fabrication of CTS Thin Films on Flexible Mo-Foil via Two-Stage Processing

M. Çam[1*], Y. Atasoy[2], R. Zan[1] and M.A. Olgar[1*]

[1]*Department of Physics, Niğde Ömer Halisdemir University, Niğde, Türkiye*

[2]*Niğde Zübeyde Hanım Vocational School of Health Services, Niğde Ömer Halisdemir University, Niğde, Türkiye*

[*]**Corresponding e-mail:** meryem_cam@mail.ohu.edu.tr

Cu_2SnS_3 (CTS) is a promising p-type semiconductor material for thin film photovoltaic and optoelectronic applications due to its earth-abundant, non-toxic constituents, suitable band gap (~0.9–1.6 eV), and high absorption coefficient ($>10^4$ cm^{-1}) [1]. However, challenges such as the formation of secondary phases, non-stoichiometric compositions, and Sn volatility during high-temperature processing can limit the performance of CTS-based devices. Therefore, one of the most critical steps in achieving the desired film homogeneity and chemical composition in CTS thin films is the thermal treatment applied after precursor layer deposition.

In this study, an alternative approach was adopted to produce high-quality CTS thin films by optimizing sulfurization parameters. While conventional studies commonly employ tube furnaces with relatively low heating rates (~25 °C/min), this work utilizes Rapid Thermal Processing (RTP) to achieve rapid heating, controlled sulfurization, and precise adjustment of temperature ramping and dwell times. The effects of heating rates ranging from 0.25 to 1.0 °C/s on the structural and morphological properties of CTS films will be systematically investigated.

This work demonstrates that the properties of CTS thin films can be tailored through the control of different heating rates, thereby providing valuable insights for the development of high-efficiency CTS-based solar cells.

Acknowledgement

The authors gratefully acknowledge the financial support of the Scientific and Technological Research Council of Türkiye (TÜBİTAK) under project grant 122F217

References

[1] He, M., et al., Influence of sulfurization temperature on photovoltaic properties of Ge alloyed Cu2SnS3 (CTGS) thin film solar cells. Solar Energy Materials and Solar Cells, 2018. 174: p. 94-101.

Machine Learning-Based Modeling of Magnetic Field-Dependent Magnetization for Magnetocaloric Materials

Mustafa Çakır[1*], Arda Kandemir[2], and Ali Osman AYAŞ[3]

[1] Department of Electrical and Electronics Engineering, Faculty of Engineering and Natural Sciences,
Iskenderun Technical University, Hatay, Türkiye
[2] Department of Physics, Faculty of Science and Letters, Çukurova University, Adana, Türkiye
[3] Department of Physics, Faculty of Science and Letters, Adıyaman University, Adıyaman, Türkiye.

[*]**Corresponding e-mail:** 98mustafacan@gmail.com

The thermal behavior of a magnetic material under an applied magnetic field is known as the magnetocaloric effect. It is the heart of the magnetic refrigeration system. Due to the harmful effects of the current cooling system, scientists study on alternative solutions and the magnetocaloric cooling system is one of them as this technology is based on sustainable, green, and cost-effective principles [1-3]. For producing compounds that are suitable as magnetic refrigerants, analysis and measurements are important. The temperature dependent and applied magnetic field dependent magnetization measurements are the backbone of these analyses. But these measurements are time-consuming and they require specialized equipment which comes at a cost. Before the analysis results, if we have a model to predict measurements (e.g., magnetic field dependence magnetization), it will save our time and budget which will make a cost-effective solution. Therefore, the model used in this study was established to produce to the applied magnetic field dependence magnetization curves with respect to the applied magnetic field, using the temperature dependence magnetization curve.

Machine learning models are popular computational methods for calculating, predicting, and visualizing. Python is one of the programming languages used in machine learning. For this study, Python is used to analyze the temperature dependence of magnetization for predicting the magnetic phase transition temperature. On the other hand, the support of the machine learning model (sklearn library), the mathematical equation was created from an example applied magnetic dependent magnetization data. Converting data from temperature dependence to applied magnetic field dependence magnetization by using the created model and equation, the predicted graph is plotted using the matplotlib [4] library of Python. The actual and the predicted data are plotted in the same graph to analyze the difference between the experimental and predicted data. For a better understanding of the difference in these data, the regression graph is also plotted. According to the regression plot, the fitting of these two data sets is well matched, and our machine learning model works successfully.

Keywords: Machine learning; Python; Scikit-learn; Magnetocaloric effect; Double Perovskite; affordable and clean energy

References

[1] M. Falsaperna and P. J. Saines, Development of magnetocaloric coordination polymers for low temperature cooling. Dalton Transactions 51(9), (2022) 3394-3410.

[2] X. Miao, C. Wang, T. Liao, S. Ju, J. Zha, W. Wang, J. Liu, Y. Zhang, Q. Ren, F. Xu and L. Caron, Novel magnetocaloric composites with outstanding thermal conductivity and mechanical properties boosted by continuous Cu network. Acta Materialia 242, (2023) 118453.

[3] A. Kitanovski, Energy Applications of Magnetocaloric Materials. Advanced Energy Materials 10(10), (2020) 1903741.

[4] J. D. Hunter, Matplotlib: A 2D Graphics Environment. Computing in Science & Engineering 9(3), (2007) 90-95.

Significance of Deposition Time on Linear and Nonlinear Optical Properties of $Cu_{0.06}Zn_{0.94}S$ Thin Films Grown by CBD

O. Erken[1*]

[1]*Department of Physics, Faculty Science and Letters, Adıyaman University, Adıyaman, Türkiye*

[*]**Corresponding e-mail:** ozgerken@adiyaman.edu.tr

Today, environmentally friendly, low-cost, optically tunable semiconductor thin film materials offer significant potential for sustainable technologies such as solar cells, photodetectors and optoelectronic devices [1,2]. In this study, the effect of deposition time on the linear and nonlinear optical properties of $Cu_{0.06}Zn_{0.94}S$ thin films, which are known for their environmentally friendly and tunable optical properties, was investigated. $Cu_{0.06}Zn_{0.94}S$ thin films were grown on glass substrates by chemical bath deposition (CBD) method at 60 °C for 2, 4, and 6 hours. Film thicknesses were calculated as 55, 92, and 183 nm, respectively, by gravimetric analysis. UV-Vis spectroscopy analyses revealed that optical transmittance (T%) values in the visible region 59%-91% in the visible region, and refractive index (n) values (at λ=550 nm) were 1.49, 1.65, and 1.84, respectively. The direct optical band gap (E_g) values determined by the Tauc method, were found to be 3.24, 3.41 and 3.61 eV. Additionally, from the nonlinear optical parameters; first order optical susceptibility ($\chi^{(1)}$), third order nonlinear optical susceptibility ($\chi^{(3)}$), and nonlinear refractive index (n_2) values were found in the range of 0.069–0.294, 3.974×10^{-12}–1.279×10^{-9} esu, and 1.094×10^{-12}–1.022×10^{-8} esu in the visible region, respectively.

The results of this study all show that deposition time in the CBD method has a direct and significant effect on both linear and nonlinear fundamental optical parameters. According to findings, it was shown that $Cu_{0.06}Zn_{0.94}S$ thin films are suitable for use as buffer layers in solar cells due to their wide band gap, high optical transmittance, and refractive index values in the visible region [3]. In addition, the optical properties of these films can be adjusted depending on the deposition time, indicating that they can be used as functional semiconductor thin films in various technologies. In conclusion, this study demonstrated that $Cu_{0.06}Zn_{0.94}S$ thin films are a promising, environmentally friendly alternative to among semiconductor thin films for use in sustainable clean energy applications, such as solar cells.

References

[1] Hassanien, A.S., Akl, A.A. & Redaf, I.M.E. Optical characteristics of the novel nanosized thin $ZnGa_2S_4$ films sprayed at different deposition times: Determination of optical band-gap energy using different methods, Emergent Mater. 6, 943–964 (2023).

[2] H.-J. Jeong, Y.-C. Kim, S.K. Lee, J.-H. Yun, J.-H. Jang, Enhanced spectral response of CIGS solar cells with anti-reflective subwavelength structures and quantum dots. Sol. Energy Mater. Sol. Cells. 194, 177–183 (2019).

[3] O. Erken, Preparation and Physical Characterization of $Cu_xZn_{1-x}S$ Thin Films: Investigation of Their Usability as Buffer Layer in Solar Cells, AKU J. Sci. Eng. 20(5), 783–793 (2020).

Pd-Co Nanoparticles with Enhanced Catalytic and Magnetic Properties

Ruveyda Beyza Uguz[1*], Emre Can Tayfun[1], Faruk Karadag[1], Zafer Eroğlu[2], Onder Metin[2,3], Ahmet Ekicibil[1], Dogan Kaya[1,4]

[1]*Department of Physics, Faculty of Art and Sciences, Cukurova University, Adana, Türkiye*
[2]*Department of Chemistry, Faculty of Sciences, Koc University, Istanbul, Türkiye*
[3]*Koç University Surface Science and Technology Center (KUYTAM), Sarıyer, Istanbul, Türkiye*
[4]*Department of of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Çukurova University, Adana, Türkiye*

[*]**Corresponding e-mail:** uguzruveyda@gmail.com

Nanotechnology enables the manipulation of matter at the nanometer scale, paving the way for ground breaking advancements in various fields. As one of the fundamental components of this field, nanoparticles (NPs) play a critical role in numerous applications such as material development and environmental technologies due to their high surface to volume ratios and size dependent unique properties. In this context, multifunctional NPs, especially those synthesized with two metals, offer both catalytic and magnetic properties, offering promise for many technological applications [1, 2]. In this study, NPs containing Pd and Co were synthesized using the modified polyol method and were comprehensively characterized. The structural properties of Pd-Co NPs synthesized via the chemical reduction method were investigated by X-ray diffraction and Rietveld analysis, and the obtained data indicated the formation of a face-centered cubic crystal structure. Morphological analyses were performed using scanning electron microscopy, and it was observed that spherical NPs with a size of approximately 28 nm were obtained when Polyvinylpyrrolidone was used as a surfactant. Catalytic performance evaluation will guide future studies [2]. Additionally, the magnetic properties of the synthesized two-component metal NPs were measured in the temperature range of 5-300 K under zero-field cooling and field cooling conditions. Compared to other bimetallic systems reported in the literature, the synthesized Pd-Co NPs demonstrated more stable and stronger magnetic responses, especially under varying temperature conditions, making them a promising alternative for magnetic-based technologies. The findings reveal that Pd-Co NPs are a strong candidate for both catalysis and magnetic based applications.

Acknowledgements: This work was supported by the Scientific and Technological Research Council of Türkiye (TÜBİTAK) under the 1001 – Scientific and Technological Research Projects Funding Program, Grand No: 123F475.

References

[1] H. Lin, Y. Liu, J. Deng, L. Jing, Z. Wang, L. Wei, Z. Wei, Z. Hou, J. Tao, H. Dai, Bimetallic nanoparticles: advances in fundamental investigations and catalytic applications, Environmental Science: Advances, 4 (2025) 33-56.

[2] H. Xue, J. Tang, H. Gong, H. Guo, X. Fan, T. Wang, J. He, Y. Yamauchi, Fabrication of PdCo Bimetallic Nanoparticles Anchored on Three-Dimensional Ordered N-Doped Porous Carbon as an Efficient Catalyst for Oxygen Reduction Reaction, ACS Appl. Mater. Interfaces, 8 (2016) 20766-20771.

Sol–Gel Spin Coated SnO_2 TFTs: Influence of Gate Dielectric Material and Thickness on Device Performance

S. Aktas[1,2*] and M. Caglar[1]

[1] Department of Physics, Faculty of Science, Eskisehir Technical University, Eskisehir, Türkiye
[2] Savronik Electronics Industry and Trade Inc., Eskisehir, Türkiye

***Corresponding e-mail:** seda_aktas@ogr.eskisehir.edu.tr

In this study, the electrical and optoelectronic performance of SnO_2-based thin-film transistors (TFTs) was comparatively evaluated using SiO_2 and HfO_2 gate dielectrics of varying thicknesses. Both the HfO_2 gate dielectrics and the SnO_2 active layers were fabricated via the sol–gel spin coating method. The results demonstrated that optimizing the dielectric thickness significantly influences device performance. Notably, structures with thinner dielectrics exhibited higher field-effect mobility and operated at lower voltages. All devices exhibited phototransistor behavior under varying light intensities. Devices with appropriately optimized dielectric layers showed improved photoresponsivity and detection capabilities under illumination. These findings confirm that SnO_2-TFTs, when properly configured through careful dielectric selection, are promising candidates for low-voltage, high-performance phototransistor applications.

References

[1] S. Aktas, M. Caglar, Electrical performance and HfO_2 gate dielectric optimization of SnO_2 thin film phototransistors, Mater. Sci. Eng., B 308 (2024) 117587,https://doi.org/10.1016/J.MSEB.2024.117587.

[2] S. Aktas, M. Caglar, Effect of SiO_2 gate insulator on electrical performance of solution processed SnO_2-Based thin film phototransistor, Physica B Condens Matter 670 (2023) 415337, https://doi.org/10.1016/J.PHYSB.2023.415337.

Luminescence Characterization of Ce-doped YBO_3 and $GdBO_3$ phosphors

S. Darilmaz*[1], and V. Altunal[1]

[1]*Cukurova University, Physics Department 01250, Saricam, Adana, TÜRKİYE*

***Corresponding e-mail:** darilmazselahattin@gmail.com

In this study, the dosimetric performance of two borate-based host materials—YBO_3 and $GdBO_3$ doped with Ce^{3+} was investigated using samples produced using a solid-state synthesis approach. Mixtures prepared from the starting reactants Y_2O_3-Gd_2O_3 and H_3BO_3 were calcined at 1000 – 1200 °C. Following pelletization and sintering, phase purity was verified by XRD and morphology was verified by SEM. Optical characterization was conducted using TL/OSL methods, and dosimetric measurements were performed using the Risø DA-20 system (integrated $^{90}Sr/^{90}Y$ source) [1].

Preliminary findings indicate that distinct OSL signals and characteristic decay curves were obtained in the Ce-doped YBO_3 and $GdBO_3$ samples with 100 s of OSL excitation under 470 nm blue light after 1 Gy beta irradiation. This behavior suggests that Ce^{3+}-induced capture-release processes are coupled to effective trapping centers within the material.

In conclusion, YBO_3 and $GdBO_3$ systems engineered with Ce-doping are promising candidates for the development of portable, low-cost, and reliable dosimeters due to their (i) simple and scalable solid-state fabrication processes, (ii) stable OSL response, and (iii) potential low MDD values. These findings support the strategic use of the boron-based indigenous materials ecosystem in dosimetric fields.

References

[1] L. Bøtter-Jensen, K.J. Thomsen, M. Jain, Review of optically stimulated luminescence (OSL) instrumental developments for retrospective dosimetry, Radiat. Measur., 45 (2010) 253-257.

Characterization and Release Studies of Dual Drug-Loaded PEG-PLGA Nanoparticles for Lung Cancer Treatment

Selin Güleç [1*], Fatma Yurt [2], Korhan Altunbaş[3]

[1] *Ege University, Institute of Natural and Applied Sciences, Department of Biotechnology, 35100, Bornova, Izmir, Türkiye*
[2]*Ege University, Institute Nuclear Science, Department of Nuclear Applications, 35100, Bornova, Izmir, Türkiye*
[3]*Afyon Kocatepe University, Faculty of Veterinary Medicine, Department of Histology and Embryology, Afyon, Türkiye*

*__Corresponding e-mail:__ selin.glc@gmail.com

Paclitaxel (PTX) and carboplatin (CRB) are widely used as an effective chemotherapeutic drug in lung cancer treatment. It has been reported that these two drugs target cancer cells through different mechanisms, creating a synergistic effect and enhancing treatment efficacy [1]. In this study, we carried out the characterization and release profiles of poly(ethylene glycol) methyl ether-block-poly(lactide-co-glycolide) (PEG-PLGA) nanoparticles designed as biocompatible and controlled drug delivery systems. PTX and CRB were successfully co-loaded into PEG-PLGA nanoparticles using the double emulsion–solvent evaporation method to achieve a synergistic therapeutic outcome [2]. The nanoparticles (PTX+CRB@PEG-PLGA) designed were characterized by Fourier Transform Infrared Spectroscopy (FTIR) and Dynamic Light Scattering (DLS). Drug loading efficiency (EE) and drug loading capacity (DL) were determined by UV-Vis spectrophotometry. Release studies were performed in PBS at pH 5.5 and 7.4. The hydrodynamic diameter of the PTX+CRB@PEG-PLGA nanoparticles was measured as 196.9±9.85 nm, with a polydispersity index (PDI) of 0.508, indicating a moderately uniform size distribution. The zeta potential was determined to be –13.9 ± 0.70 mV, reflecting the surface charge stability of the nanoparticles. The encapsulation efficiencies (EE) were calculated as 65.73 ± 1.4% for PTX and 45.1 ± 2.6% for CRB, while the drug loading capacities (DL) were 25.48 ± 0.92% for the dual formulation. *In vitro* release studies showed that PTX release from the dual-loaded system was 46.75 ± 4.92% at pH 5.5 and 29.87± 4.90% at pH 7.4, whereas CRB release was 50.01 ± 4.92% at pH 5.5 and 35.89 ± 4.90% at pH 7.4, after 168 hours. These findings demonstrate that dual drug-loaded PEG-PLGA nanoparticles provide an effective nanocarrier platform for the controlled release of both hydrophobic and hydrophilic drugs in lung cancer therapy and hold promise for combination chemotherapy. *In vitro* cell studies to assess the biological efficacy of the formulations are planned.

Keywords: Lung cancer, paclitaxel, carboplatin, PEG-PLGA, drug delivery system, controlled release, nanotechnology.

Acknowledgment: This study was supported by the Scientific Research Projects Coordination Unit of Ege University under project number FM-DKT-2024-32536.

References

[1] W. Zhang et al., “Prodrug-based nano-drug delivery system for co-encapsulate paclitaxel and carboplatin for lung cancer treatment,” Drug Deliv., vol. 23, no. 7, pp. 2575–2580, 2016.
[2] Y. Chevalier and M.-A. Bolzinger, “Micelles and nanoemulsions,” in Nanocosmetics: From Ideas to Products, Springer, 2019, pp. 47–72.

Green Synthesis of Pt Nanoparticles Using Rosemary Extract: Structural and Catalytic Properties

Selin Karavul[1]*, Emre Can Tayfun[1], Dogan Kaya[1,2], Faruk Karadag[1], Ahmet Ekicibil[1]

[1]Department of Physics, Faculty of Art and Sciences, Cukurova University, 01250, Adana, Türkiye
[2]Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Çukurova University, 01250, Adana, Türkiye

***Corresponding e-mail:** selinkrvl@gmail.com

In recent years, the increasing energy demand and the environmental impacts of fossil fuels have heightened interest in clean and sustainable energy sources. Hydrogen energy holds great potential due to its zero-emission combustion product—water—and its easy portability. It is particularly preferred for clean and efficient energy generation in fuel cells [1]. Platinum nanoparticles (Pt NPs) exhibit high catalytic performance in reactions such as the hydrogen evolution reaction (HER) owing to the intrinsic catalytic activity [2]. Conventional synthesis methods, however, pose environmental toxicity and high energy consumption challenges. Therefore, plant extract-based green synthesis offers an environmentally friendly and sustainable alternative. In this study, Pt NPs were synthesized via green reduction of Pt(acac)$_2$ metal salts using rosemary extract as a natural reducing agent. The synthesis was carried out in a closed system, at low temperature, under argon atmosphere, without the addition of chemical catalysts, using an ethanol-based rosemary extract prepared in stoichiometric proportions. The reaction followed the polyol method, where the NPs formation was driven by the reducing capacity of rosemary's natural bioactive components such as carnosic acid and rosmarinic acid. The structure and distribution of the obtained Pt NPs were characterized by X-ray diffraction, scanning electron microscopy coupled with energy dispersive X-ray spectroscopy, and Raman spectroscopy. Raman spectra revealed characteristic peaks at 1460 cm^{-1} corresponding to CH$_2$ bending, 1617 cm^{-1} attributed to aromatic C=C vibrations, and 2939 cm^{-1} associated with aliphatic C–H stretching, supporting the presence of bioactive compounds such as 1,8-cineole and rosmarinic acid in the rosemary extract. XRD analysis of the Pt NPs sample showed characteristic cubic phase peaks corresponding to both Pt and PtO$_2$. The calculated crystallite sizes were 2.27 nm for Pt NPs and 8.57 nm for PtO$_2$ NPs. Partial oxidation of Pt NPs is believed to result from the redox properties of phenolic and terpene derivatives present in the rosemary extract. Furthermore, surface morphology and elemental composition analyses were performed using SEM and EDS. Catalytic performance results will be discussed.

Aknowledgement: This work was supported by the Scientific and Technological Research Council of Türkiye (TÜBİTAK) under the 2209-A Program, Project No. 1919B012419837.

References

[1] S. Algburi, H. Munther, O. Al-Dulaimi, H.F. Fakhruldeen, I.B. Sapaev, K.F.K.A. Seedi, D.H. Khalaf, F.I. Jabbar, Q. Hassan, A. Khudhair, G. Nakimera, Green Hydrogen Role in Sustainable Energy Transformations: A Review, Results in Engineering, 26 (2025).

[2] C. Zhang, X. Shen, Y. Pan, Z. Peng, A review of Pt-based electrocatalysts for oxygen reduction reaction, Frontiers in Energy, DOI 10.1007/s11708-017-0466-6(2017) 1-18.

Biosensor Applications of Ruthenium Complexes Bearing Schiff Base Ligands

H. KAPLAN[1], E. K. U. KURUN[1] , R. B. TAŞDEMİR[1], and S. DAYAN[1,2*]

[1] Erciyes University, Drug Application and Research Center, Molecular Synthesis and Industrial Applications Laboratory (MSIA-Lab), Talas, Kayseri, Türkiye

[2] Department of Pharmaceutical Basic Sciences, Erciyes University Faculty of Pharmacy, Talas, Kayseri, Türkiye

[*]**Corresponding e-mail: :** serkandayan@erciyes.edu.tr

Ruthenium (Ru) is a rare transition metal distinguished by its high electrical conductivity, resistance to tarnishing, and broad chemical versatility. These characteristics make ruthenium highly valuable in catalysis, biomedical applications, and drug delivery systems. The ruthenium complexes are widely utilized in biosensor technologies due to their sensitivity, selectivity, signal-generation capability, and biocompatibility [1,2]. Also, they play a pivotal role in electrochemiluminescence (ECL)-based biosensors. When they are synthesized with specific ligands, these complexes acquire distinct electrochemical and optical properties, enabling selective recognition of target biomolecules. In ECL systems, ruthenium(II) complexes emit light upon electrical stimulation, and the emitted intensity varies depending on the interaction with the analyte. This property allows the sensitive detection of biomolecules at very low concentrations [3].

In this work, the sulfonamide ligands with enhanced structural features and potential for diverse applications were synthesized by using 4-fluorobenzenesulfonyl chloride and 4-(trifluoromethyl)benzenesulfonyl chloride. Subsequently, the novel Ru(II) complexes were prepared with these ligands for potential biosensor applications. Their structures will be verified through FT-IR, NMR, and XRD analyses. The synthesized and chemically characterized ruthenium complexes will then be employed in enzyme-free glucose biosensors. Given their proven stability and catalytic activity in electrochemical sensor technologies, these ruthenium complexes represent promising candidates for the development of biocompatible, cost-effective, and stable glucose sensors.

References

[1] A. K. Sahu, K. D. Deepak, M. Koushlesh, P. M. Saraswati, R. Yadav, and P. Kashyap, 'Properties and Applications of Ruthenium' Noble and Precious Metals - Properties, Nanoscale Effects and Applications. (2018).

[2] J. Hafeez, M. Bilal, N. Rasool, U. Hafeez, S. A. A. Shah, S. Imran, Z. A. Zakaria, Synthesis of ruthenium complexes and their catalytic applications: A review, Arabian Journal of Chemistry. 15 (11) 104165 (2022).

[3] W.M Haynes, RC Handbook of Chemistry and Physics (97th ed.). CRC Press (2016).

Fabrication and Characterization of ZnS/CdS Multilayer Thin Films by Chemical Bath Deposition

Şahide Gülizar Kızıl[1*], Sevda İldan Özmen[2,3], and Hülya Metin Gübür[1]

[1]*Department of Physics, Faculty of Science, Mersin, Türkiye*
[2]*Advanced Technology Education Research and Application Centre, Mersin University, Mersin, Türkiye*
[3]*Technical Science Vocational School, Department of Chemistry and Chemical Processing Technologies, Mersin, Türkiye*

***Corresponding e-mail:** sahidegulizarkizil@gmail.com

In this study, multilayer ZnS/CdS thin films consisting of nine consecutive layers were produced on glass substrates by the chemical bath deposition (CBD) method, starting with ZnS as the first layer. The primary objective is to explore the potential contributions of such multilayer architectures to nanotechnology and to investigate the structural characteristics of the resulting films.The structural, optical, morphological, and electrical properties were investigated by X-ray diffraction (XRD), UV–Vis spectrophotometry, field-emission scanning electron microscopy (FE-SEM), and Hall-effect measurements, respectively. As members of the II–VI semiconductor group, ZnS and CdS are promising materials for optoelectronic applications owing to their wide band gaps, high transmittance, and cost-effective processability. The multilayer configuration was designed to exploit band gap differences between ZnS (≈3.5–3.9 eV) and CdS (≈2.4 eV), enabling precise control of transmittance, reflectance, and electron transport through band discontinuities at the interfaces [1,2].

Keywords: CdS, ZnS, multilayers, thin film, chemical bath deposition, characterization.

References

[1] T. Abza, S. Tadesse, D. M. Andoshe, Characterization of CdS/ZnS and CdS/CoS multilayer thin films synthesized by chemical bath deposition, International Journal of Thin Film Science and Technology, 10,1 (2021).
[2] R. Sharma et al., Effect of Chemical Bath Deposition Variables on the Properties of ZnS Thin Films: A Review, PubMed Central, *28*, 6 (2023).

Thermoluminescence characteristics of SrB_6O_{10}:Dy,Na phosphors

A. Ozdemir[1], **V. Altunal[2*]**, and Z. Yegingil[3]

[1] Kahramanmaras Istiklal University, Elbistan Vocational High School of Health Service, Kahramanmaras, TÜRKİYE
[2] Cukurova University, Physics Department 01250, Saricam, Adana, TÜRKİYE
[3]Toros University, Engineering Faculty, Electrical and Electronic Engineering Department, Mersin, TÜRKİYE

[*]Corresponding e-mail: valtunal@cu.edu.tr

In this study, SrB_6O_{10}-based phosphor materials were synthesized using the solution combustion synthesis (SCS) method using Dy^{3+} doping and Na^+ co-doping. Structural analyses were performed using XRD and SEM techniques, and the effects of Dy^{3+} and Na^+ doping on the crystal structures of the obtained samples were revealed. Photoluminescence (PL), radioluminescence (RL), and thermoluminescence (TL) measurements showed that the optical properties of the material were significantly improved with doping. In particular, the 470 nm (blue) and 570 nm (yellow) emission peaks observed under 310 nm excitation correspond to the characteristic transitions of Dy^{3+} ions [1], and the intensity of these transitions was approximately doubled with Na^+ doping. In TL measurements, a broad emission peak was obtained in the range of 150 – 230 °C, and it was determined that the SrB_6O_{10}:Dy,Na samples exhibited linear dose-response behavior in the range of 1 – 100 Gy. Furthermore, high stability and reusability were observed in repeated measurements. The findings demonstrate that SrB_6O_{10}:Dy,Na phosphors are strong candidate materials for both light-emitting devices and radiation dosimetry applications in medical and industrial fields.

References

[1] V. Altunal, V. Guckan, Y. Yu, A. Dicker, Z. Yegingil, A newly developed OSL dosimeter based on beryllium oxide: BeO:Na,Dy,Er, J. Lumin., 222 (2020) 117140.

New Dosimetric Host for Radiation Dosimetry: La_2MgTiO_6 (LMT) ceramics

V. Altunal[1], V. Guckan[1], A. Ozdemir[2], O. Yigit[3], K. Kurt[4], and **Z. Yegingil*[5]**

[1]*Cukurova University, Physics Department 01250, Saricam, Adana, TÜRKİYE*
[2]*Kahramanmaras Istiklal University, Elbistan Vocational High School of Health Service, Elbistan, Kahramanmaras, TÜRKİYE*
[3]*Mersin University, Physics Department, Yenisehir, Mersin, 33343, TÜRKİYE*
[4]*Mersin University, Aydincik Vocational School, Electricity and Energy Department, Anamur, Mersin, TÜRKİYE*
[5]*Toros University, Engineering Faculty, Electrical and Electronic Engineering Department, Mersin, TÜRKİYE*

***Corresponding e-mail:** Zehra.Yegingil@gmail.com

In this study, lead-free double perovskite La_2MgTiO_6 (LMT) ceramics were synthesized, and their thermoluminescence (TL) and optically stimulated luminescence (OSL) properties were investigated in detail from a dosimetric perspective. Samples were prepared using the solid-state method, and a dense and homogeneous microstructure was obtained after high-temperature sintering. X-ray diffraction Rietveld analysis confirmed the formation of a pure phase in the monoclinic P21/c space group. The average crystallite size was determined to be in the nanometer range, while the grain sizes were determined to be in the micron range. Photoluminescence measurements showed that the material exhibited characteristic emission at 452, 532, and 590 nm under 370 nm excitation. The radioluminescence spectra were broad-band, exhibiting peaks around 450 and 650 nm.

In TL measurements, two distinct peaks were detected at ~100 °C and ~240 °C after 10 Gy irradiation. General-order kinetic peak decomposition (CGCD) analysis revealed five distinct trap levels, with activation energies calculated in the range of 0.8 – 1.6 eV. The OSL decay curve was defined by three components ($\tau \approx 0.3$ s, 1.8 s, and 25 s) and directly correlated with the TL peaks using step-annealing experiments [1]. Energy values obtained using the Tm–Tstop and IR methods were found to be consistent with the CGCD results. The dose response exhibited excellent linearity in the range of 5 – 1000 Gy ($R^2 \approx 0.999$), and repeatability was achieved with an uncertainty of 3%. In dark storage experiments, a decrease of approximately 7% was observed in the first 24 hours, and the total loss remained around 8% after five days. The results show that LMT stands out among the next generation dosimetric material candidates thanks to its environmentally friendly structure, stable TL/OSL response, low fading tendency and wide dynamic dose response.

References

[1] V. Altunal, A. Ozdemir, K. Kurt, O. Yigit, V. Guckan, B. Isik, Z. Yegingil, Luminescence properties of Ce and Be-doped CaAl12O19 for dosimetric and light-emitting applications, J. Alloys Compd., 985 (2024) 174081.

Characterization of Nanorod-Structured CdTe Thin Films Deposited by CBD

Zeynep Karabacak[1*], Sevda İldan Özmen[2,3], and Hülya Metin Gübür[1]

[1]Department of Physics, Faculty of Science, Mersin, Türkiye
[2]Advanced Technology Education Research and Application Centre, Mersin University, Mersin, Türkiye
[3]Technical Science Vocational School, Department of Chemistry and Chemical Processing Technologies, Mersin, Türkiye

[*]**Corresponding e-mail:** 24023090004@mersin.edu.tr

Cadmium telluride (CdTe) is a II–VI group compound semiconductor with a direct band gap of around 1.45 eV and a high absorption coefficient (>10^4 cm^{-1}) in the visible region. Owing to these properties, CdTe has been extensively employed in thin-film solar cells, photodetectors, and various optoelectronic devices [1,2]. In the present study, CdTe thin films were deposited onto glass substrates by the chemical bath deposition (CBD) method, a simple and cost-effective technique, at 65 °C. The optical, structural, and morphological properties of the CdTe films examined using UV–visible spectrophotometry, X-ray diffraction (XRD), and field emission scanning electron microscopy (FE-SEM), respectively. The optical band gap (E_g) of the CdTe film was estimated to be 1.35 eV from the transmission spectrum, and the XRD pattern showed that the CdTe film had a polycrystalline structure comprising both cubic and hexagonal phases. Furthermore, FE-SEM images revealed that the CdTe film exhibited a nanorod-like morphology.

Keywords: CdTe, nanorods, thin-film solar cells, chemical bath deposition, characterization.

References

[1] S. Zalak et al., Chemical bath deposited CdTe thin film: Optical, electrical, and photoresponse aspects, Next Materials, 3 (2024).

[2] H. Robatjazi, H. Eshghi, Elimination of Secondary Oxide Phases in CdTe Nanostructured Thin Films Prepared by Conventional Spray Pyrolysis, and the Influence of Thermal Annealing. J. Electron. Mater., 52, 5922–5930 (2023).