Symposium on Functional Materials Science and Engineering (SFME 2025)

ABSTRACTS AND PROCEEDINGS

TOROS UNIVERSITY
FACULTY OF ENGINEERING

Symposium on Functional Materials Science and Engineering (SFME 2025)

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Symposium on

Functional Materials

Science and Engineering 2025

DİVAN OTELİ, MERSİN
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INVITED SPEAKERS

Prof. Dr. Recep Zan

Ömer Halis Demir University, Art-Sciences Faculty, Physics Department Niğde TURKEY

Title: Advancing Solar Frontiers: Graphene Integrated CTS Thin Film Solar Cells

Doç. Dr. Doğan Kaya

Çukurova University, Art-Sciences Faculty, Physics Department Adana TURKEY

Title: Nanoparticle-Engineered Catalysts for Clean Hydrogen Prodcution: Innovations and Future Perspectives

Symposium on Functional Materials Science and Engineering
23th May 2025
SYMPOSIUM PROGRAM

08:30-09:00		*Registration*
09:00-09:15		*Opening Ceremony*
09:15-09:20		***Prof. Dr. Ömer ARIÖZ*** *Rector, Toros University*
09:20-09:25		***Prof. Dr. Adnan MAZMANOĞLU*** *Dean of Engineering Faculty, Toros University*
Session I-Invited Speakers		
I1	09:30-10:00	**Nanoparticle-Engineered Catalysts for Clean Hydrogen Prodcution: Innovations and Future Perspectives** ***Doğan Kaya*** *Department of Physics, Faculty of Sciences and Letters, Çukurova University, Adana, Türkiye*
I2	10:00-10:30	**Advancing Solar Frontiers:Graphene Integrated CTS Thin Film Solar Cells** ***Recep Zan*** *TÜBA-Üstün Başarılı Genç Bilim İnsanı* *Department of Physics, Faculty of Sciences, Niğde Ömer Halisdemir University, Niğde, Türkiye*
S	10:30-10:35	Special thanks to Akyürek Technology and OSF Logistics
Coffee Break and Poster Session (10:35-11:00)		
P1	10:30-11:00	**$Bi_2Sr_2Ca_{1-x}Sb_xCu_{1.75}Na_{0.25}O_y$ (x = 0.0, 0.0125, 0.0250, 0.050, 0.075, 0.1) Investigation of Phase Formation of Superconductors** ***Meryem Ebru Kır[1], M. Ersin Aytekin[2]*** *[1]Department of Energy Systems Engineering, Faculty of Engineering, Tarsus University, Tarsus, Türkiye* *[2]Department of Mechatronics Processing, Vocational School of Technical Sciences at Mersin Tarsus Organized Industrial Zone, Tarsus University, Tarsus, Türkiye*
P2		**Processing and characterization of sustainable flax-jute/PA11 thermoplastic composites** ***Melisa Yeke*** *Telateks Tekstil Ürünleri Sanayi ve Ticaret A.Ş. METYX Composites, Manisa, Türkiye*
P3		**Luminescence Characterization of $SrSiO_3$: Ce, Li dosimetry pellets synthesized by solid state technique** ***Ahmad Mesto[1], Volkan Altunal[1], Veysi Gückan[1], Bilal Isik[1], Ahmet Ekicibil[1], Zehra Yegingil[2]*** *[1]Department of Physics, Faculty of Science and Letters, Çukurova University, Adana, Türkiye* *[2]Toros University, Engineering Faculty, Electrical and Electronic Engineering Department, Mersin, Türkiye*
P4		**Kinetic Analysis of K_2SO_4: Dy, Na TL phosphors** ***Bilal Isik[1], Volkan Altunal[1], Veysi Guckan[1], Ahmad Mesto [1], Adnan Ozdemir[2], Ahmet Ekicibil[1], Zehra Yegingil[3]*** *[1]Department of Physics, Faculty of Sciences and Letters, Çukurova University, Adana, Türkiye* *[2]Department of Optician, Elbistan Vocational High School of Health Service, K. İstiklal Uni., K.Maraş, Türkiye* *[3]Toros University, Engineering Faculty, Electrical and Electronic Engineering Department, Mersin, Türkiye*
Session II-Plenary Speakers *Chair, Assist. Prof. İbrahim İNAN, Scientific Committee*		

O1	11:00-11:15	**Modeling of Electrical Properties of $Bi_2Sr_2Ca_{1-x}Zn_xCu_{1.75}Na_{0.25}O_y$ (x = 0.00, 0.0125, 0.025, 0.050 and 0.075) Superconductors** ***M. Ersin Aytekin*** *Department of Mechatronics Processing, Vocational School of Technical Sciences at Mersin Tarsus Organized Industrial Zone, Tarsus University, Tarsus, Türkiye*
O2	11:15-11:30	**Effects of Noble Metal Alloy Based Magnetic Elements on Nanoparticles and Detailed Investigation** ***Emre Can Tayfun[1], Mustafa Akyol[2], Doğan Kaya[1,3], Faruk Karadağ[1], Ahmet Ekicibil[1]*** *[1]Department of Physics, Faculty of Sciences and Letters, Çukurova University, Adana, Türkiye* *[2]Materials Engineering Department, Faculty of Engineering, Adana Alparslan Turkes Science and Technology University, Adana, Türkiye* *[3]Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Cukurova University, Adana, Türkiye*
O3	11:30-11:45	**Novel Arc-Melted Ni-Si-M (M = Al, Cu, Co, Fe, Zr) Ternary Alloys: Effects of Additive Elements on Morphology, Mechanical Strength, and Magnetic Performance** ***Sinan Diken[1], Celal Kursun[2], Musa Gogebakan[2]*** *[1]Department of Physics, Faculty of Science, Kilis 7 Aralık University, Kilis, Türkiye* *[2] Department of Physics, Faculty of Art and Sciences, K. Sütçü İmam University, Kahramanmaras, Türkiye*
Lunch (12:00-13:00)		
Session III-Plenary Speakers *Chair, Assist Prof. Cevher Ak, Scientific Committee*		
O4	13:00-13:15	**Emulsion-Based Strategies for Water-Resistant Biobased Films: A Comparative Evaluation of Contact Angle and Swelling Ratio** ***Sevgin Dıblan[1], Yasin Özay[2], Zafer Erbay[3]*** *[1]Department of Food Processing, Vocational School of Technical Sciences at Mersin Tarsus Organized Industrial Zone, Tarsus University, Tarsus, Türkiye* *[b]Department of Environmental Protection Technologies , Vocational School of Technical Sciences at Mersin Tarsus Organized Industrial Zone, Tarsus University, Tarsus, Türkiye* *[c]Department of Food Engineering, Faculty of Engineering, Adana Alparslan Turkes Science and Technology University, Adana, Türkiye*
O5	13:15-13:30	**Impact of Growth Environment on the Controlled Synthesis of 2D Mo_2C by CVD** ***Zehra Zisan Guler[1], Nevzat Duman[1,2] Elif Okay[1], Goknur Buke[1,3]*** *[1]Micro and Nanotechnology, Graduate School of Engineering and Science, TOBB University of Economics and Technology, Ankara, Turkiye* *[2]Togg, Powertrain & High Voltage Electronics, Ankara, Turkiye* *[3]A.J. Drexel Nanomaterials Institute, Drexel University, Philadelphia, Pennsylvania, United States*
O6	13:30-13:45	**Investigating Gas Uptake and Electric Field Response of ZIF-71 with Monte Carlo and ab-initio Simulations** ***Ömer Şahin Arısoy, Yeliz Gürdal*** *[1]Department of Bioengineering, Institute of Graduate School, Adana Alparslan Türkeş Science and Technology University, Adana, Türkiye* *[2]Department of Bioengineering, Adana Alparslan Türkeş Science and Technology University, Adana, Türkiye*
O7	13:45-14:00	**The New Double Perovskite La_2TiNiO_6 As Electrocatalyst for Efficient Hydrogen Evolution Reaction** ***Evrim Baran Aydın[1], Sevgi Ateş[1], Gökmen Sığırcık[2], Birgül Yazıcı[2]*** *[1]Department of Chemistry, Faculty of Science, Kilis 7 Aralık University, Kilis, Türkiye* *[2]Department of Chemistry, Faculty of Science and Letters, Çukurova University, Adana, Türkiye*
Coffee Break and Poster Session (14:00-14:30) Session IV-Plenary Speakers *Chair, Prof. Dr. Ahmet Ekicibil, Scientific Committee*		
O8	14:30-14:45	**Electronic and transport properties of monolayer ZrS_2** ***Berrin Özdemir[1], Nihal T. Yıldız[2], H. Cengiz Çekil[1], M. Akif Sabaner[2], Ünal Dömekeli[2], Fikret Işık[2], Sedat Şengül[2], Metin Özdemir[1]*** *[1]Department of Physics, Faculty of Arts and Sciences, Çukurova University, Adana, Türkiye* *[2]Department of Physics, Faculty of Sciences, Trakya University, Edirne, Türkiye*

O9	14:45-15:00	**Fabrication and characterization of scaffolds with heterogeneous architecture as potential in vitro 3D model for cancer research** ***Didem Demir Karakuş[1], Murat İdikut[2], Sibel Dağlı[3], Mehmet Tarakçıoğlu[4]*** *[1]Department of Chemistry and Chemical Process Technologies, Tarsus University, Mersin, Türkiye* *[2]Department of Bioengineering, Adana Alparslan Turkes Science and Technology University, Adana, Türkiye* *[3]Department of Medical Microbiology, Hatay Mustafa Kemal University, Antakya, Türkiye* *[4]Department of Medical Biochemistry, Faculty of Medicine, Gaziantep University, Gaziantep, Türkiye*
O10	15:00-15:15	**Enhancing The Mechanical and Barrier Properties of PLA Films: Biocomposite Development Using Tomato Peel Extract** ***Aysima Yediler, Özlem Kızılırmak Esmer*** *Department of Food Engineering, Faculty of Engineering, Ege University, İzmir, Türkiye*
O11	15:15-15:30	**Yeşil Enerji Dönüşümü Sağlayan İleri Teknoloji Malzemelerin Üretiminde Endüstri 5.0 Uygulamalarının Rolü** ***İbrahim İnan*** *Department of Industrial Engineering, Faculty of Engineering, Toros University, Mersin, Türkiye*
Coffee Break and Poster Session (15:30-15:45)		
Session V-Plenary Speakers *Chair, Assoc. Prof. Evrim Ersin Kangal, Scientific Committee*		
O12	15:45-16:00	**Mechanical and Thermal Analysis of Carbon Fiber Reinforced Discs under Thermal Loading** ***Hüseyin Fırat Kayıran[1,2]*** *[1]Mersin Provincial Coordinator, Department of Agriculture and Rural Development Support (ARDSI), Mersin, Türkiye* *[2]Department of Industrial Engineering, Faculty of Engineering, Toros University, Mersin, Türkiye*
O13	16:00-16:15	**Seri üretim teknolojilerinde enerji ve kaynak verimliliği açısından proses hatalarının minimize edilmesi: Preform kalıplarında aşınma ve malzeme performansının iyileştirilmesine yönelik yenilikçi yaklaşımlar** ***Berk Şahin[1], Gamze Arslan[1], Mehmet Yüksel[1], Gökhan Parsak[1], Tuğçe Demirdelen[2]*** *[1]Petka Mold Industry, Adana, Turkey* *[2]Department of Electrical and Electronic Engineering, Faculty of Engineering, Adana Alparslan Türkeş Science and Technology University, Adana, Türkiye*
O14	16:15-16:30	**Enhancing CTS Thin Film Characteristics via Graphene Interlayer: Influence of Sulfurization Temperature** ***Sevde Erkan[1], Yavuz Atasoy[2], M. Ali Olğar[1,3], Recep Zan[1,3]*** *[1]Department of Physics, Niğde Ömer Halisdemir University, Nanotechnology Application and Research Center, Niğde, Türkiye* *[2]Niğde Ömer Halisdemir University, Niğde Zübeyde Hanım Vocational School of Health Services, Niğde, Türkiye,* *[3]Department of Physics, Niğde Ömer Halisdemir University, Niğde, Türkiye*
O15	16:30-16:45	**Catalytic and Photocatalytic Properties of NiFe2O4 Nanomaterials** ***Hasan Işık, İlknur Baldan Işık, Doğan Kaya, Faruk Karadağ, Ahmet Ekicibil*** *Department of Physics, Faculty of Sciences and Letters, Çukurova University, Adana, Türkiye*
O16	16:45-17:00	**The Electronic Transport Properties of Monolayer MoS_2** ***M. Derya Alyörük[1,2], H. Cengiz Çekil[2], Berrin Özdemir[3], Zeki Yarar[4], Metin Özdemir[3]*** *[1]Department of Physics, Aksaray University, 68100 Aksaray, Turkey* *[2]Department of Medical Services and Techniques, Opticianry Program, Health Services Vocational School, Aksaray University, Aksaray, Turkey* *[3]Department of Physics, Faculty of Sciences and Letters, Çukurova University, Adana, Turkey* *[4]Department of Physics, Faculty of Arts and Sciences, Mersin University, Mersin, Turkey*
Panel: Climate Change-Oriented Renewable Energy Solutions and Green Functional Materials **Closing Ceremony**		
Assoc. Prof. Ali Kemal HAVARE ***Chair of Scientific Organization Committee, Toros University***		

Preface

Dear Participants,

A one day Symposium on Functional Materials Science and Engineering (SFME) 2025 was held at the Mersin Divan Hotel, on 23th May 2025, focusing on mainly novel functional materials. We aimed to share and discuss theoretical and practical knowledge of Functional Materials in a scientific framework by bringing together scientists, educators, non-governmental organizations, and private sector representatives in a multidisciplinary environment. This symposium will provide a multidisciplinary meeting opportunity for the presentation and discussion of scientific studies in Applied Sciences, Advanced and Functional Materials, Materials and Devices, New Materials for Energy and Energy Conversion, Biomaterials, Theoretical/Modeling/Computer Simulations of Functional Materials, Spectroscopy for Advanced Materials, Hybrid and Composite Materials, Magnetic Materials, and Emerging Materials for Ionizing Radiation Detectors and Dosimeters.

The valuable presentations from expert speakers and the intriguing research shared by participants have provided a rich experience in terms of interaction and learning. Knowledge sharing and collaboration were the cornerstones of this event.

As SFME organizing committee, we will continue to organize scientific meetings to inspire each other and to contribute to science. Hope to meet you again at future events.

Vice Chair of the Organizing Committee

Assist. Prof. Dr. Merve ÖZCAN

Chair of the Organizing Committee

Assoc. Prof. Dr. Ali Kemal HAVARE

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The symposium was organised and hosted by Toros University, Engineering Faculty, Electrical and Electronics Engineering Department on 23th May 2025 in Mersin. 22 scholars presented papers and posters which are published in the SFME 2025 E-Proceedings Book.

CHAPTER 1. ABSTRACTS

INVITED

Advancing Solar Frontiers: Graphene Integrated CTS Thin Film Solar Cells

Recep Zan[1,2]*

[1] *Department of Physics, Niğde Ömer Halisdemir University, Nanotechnology Application and Research Center, Niğde, Türkiye*

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

ABSTRACT

Copper tin sulfide (Cu_2SnS_3, CTS) thin films are gaining attention as sustainable absorber layers for next-generation photovoltaic technologies due to their earth-abundant, non-toxic composition and favorable optoelectronic characteristics. Like other kesterite-based materials, CTS exhibits intrinsic p-type conductivity and a high absorption coefficient, making it a promising candidate for low-cost solar energy conversion. However, limitations in film quality and interface properties continue to hinder performance optimization. In this study, a fully solution-based fabrication approach was employed to develop CTS thin films, where pristine and doped graphene was integrated both as an interfacial layer and as a functional additive within the CTS matrix. The p-type doping of graphene aimed to enhance electrical conductivity and facilitate hole transport, thereby improving overall film performance. Graphene was synthesized via chemical vapor deposition and liquid phase exfoliation approaches. Following that, these obtained graphene layers were introduced into the process through two routes: as a substrate interlayer and as a dopant dispersed in the precursor solution, respectively. Comprehensive characterization results showed that the incorporation of p-type graphene led to marked improvements in film morphology, crystallinity, and compositional uniformity. Notably, secondary phase formation was suppressed, and grain growth was promoted under optimized sulfurization conditions. Optical analyses confirmed enhanced light absorption and film homogeneity, while the electrical influence of the p-doped graphene contributed to better charge transport properties. These enhancements were both measurable and visually evident, supporting the critical role of doped graphene in improving CTS absorbing quality. Overall, this work underscores the effectiveness of graphene integration through a solution-processable route as a strategy to advance the structural, optical, and electrical performance of CTS thin films, making them more viable for flexible and high-efficiency solar cell applications.

Keywords: *Cu_2SnS_3 Thin film, Spin coating, Sulfurization process, pristine and doped graphene, Flexible*

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Acknowledgement

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INVITED

Nanoparticle-Engineered Catalysts for Clean Hydrogen Production: Innovations and Future Perspectives

Dogan Kaya[1,2]*

[1] *Cukurova University, Faculty of Art and Science, Department of Physics, Adana, Türkiye*

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

ABSTRACT

The transition to a sustainable energy future hinges on the development of efficient and cost-effective methods for clean hydrogen production [1]. Noble metal based catalytic materials offer unprecedented opportunities to enhance reaction kinetics, selectivity, and stability in hydrogen production processes. This talk will explore recent advancements in the design and application of magnetic and catalytic based nanoparticles for hydrogen generation, focusing on their role in water splitting, reforming, and other key processes. Alloying noble based with 3d transition metals control both catalytic properties to enhance hydrogen gas production and provide magnetic properties for magnetically recycling process [2-4]. Special attention will be given to how nanostructuring, composition tuning, and magnetic properties contribute to improving catalyst performance and longevity. By bridging fundamental insights with applied research, this presentation aims to highlight the potential of nanoparticle-engineered catalysts in overcoming existing challenges and accelerating the global adoption of clean hydrogen technologies.

Keywords: *Nanostructures, Catalysis, Magnetism, Hydrogen production*

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References

[1] Z. Li, C. Yu, Y. Kang, X. Zhang, Y. Wen, Z.-K. Wang, C. Ma, C. Wang, K. Wang, X. Qu, Ultra-small hollow ternary alloy nanoparticles for efficient hydrogen evolution reaction, National Science Review, 8 (2021) nwaa204.

[2] I.B. 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 (2024) 143794.

[3] D. Kaya, H.H. Isik, I.B. Isik, G. Sigircik, T. Tuken, F. Karadag, A. Ekicibil, Electrocatalytic hydrogen evolution on metallic and bimetallic Pd–Co alloy nanoparticles, Int. J. Hydrogen Energy, 48 (2023) 14633-14641.

[4] A.E. Noua, D. Kaya, F. Karadag, A. Ekicibil, Comprehensive investigation of Ni-rich PtNi alloy nanoparticles: structural, magnetic, and catalytic properties for efficient alkaline water electrolysis, Journal of Nanoparticle Research, 26 (2023) 8.

ORAL

The Electronic Transport Properties of Monolayer MoS_2

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ABSTRACT

This study investigates the electronic structure and transport properties of monolayer molybdenum disulfide (MoS_2) using an Ensemble Monte Carlo (EMC) method where the effects of both intrinsic acoustic and optical phonon scattering mechanisms are considered. The electronic band structure is derived using density functional theory (DFT), employing both the Heyd-Scuseria-Ernzerhof (HSE) hybrid functional and the Perdew-Burke-Ernzerhof (PBE) approach. Based on the calculated band structures, the electronic transport behavior is explored using deformation potential scattering rates. Carrier drift velocity is computed as a function of time under an applied electric field, leading to steady-state drift velocity versus electric field characteristics at various temperatures. These simulations reveal a velocity overshoot phenomenon. Furthermore, the energy separation between the Q and K valleys of MoS_2 (ΔE_{KQ}) influences carrier transport properties and electron mobility. The temperature dependence of carrier mobility is also evaluated, with results aligning well with existing theoretical models. The results are compared to other similar materials.

Keywords: *MoS_2, Ensemble Monte Carlo, Scattering, Transport, Drift velocity, Mobility*

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ORAL

The New Double Perovskite La_2TiNiO_6 as Electrocatalyst for Efficient Hydrogen Evolution Reaction

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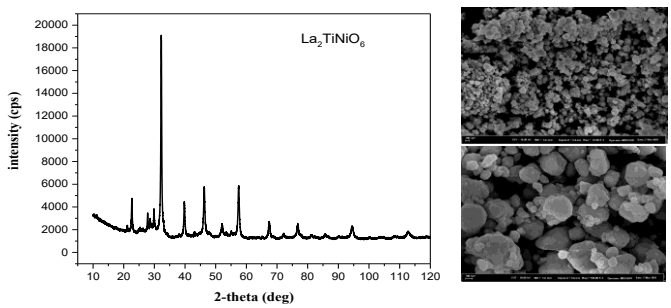
ABSTRACT

Perovskite double oxides are a functional material category that has emerged as very promising for hydrogen production due to their tunable activity, diverse elemental selection, low cost, abundant availability in the world, and promising activities [1]. In this study, La_2TiNiO_6 double perovskite was prepared by a high-temperature solid-state reaction method and investigated as a catalyst for hydrogen production. The obtained powder was characterized by X-ray Powder Diffraction , Field Emission Scanning Electron Microscopy, Brunauer-Emmett-Teller,Raman spectroscopy and X-ray Photoelectron Spectroscopy techniques. From the XRD results, it was determined that the 2θ values at 22.64°, 32.22°, 39.75°, 46.22°, 57.45° and 67.40° belong to the monoclinic La2TiNiO6 perovskite oxide structure, corresponding to the (002), (111), (20-4), (22-2), (31-1), and (22-6) orientations, respectively. The unit cell parameters were calculated based on the (111) orientation of the 2θ value at 32.22°, which has the highest peak intensity, and it was found that the unit cell constants were compatible with the standard values. From the FE-SEM images, the presence of nanoclusters ranging in size from 400 nm to 80 nm was observed in the perovskite structure. The BET surface area of the La_2TiNiO_6 perovskite oxide structure was found to be 6.3629 m²/g and the pore diameter was approximately 18-26 nm. From the Raman analysis results, broad emission bands were observed around 450 nm at 220 nm excitation wavelength and around 510 nm at 260 nm excitation wavelength. The catalytic efficiency of the electrocatalyst on hydrogen Evolution Reaction (HER) in 1 M KOH was investigated using electrochemical impedance spectroscopy, cyclic voltammetry, and cathodic polarization curves. As a result, our study shows the future research direction to promote the application and development of double perovskites in clean energy, thanks to the use of La_2TiNiO_6 double perovskite as an electrocatalyst in HER.



Keywords: *Double perovskite, Hydrogen, Electrocatalysis, Characterization*

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References

[1] Hossain, A., Gopika, T., Anil, Bijimol, B.I., Meera, M.S., Jana, P.P., Sameera, S., Soldatov, A.V., Shibli, S.M.A. 2024. "The effect of double perovskite decoration in NiP composite coating for efficient electrocatalytic hydrogen evolution" International Journal of Hydrogen Energy, 80, 612–621.

ORAL

Emulsion-Based Strategies for Water-Resistant Biobased Films: A Comparative Evaluation of Contact Angle and Swelling Ratio

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ABSTRACT

In this study, biobased films were developed using double emulsion (W1/O/W2) systems to enhance water resistance. The outer with growing interest in sustainable alternatives to synthetic plastics, this study investigates water-resistant biobased films produced using double emulsion (W1/O/W2) systems. The outer aqueous phase (W2) consisted of whey protein isolate (WPI) or sodium caseinate (NaC) conjugated with chitosan via Maillard-type reaction. The dispersed phase (W1/O) included anthocyanin-loaded emulsions stabilized by either PGPR or AMP emulsifiers. The primary objective was to reduce film hydrophilicity and enhance moisture resistance through biopolymer conjugation. Water resistance was assessed by measuring contact angle and swelling ratio. AMP-stabilized or high internal phase formulations exhibited low contact angles, indicating increased surface wettability. Conversely, swelling ratios consistently indicated improved structural water resistance, notably in PGPR-stabilized formulations such as NaC-P-10, which displayed significantly lower swelling. Statistical analyses (ANOVA and Tukey tests) confirmed significant differences among formulations ($p < 0.05$), while correlation analysis revealed a weak-to-moderate positive relationship ($r \approx 0.35–0.46$) between contact angle and swelling ratio. AMP-stabilized NaC films demonstrated superior surface hydrophobicity, whereas WPI films performed better with PGPR, highlighting the critical role of protein–emulsifier compatibility. This study underscores the potential of conjugated protein–chitosan matrices in improving water resistance of emulsion-based films, identifying swelling ratio as a more reliable indicator than contact angle alone. These insights support the development of sustainable smart packaging materials. This research was supported.

Keywords: *Biobased film, Emulsion technology, Water resistance*

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ORAL

Novel Arc-Melted Ni-Si-M (M = Al, Cu, Co, Fe, Zr) Ternary Alloys: Effects of Additive Elements on Morphology, Mechanical Strength, and Magnetic Performance

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ABSTRACT

Ni-Si-based ternary alloys are critical for advanced industrial applications due to their exceptional thermal stability, low density, and tunable magnetic properties. These characteristics make them ideal for use in the aerospace, automotive, and energy sectors, particularly in turbine blades, electromagnetic shields, and soft magnetic devices [1-6]. This study focuses on the morphology, mechanical properties, and magnetic performance of arc-melted $(Ni_{80}Si_{20})_{95}M_5$ (M = Al, Cu, Co, Fe, Zr) ternary alloys, characterized using scanning electron microscopy with energy-dispersive X-ray spectroscopy (SEM-EDX), Vickers microhardness testing, and vibrating sample magnetometry (VSM). SEM-EDX revealed distinctive morphological features unique to each alloying element, ranging from lamellar structures to various dendritic patterns, reflecting different solidification dynamics. Magnetic characterization showed diverse behaviors across the alloy systems, with Fe and Co additions promoting soft magnetic properties while Al, Cu, and Zr additions resulted in weak permanent magnetism, with the Al-containing alloy demonstrating the highest coercivity of 307 Oe. Mechanical property assessment through Vickers microhardness testing revealed significant variations among the different alloy compositions, with $(Ni_{80}Si_{20})_{95}Fe_5$ exhibiting the highest hardness value of 885.0 HV. These results highlight how strategic selection of minor alloying elements can significantly modify the microstructure, magnetic behavior, and mechanical properties of Ni-Si based alloys, providing valuable insights for tailoring these materials for specific industrial applications.

Keywords: *Arc melting, Ni-Si based alloys, Ternary alloys, Morphology, Magnetic properties, Hardness, Alloying elements*

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References

[1] K. Lu, The Future of Metals, Science 328(5976) (2010) 319-320. https://doi.org/10.1126/science.1185866
[2] X. Li, K. Lu, Playing with defects in metals, Nature Materials 16(7) (2017) 700-701. https://doi.org/10.1038/nmat4929
[3] Y. Lu, G. Yang, Z. Xi, H. Wang, Y. Zhou, Directional solidification of highly undercooled eutectic Ni78.6Si21.4 alloy, Materials Letters 59(12) (2005) 1558-1562. https://doi.org/10.1016/j.matlet.2005.01.022
[4] B. Cantor, I.T.H. Chang, P. Knight, A.J.B. Vincent, Microstructural development in equiatomic multicomponent alloys, Materials Science and Engineering: A 375-377 (2004) 213-218. https://doi.org/10.1016/j.msea.2003.10.257
[5] T.M. Pollock, Alloy design for aircraft engines, Nature Materials 15(8) (2016) 809-15. https://doi.org/10.1038/nmat4709
[6] T.M. Pollock, S. Tin, Nickel-Based Superalloys for Advanced Turbine Engines: Chemistry, Microstructure and Properties, *Journal of Propulsion and Power* 22(2) (2006) 361-374. https://doi.org/10.2514/1.18239

ORAL

Enhancing CTS Thin Film Characteristics via Graphene Interlayer: Influence of Sulfurization Temperature

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ABSTRACT

Cu_2SnS_3 (CTS) thin films, similar to CZTS, exhibit p-type semiconductor properties with absorption coefficients higher than 10^4 cm^{-1} and are considered as alternative absorber layers in photovoltaic applications [1]. Furthermore, research trends have focused on solar cell absorber materials, which consists of non-toxic and naturally abundant elements. In this context, CTS has emerged as a promising candidate for solar energy applications due to its environmentally friendly structure and suitable optoelectronic properties [2]. However, studies have shown that the desired performance of absorbing layers in CTS could not be achieved despite various optimization efforts. It has been reported that the use of graphene as an interlayer in Cu-based kesterite compounds contributes to the reduction of interface recombination and defect passivation due to the high electrical conductivity and carrier mobility [3,4]. Therefore, in this study, the effects of incorporating single-layer graphene layer, grown by chemical vapor deposition (CVD), as an interfacial layer within the CTS absorber were investigated. The samples were deposited using a spin coating method onto the graphene covered glass substrates and subsequently annealed at sulfurization temperatures of 475 °C, 500 °C, and 525 °C for durations of 4 min. The impact of the graphene interlayer on the properties of CTS thin films was examined and compared with graphene-free samples in terms of optical and structural properties of the thin films. Energy dispersive X-ray spectroscopy (EDX) confirmed that all samples exhibited a Cu-poor composition. XRD and Raman results showed that CTS films crystallized in a monoclinic structure, although traces of secondary phases such as SnS and CuS2 were also detected. It was observed that in samples produced on graphene layer, the presence of secondary phases decreased, and structural properties improved, while higher annealing temperatures (500°C and 525°C) led to structural degradation. According to the SEM images of the samples, it was observed that CTS thin film with graphene inter layer had a smooth surface, which lead to encourage grain growth with a homogenous distribution. Ellipsometry spectroscopy measurement reveals that samples with graphene yielded very good results in terms of optical properties. The CTS film deposited on glass at 475°C demonstrated the most promising properties for photovoltaic applications. Furthermore, the inclusion of graphene at this temperature significantly improved the structural quality of the CTS films, leading to its selection as a candidate for solar cell formation. The contribution of the graphene interlayer in enhancing film homogeneity and improving crystallization, particularly at optimal sulfurization temperatures, was extensively evaluated.

Keywords: *Cu_2SnS_3 Thin film, Spin coating, Sulfurization temperature, Single layer-graphene*

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References

[1] Wang JJ, Liu P, Ryan KM. A facile phosphine-free colloidal synthesis of Cu2SnS3 and Cu2ZnSnS4 nanorods with a controllable aspect ratio. Chemical Communications 2015;51:13810–3. https://doi.org/10.1039/c5cc04979b.
[2] Tanaka K, Maeda T, Araki H. Photoluminescence observation of the effects of Cu/Sn ratio and Na addition on Cu2SnS3. Solar Energy 2020;199:143–51. https://doi.org/10.1016/j.solener.2020.02.014.
[3] Özbek D, Erkan S, Olğar MA, Zan R. Use of graphene as an interlayer in CZTS-based thin film solar cell employing various substrate temperatures. J Alloys Compd 2025;1013. https://doi.org/10.1016/j.jallcom.2025.178514.
[4] Peksu E, Yener C, Unlu CG, Karaagac H. Exploring graphene's potential as a transparent conductive layer in Cu2ZnSnS4 superstrate solar cells. J Alloys Compd 2024;976. https://doi.org/10.1016/j.jallcom.2023.172979.

ORAL

Impact of Growth Environment on the Controlled Synthesis of 2D Mo_2C by CVD

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ABSTRACT

Two-dimensional (2D) molybdenum carbide (Mo_2C) has garnered considerable attention for its potential in electrocatalysis—particularly the hydrogen evolution reaction (HER)—as well as sensing and nanoelectronic applications. This interest is driven by its exceptional electrical conductivity, chemical stability, and catalytic activity. Among various synthesis routes, the chemical vapor deposition (CVD) of Mo_2C, where Mo/Cu stack is held under methane (CH_4) atmosphere at elevated temperatures (T> 1080 °C), has emerged as a promising method to achieve large-area, ultrathin, and high-quality 2D crystals [1-9]. Despite its promise, the controlled and reproducible synthesis of 2D Mo_2C via CVD remains challenging. The process is highly sensitive not only to conventional growth parameters such as temperature, duration, and gas composition, but also to the system setup—specifically the growth environment and supporting materials. In this study, we systematically investigated the low-pressure CVD (LPCVD) growth of 2D Mo_2C by varying growth parameters and examining their effect on crystal morphology and quality. Structural and compositional characterizations were carried out using scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDS), and Raman spectroscopy. A key finding of this work is the significant influence of the growth environment, particularly the crucible material, on the reproducibility and purity of the resulting Mo_2C crystals. We identified that contamination originates from the degradation of quartz crucibles during prolonged exposure to high-temperature, hydrogen-rich, low-pressure conditions. At high processing temperatures, molten copper wets the molybdenum substrate and, if not carefully controlled, diffuses to the bottom surface of Mo and comes in contact with the crucible, forming a bridge. Moreover, Copper also exists in a vapor form within the experimental conditions, reacting with quartz crucible surface to yield loose particle byproducts. These interactions are responsible for the presence of silicate-based species on the Cu surface where Mo_2C crystals are growing, thereby altering the growth dynamics and degrading crystal quality. These findings highlight the critical importance of crucible material stability in CVD processes and offer practical guidance for minimizing contamination and enhancing the consistency of 2D Mo_2C synthesis.

Keywords: *Mo_2C, Cu, CVD, 2D materials*

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References

[1] Xu C, Wang L, Liu Z, Chen L, Guo J, Kang N, Ma X-L, Cheng H-M and Ren W 2015 Large-area high-quality 2D ultrathin Mo2C superconducting crystals *Nature materials* 14 1135–41

[2] Geng D, Zhao X, Li L, Song P, Tian B, Liu W, Chen J, Shi D, Lin M, Zhou W and Loh K P 2016 Controlled growth of ultrathin Mo_2 C superconducting crystals on liquid Cu surface *2D Mater.* 4 011012

[3]Geng D, Zhao X, Chen Z, Sun W, Fu W, Chen J, Liu W, Zhou W and Loh K P 2017 Direct Synthesis of Large-Area 2D Mo_2 C on In Situ Grown Graphene *Advanced Materials* 29 1700072
[4]Qiao J-B, Gong Y, Zuo W-J, Wei Y-C, Ma D-L, Yang H, Yang N, Qiao K-Y, Shi J-A, Gu L and He L 2017 One-step synthesis of van der Waals heterostructures of graphene and two-dimensional superconducting α − M o 2 C *Phys. Rev. B* 95 201403
[5]Turker F, Caylan O R, Mehmood N, Kasirga T S, Sevik C and Cambaz Buke G 2020 CVD synthesis and characterization of thin Mo_2 C crystals *J Am Ceram Soc* 103 5586–93
[6]Caylan O R and Cambaz Buke G 2021 Low-temperature synthesis and growth model of thin Mo2C crystals on indium *Scientific Reports* 11 8247
[7]Buke G C, Caylan O R and Ogurtani O T 2023 Growth Mechanism of 2D Mo_2 C on Cu via CVD *Crystal Growth & Design* 23 5462–8
[8] Buke G C, Caylan O R and Ogurtani O T 2023 Kinetic analysis of 2D Mo2C crystal growth via CVD *Physica Scripta* 98 105976
[9]Sumaiya S A, Demiroglu I, Caylan O R, Buke G C, Sevik C and Baykara M Z 2023 Atomically Resolved Defects on Thin Molybdenum Carbide (α-Mo_2 C) Crystals *Langmuir* 39 10788–94

ORAL

Yeşil Enerji Dönüşümü Sağlayan İleri Teknoloji Malzemelerin Üretiminde Endüstri 5.0 Uygulamalarının Rolü

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ABSTRACT

Günümüzde yeşil enerji dönüşümü, fosil yakıt tüketiminin azaltılması ve karbon salınımının düşürülmesi açısından büyük önem taşımaktadır. Küresel ısınma ve çevresel kirliliğin önlenmesi için yenilenebilir enerji kaynaklarına geçiş hız kazanmış, güneş, rüzgar ve hidrojen gibi temiz enerji teknolojileri ön plana çıkmıştır. Ancak, bu enerji sistemlerinin verimliliği ve sürdürülebilirliği, ileri teknoloji malzemelerin geliştirilmesine bağlıdır. Yeşil enerji dönüşümünü destekleyen ileri teknoloji malzemeler, enerji üretimi, depolanması ve iletiminde önemli avantajlar sağlamaktadır. Örneğin, perovskit güneş hücreleri, enerji dönüşüm verimliliğini artırırken, lityum-iyon ve katı hal bataryalar uzun ömürlü ve yüksek kapasiteli enerji depolama imkânı sunmaktadır. Hidrojen üretimi için geliştirilen yeni nesil katalizörler, elektroliz süreçlerinde enerji kayıplarını azaltarak yeşil hidrojen üretimini teşvik etmektedir. Ancak bu malzemelerin üretim süreçleri, yüksek enerji tüketimi ve çevresel etkiler açısından dikkatle ele alınmalıdır. Bu noktada, Endüstri 5.0 uygulamaları enerji dönüşümü sağlayan ileri teknoloji malzemelerin üretiminde kritik bir rol oynamaktadır. Endüstri 5.0, insan-makine iş birliğini, yapay zeka destekli üretim süreçlerini ve akıllı otomasyonu ön plana çıkararak malzeme üretiminde sürdürülebilirliği artırmaktadır. Gerçek zamanlı veri analitiği, robotik sistemler ve döngüsel ekonomi prensipleri sayesinde, enerji verimliliği yüksek ve çevresel etkileri minimum olan üretim süreçleri geliştirilmektedir. Bu çalışma, yeşil enerji dönüşümü, ileri teknoloji malzemeler ve Endüstri 5.0'ın entegrasyonu arasındaki ilişkiyi inceleyerek, sürdürülebilir üretim stratejileri için öneriler sunmayı amaçlamaktadır.

Keywords: *Endüstri 5.0, Enerji dönüşümü, İleri teknoloji, Yeşil enerji dönüşümü*

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POSTER

Kinetic Analysis of K_2SO_4: Dy,Na TL Phosphors

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ABSTRACT

This study aims to systematically investigate the thermoluminescence (TL) properties and kinetic parameters of K_2SO_4:Dy,Na phosphors obtained by co-doping dysprosium (Dy) and sodium (Na) ions into the crystal structure of potassium sulphate (K_2SO_4). The material was synthesised using a high temperature solid state reaction method and the TL responses were characterised in detail by exposure to different doses of beta radiation. The obtained TL radiation curves revealed that the emission intensity exhibits multiple peaks during heating, indicating the presence of electron traps with different depths within the material. A comprehensive analysis was carried out to understand the nature of these traps and their kinetic behaviour. Complementary methods such as computerised radiation curve decomposition (CGCD) technique, initial rise method, variable heating rate approach and Tm-Tstop method were used to determine the kinetic parameters. As a result of these analyses, basic parameters such as activation energy (E), frequency factor (s) and kinetic order (b) were calculated for each peak. The results show that TL peaks generally obey general order kinetics, with activation energies ranging from 1 eV to 2.8 eV and frequency factors in the range 10^9 to 10^14 s^-1. These values reveal that the energy levels of the traps directly affect the dosimetric performance of the material and that the doping of Dy and Na optimises these levels. It was observed that Dy ions increase the TL intensity by acting as luminescent centres, while Na ions improve the stability of the crystal structure through charge balancing. When the dose-response relationship was examined, it was determined that K2SO4:Dy,Na phosphors exhibited a linear behaviour over a wide dose range and had low fading rates. These properties indicate that the material is highly suitable for radiation dosimetry applications. The effects of synthesis conditions and doping ratios on TL sensitivity were also discussed and it was concluded that optimum Dy and Na concentrations play a critical role in maximising dosimetric performance. In conclusion, K_2SO_4:Dy,Na phosphors offer high sensitivity, stability and reproducibility, making them a potential material for personal dosimetry and environmental radiation monitoring.

Keywords: *Thermoluminescence, Kinetic analysis, K_2SO_4:Dy,Na, Radiation dosimetry, Activation energy, Trapping parameters.*

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ORAL

Catalytic and Photocatalytic Properties of $NiFe_2O_4$ Nanomaterials

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ABSTRACT

Nickel ferrite ($NiFe_2O_4$), a spinel-type metal oxide, is a promising material for catalytic and photocatalytic applications due to its structural, electronic, and magnetic properties [1,2]. Its thermal and chemical stability, high surface area, and tunable band gap make it suitable for various catalytic processes, including wastewater treatment and pollutant degradation. In this study, the electrochemical properties of $NiFe_2O_4$ were investigated to evaluate its oxygen evolution reaction (OER) activity and its efficiency in methylene blue (MB) degradation under UV light [3]. The catalytic performance of $NiFe_2O_4$ was assessed using linear scan voltammetry (LSV) and cyclic voltammetry (CV). LSV measurements revealed a low onset potential of 1.59 V (vs. RHE) and a high current density of 104.84 mA cm^{-2}, confirming its excellent OER performance in 1 M KOH solution. Additionally, the overpotential required to achieve a current density of 10 mA cm^{-2} was determined to be 0.317 V, which is competitive with commercially available electrocatalysts. CV measurements conducted at different scan rates showed the lowest current density at 10 mV s^{-1}. The electrochemical stability and reproducibility of $NiFe_2O_4$ further support its potential for long-term applications. Furthermore, its high conductivity, enhanced redox activity, and optimized structural properties make $NiFe_2O_4$ a promising candidate for OER and other electrochemically catalyzed processes such as water splitting and fuel cell applications. Photocatalytic experiments with MB demonstrated significant degradation, with an 88% reduction in absorption under UV light at room temperature, highlighting its potential for environmental remediation.

Keywords: *Nickel ferrite, Oxygen evolution reaction, Photocatalyst, Methylene blue*

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References

[1] B. Agarwal, M. Rani, U. Shanker, Green biosynthesized NiFe2O4 coated with rGO for efficient photocatalytic degradation of plastic additives: Synthesis, mechanism, and kinetics, Diamond and Related Materials, 153 (2025) 112115.

[2] BindiyaDey, M. Venkateshwarlu, C. Manoharan, S. AsathBahadur, P. Dhamodharan, Magnetic, electrochemical and gas sensing properties of hydrothermally synthesized NiFe2O4 nanoparticles, Inorganic Chemistry Communications, 152 (2023) 110666.

[3] A.A. Krishnan, S. Harikumar, M.A. Aneesh Kumar, R.B. Nair, S. Kurian, M. Ameen Sha, P.S. Arun, NiFe2O4: harnessing catalytic potential in water splitting, Catalysis Science & Technology, 14 (2024) 6155-6175.

ORAL

Fabrication and Characterization of Scaffolds with Heterogeneous Architecture as Potential in vitro 3D Model for Cancer Research

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ABSTRACT

In vitro artificial tumor models developed using tissue engineering approaches aim to mimic the tumor microenvironment more realistically; thus, it is aimed to model preclinical drug studies more reliably, to examine tumor-specific cellular behaviors in detail, and to determine the stages of cancer progression more accurately. Based on this, in this study, scaffolds with different morphologies were developed with a tissue engineering approach to mimic the breast cancer tumor micro framework. The scaffolds were produced by processing solutions of chitosan, gelatin, and poly (e-caprolactone) polymers prepared in different compositions using cryotropic gelation at -16°C and electrospinning methods. According to scanning electron microscopy images, the produced scaffolds exhibited a heterogeneous architecture that contained two different morphologies with an average fiber diameter of approximately 760 nm and an average pore size of approximately 600 µm. The chemical interactions between polymers were analyzed by Fourier Transform Infrared Spectroscopy. The contact angle values on the scaffold surface varied between approximately 90-105°. The scaffolds with heterogeneous architecture exhibiting high water retention capacity, biocompatibility, and biodegradability are expected to exhibit potential to mimic the complex and dynamic breast tumor framework, thereby providing a powerful platform to investigate tumor biology and advance preclinical drug screening.

Keywords: *Scaffold, Fibrous, Porous, In vitro model, Breast cancer*

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ORAL

Mechanical and Thermal Analysis of Carbon Fiber Reinforced Discs Under Thermal Loading

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ABSTRACT

In this study, thermal stresses and radial displacements occurring in a disk made of carbon fiber reinforced polymer (CFRP) material were investigated. Accurate determination of thermal stress analyses requires careful consideration of temperature distribution and me-chanical properties such as elasticity modulus and thermal expansion coefficients. In the present analysis, temperature distributions ranging from 20°C to 200°C, which are ideal for practical engineering applications, were utilized. CFRP materials are increasingly pre-ferred in industries such as unmanned aerial vehicles (UAVs), aircraft, and aerospace due to their high strength-to-weight ratio, stiff-ness, and durability. These materials consist of carbon fibers embedded in a polymer matrix, providing excellent mechanical and thermal properties. The study calculated both radial and tangential stresses as well as radial displacement within the CFRP disk. The results ob-tained through analytical methods were presented comparatively for various temperature levels. Additionally, the analytical findings were validated using finite element analysis (FEA), ensuring accuracy and reliability. The comparisons revealed good agreement be-tween analytical results and FEA simulations performed with ANSYS 2023 software. It was observed that variations in temperature significantly influenced the stress distributions and displacement behavior of the CFRP disk, demonstrating the critical importance of precise thermal modeling in the structural analysis of composite materials.

Keywords: *Thermal loading, ANSYS, CFRP disk, Elastic modulus*

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POSTER

Luminescence Characterization of $SrSiO_3$: Ce,Li Dosimetry Pellets Synthesized by Solid State Technique

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ABSTRACT

This investigation serves to contribute significantly to the field by exploring the luminescent responses of $SrSiO_3$:Ce,Li phosphors and enhancing their efficacy as radiation-sensitive materials. The fabrication of SrSiO3 samples involved a meticulous doping process employing Ce+3 and Li+ ions through the solid-state reaction synthesis method. Comprehensive structural and morphological analyses of undoped and doped samples were conducted using X-ray diffraction (XRD) and scanning electron microscopy (SEM) techniques. The luminescent behaviour of the $SrSiO_3$:Ce,Li pellets was meticulously characterized through the utilization Optically Stimulated Luminescence (OSL) and Thermoluminescence (TL) methods. A thorough investigation into concentration quenching revealed that the optimal OSL and TL sensitivities were attained at a 0.1% concentration of Ce dopant and at a 5% concentration of Li dopant. Additionally, the OSL decay curve showed the presence of three decay components, whereas the TL glow curve displayed unique characteristics, displaying five separate TL peaks. Notably, OSL signals of SrSiO3:Ce0,1%,Li5% ceramic pellets showed nonlinear characteristics from 0.5 up to 100 Gy with a slope value of 1.06 and sustained reusability during ten cycles of experimentation. These admirable character-istics support the application viability of $SrSiO_3$:Ce,Li samples in radiation dosimetry and highlight their potential as highly promising dosimeters. The thorough knowledge gained from this investigation not only advances our knowledge of the luminescent behavior of SrSiO3:Ce,Li phosphors but also opens the door for their effective application as dosimetry in-struments in a variety of radiation-related fields.

Keywords: *Strontium silicate (SrSiO3), Solid state synthesis, OSL, Radiation dosimetry*

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ORAL

Electronic and Transport Properties of Monolayer ZrS_2

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ABSTRACT

The electronic properties, phonon dispersions and transport characteristics of monolayer ZrS_2 are analyzed through first-principles calculations. The study computes the energy band structure and phonon dispersion relations for ZrS_2 along high-symmetry points in reciprocal space. Electron scattering rates due to both acoustic and optical phonons crucial for evaluating electron transport are determined across the entire Brillouin zone and are presented as a function of energy. Mode resolved scattering rates due to each mode of elastic crystal vibrations including absorption and emission phonon processes are presented. It is revealed that the energy bands are non parabolic near the bottom of the conduction band and significant anisotropy exist in effective masses. Finally, the mobility of electrons is calculated as a function of temperature and significant limiting factor for mobility may be the high effective mass of electrons.

Keywords: *ZrS_2, Phonon dispersion, scattering, mobility.*

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ORAL

Investigating Gas Uptake and Electric Field Response of ZIF-71 with Monte Carlo and *Ab-initio* Simulations

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ABSTRACT

Molecular hydrogen (H_2) is widely regarded as a clean and sustainable energy carrier, yet its widespread use is hindered by the lack of safe, compact, and efficient storage solutions [1]. Hydrogen sulfide (H_2S) is a hazardous contaminant frequently encountered in petroleum, natural gas, and biomass-derived synthesis gas streams [2]. Even at trace levels, H_2S poses serious challenges by causing catalyst poisoning and severe corrosion in industrial systems. In this study, we theoretically investigated the adsorption performance of the Zeolitic Imidazolate Framework ZIF-71[3] for both H_2 and H_2S gases. Grand Canonical Monte Carlo (GCMC) simulations were employed to evaluate the gas uptake behavior under varying temperatures and pressures. The results revealed that ZIF-71 exhibits enhanced H_2 adsorption at lower temperatures and higher pressures, reaching up to 29.33 g/L at 193 K and 100 bar. Notably, at 233 K and elevated pressures, the performance approaches U.S. DOE volumetric targets [4], highlighting the material's potential for hydrogen storage. Similarly, H_2S adsorption significantly increases with decreasing temperature, achieving up to 25.88 mg/g at 193 K and 50 bar—far exceeding previously reported values for related frameworks [2]. Furthermore, ab initio molecular dynamics simulations show that external electric fields influence the dihedral angles of ZIF-71 ligands. While a field strength of 1 V/nm induces minor changes, a stronger field of 2 V/nm causes a more noticeable structural shift, suggesting tunability of the framework under external stimuli. These findings underscore ZIF-71's promise as a multifunctional material for gas storage and responsive applications. We appreciate the support provided by the Scientific and Technological Research Council of Türkiye (TÜBİTAK) within the TÜBİTAK-1001 Research Program (Project No: 124Z002). All reported simulations were carried out using TRUBA HPC resources.

Keywords: *Physisorption, H_2 adsorption, H_2S adsorption, electric field response*

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We appreciate the support provided by the Scientific and Technological Research Council of Türkiye (TÜBİTAK) within the TÜBİTAK-1001 Research Program (Project No: 124Z002). All reported simulations were carried out using TRUBA HPC resources.

References

[1] Gökdemir, T., & Gurdal, Y. (2024). Theoretical investigation of mixed-metal metal-organic frameworks as H2 adsorbents: insights from GCMC and DFT simulations. Molecular Simulation, 50(15), 1233–1245. https://doi.org/10.1080/08927022.2024.2395569

[2] Hamon, L., Leclerc, H., Ghoufi, A., Oliviero, L., Travert, A., Lavalley, J.-C., Devic, T., Serre, C., Férey, G., De Weireld, G., Vimont, A., & Maurin, G. (2011). Molecular insight into the adsorption of H_2S in the flexible MIL-53(Cr) and rigid MIL-47(V) MOFs: Infrared spectroscopy combined with molecular simulations. The Journal of Physical Chemistry C, 115(5), 2047–2056.

[3] Banerjee, R., Phan, A., Wang, B., Knobler, C., Furukawa, H., O'Keeffe, M., & Yaghi, O. M. (2008). High-throughput synthesis of zeolitic imidazolate frameworks and application to CO_2 capture. Science, 319(5865), 939–943.

ORAL

Seri Üretim Teknolojileriinde Enerji ve Kaynak Verimliliği Açısından Proses Hatalarının Minimize Edilmesi: Preform Kalıplarında Aşınma ve Malzeme Performasının İyileştirilmesine Yönelik Yenilikçi Yaklaşımlar

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ABSTRACT

Sanayide artan rekabet koşulları, firmaları enerji ve kaynak kullanımında daha verimli ve sürdürülebilir çözümler geliştirmeye yönlendirmektedir. Seri üretim teknolojilerinde hataların minimize edildiği, tekrarlanabilir ve sürdürülebilir proseslerin kurgulanması yalnızca üretim verimliliğini değil, aynı zamanda nihai ürün kalitesini de doğrudan etkilemektedir. Bu bağlamda, firmaların üretim süreçlerinde sürekli iyileştirme yaklaşımını benimsemesi ve katma değeri yüksek ürünler elde etme motivasyonu, sektörel üstünlük açısından kritik öneme sahiptir. Bu çalışma, firma bünyesinde seri üretimi gerçekleştirilen preform kalıplarında yer alan ve sürekli temas halinde çalışan kalıp bileşenlerinin aşınma davranışlarının incelenmesini ve bu aşınmanın neden olduğu performans kayıplarının azaltılmasına yönelik proses iyileştirme uygulamalarını kapsamaktadır. Mevcut durumda, bu bileşenlerde proses süresiyle doğru orantılı olarak gelişen aşınma, kalıpların genel kullanım döngüsünü önemli ölçüde azaltmakta; bazı durumlarda kalıp ömrü tamamlanmadan sistem işlevselliğini kaybetmektedir. Bu durum, müşteri firmaların üretim kapasitesini ve proses sürekliliğini olumsuz yönde etkilemektedir. Çalışmanın özgün yönü, yalnızca kalıp tasarımına değil, aynı zamanda malzeme mühendisliğine dayanan disiplinler arası bir analiz yaklaşımı içermesidir. Malzeme kimyasal ve fiziksel özelliklerinin analiz edilmesi, aşınma ve korozyon davranışlarının laboratuvar ortamında modellenmesi ve mevcut malzemelere muadil olabilecek alternatiflerin sistematik olarak değerlendirilmesi, çalışma çıktılarının sektördeki mevcut uygulamalara kıyasla fark yaratmasını sağlamaktadır. Çalışma sürecinde edinilecek teknik bilgi birikimi, tasarım ve Ar-Ge birimlerinde görev alan araştırmacıların malzeme alanındaki yetkinliklerini de artıracaktır. Bu çalışmanın en somut çıktılarından biri, preform kalıplarında mevcutta 7,5 milyon üretim döngüsüne ulaşan bileşenlerin, yeni malzeme uygulamaları ile 15 milyon döngüye kadar performans göstermesinin hedeflenmesidir. Böylece kalıp verimliliğinde %50 oranında bir artış sağlanması öngörülmektedir. Ayrıca, geliştirilecek yeni kalıp bileşenlerinin üretim sürecinde kullanıma alınmasıyla hem enerji hem de kaynak tüketiminde önemli kazanımlar elde edilmesi beklenmektedir. Sonuç olarak bu çalışma; sürdürülebilir üretim teknolojilerinin geliştirilmesi, proses verimliliğinin artırılması ve kaynak optimizasyonu gibi kritik hedeflere doğrudan katkı sağlayan, yüksek yenilikçilik düzeyine sahip bir araştırmadır. Elde edilen bulguların hem akademik literatüre katkı sunması hem de sektörel uygulamalar açısından yol gösterici olması hedeflenmektedir.

Keywords: *Seri üretim, Preform kalıp, Aşınma, Malzeme seçimi, Proses verimliliği, Enerji tasarrufu, Kaynak optimizasyonu, Sürdürülebilir üretim*

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ORAL

Effects of Noble Metal Alloy Based Magnetic Elements on Nanoparticles and Detailed Investigation

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ABSTRACT

Nanomaterials play important role in a wide range of applications, including energy conversion, catalysis, and magnetic storage [1]. The unique properties of noble metal nanoparticles (NPs), such as platinum (Pt) and gold (Au), make them highly desirable for various catalytic and magnetic applications when doping with ferromagnetic elements [2, 3]. In this study, cobalt (Co) atoms incorporated into Pt-Au NPs, synthesized using a modified polyol method and explored their catalytic and magnetic properties. 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 6.31 nm. Scanning electron microscopy analyzed the surface morphology and particle size distribution, with Co-doped particles showing an average size of approximately 51.8 nm. The catalytic activity of the triatomic NPs assessed using a three-electrode system, with hydrogen evolution reaction performance evaluated via cyclic voltammetry and linear sweep voltammetry. Additionally, magnetic behavior studied through zero-field cooling (ZFC) and field-cooling (FC) magnetization versus temperature (M-T) curves measured between 5 K and 350 K. The ZFC curve indicated a blocking temperature, TB, of 56 K, and the hysteresis loop (M-H) obtained in a ±3 T magnetic field. These results suggest a transition from the paramagnetic phase to ferromagnetic behavior. The saturation magnetization, Ms, at 5 K was measured 0.12 emu/g for PtAu and 14.8 emu/g for PtAuCo, with coercive field, Hc, values found to be 191 Oe and 3410 Oe, respectively.

Keywords: *PtAu-based Trimetallic NPs, Modified Polyol Synthesis Method, Catalytic and Magnetic Properties*

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References

[1] S. Ali, A.S. Sharma, W. Ahmad, M. Zareef, M.M. Hassan, A. Viswadevarayalu, T. Jiao, H. Li, Q. Chen, Noble Metals BasedBimetallic and Trimetallic Nanoparticles: Controlled Synthesis, Antimicrobial and Anticancer Applications, Crit Rev Anal Chem, 51 (2021) 454-481.

[2] A. Albanese, P.S. Tang, W.C. Chan, The effect of nanoparticle size, shape, and surface chemistry on biological systems, Annu Rev Biomed Eng, 14 (2012) 1-16.

[3] G. Fu, L. Ding, Y. Chen, J. Lin, Y. Tang, T. Lu, Facile water-based synthesis and catalytic properties of platinum–gold alloy nanocubes, CrystEngComm, 16 (2014) 1606-1610.

ORAL

Enhancing The Mechanical and Barrier Properties of PLA Films: Biocomposite Development using Tomato Peel Extract

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ABSTRACT

Petroleum-derived materials are commonly used nowadays for their advantages such as low cost and easy processability. The high production and usage of these materials cause many problems for the world. According to a 2022 OECD report, the world now produces twice as much plastic waste as it did 20 years ago, and only 9% is successfully recycled [1]. Plastics accumulate in the environment due to their long degradation processes, causing environmental pollution. One possible solution to these issues is to develop a new biocomposite material as a substitute for commercial plastics. Biodegradable plastics are the plastics that are produced from sources such as corn starch, recycled food waste etc. Among bioplastics, Polylactic acid (PLA) is the most promising biopolymer due to its excellent optical properties, relatively high mechanical strength, hardness, heat processability, and lower cost than other biopolymers. PLA is the market leader in the bio-based and biodegradable plastics segment [2]. On the other hand, its brittleness, high oxygen permeability, and water vapor permeability are the main drawbacks which restricts the use of PLA in the packaging industry. To improve PLA's properties for food packaging, plant fibers from agricultural wastes can be used [3]. In this study, Tomato Peel Extract (TPE) was incorporated into biocomposite films, as tomatoes are among the most widely consumed fruits globally, and their processing produces waste—such as seeds, pulp, and peels—that contributes to environmental pollution. Various ratios of TPE (10%, 20%, 30%, and 40% w/w) were incorporated into PLA, and PLA-TPE biocomposite films were produced by coating method to examine the impact of TPE on the mechanical and permeability properties of PLA. The TPE was obtained through an alkaline extraction method. The PLA/TPE biocomposite films were analysed in tensile strength, elongation at break, young modulus, oxygen transmission rate and water vapor transmission rate.

Keywords: *PLA, Tomato Peel Extract, Biodegradable, Sustainability*

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References

[1] OECD. (2022). Plastic pollution is growing relentlessly as waste management and recycling fall short, says OECD. https://www.oecd.org/environment/plastic-pollution-is-growing-relentlessly-as-waste-management-and-recycling-fall-short.html

[2] Islam, M. M., Chaudry, S., Thornton, A. W., Haque, N., Lau, D., Bhuiyan, M., & Pramanik, B. K. (2025). Environmental footprint of polylactic acid production utilizing cane-sugar and microalgal biomass: An LCA case study. Journal of Cleaner Production, 496, 145132. https://doi.org/10.1016/j.jclepro.2025.145132

[3] Zhao, X., Liu, J., Li, J., Liang, X., Zhou, W., & Peng, S. (2022). Strategies and techniques for improving heat resistance and mechanical performances of poly(lactic acid) (PLA) biodegradable materials. International Journal of Biological Macromolecules, 218, 115–134. https://doi.org/10.1016/j.ijbiomac.2022.07.091

POSTER

Processing and Characterization of Sustainable Flax-Jute/PA11 Thermoplastic Composites

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ABSTRACT

The aim of this project is to produce high-performance, eco-friendly composite parts using woven fabric made from flax-jute hybrid yarn and PA11 thermoplastic powder resin. The biodegradable flax-jute fabric was employed as a reinforcement material. The fine particle size and low melting temperature of the PA11 powder resin allow for easy processability and uniform impregnation. Using a double-belt press and a powder scattering method, the resin was impregnated into the fabric under heat and pressure. Before molding, multiple layers of these prepregs were compressed under a hydraulic press at the melting point of PA11. The obtained composites were subjected to tensile and impact tests to examine their mechanical properties, and the bonding performance between the resin and fibers was characterized by using a scanning electron microscope (SEM). Mechanical test results indicated that the bio-based hybrid composites offer a sustainable alternative to conventional composites. SEM analysis confirmed strong adhesion between fibers and resin. These results suggest that natural fiber-reinforced composites can offer innovative solutions in sectors such as automotive and construction.

Keywords: *Bio-based composites, Flax-jute hybrid yarn, PA11 thermoplastic resin*

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CHAPTER 2. FULL PAPER PROCEEDINGS

FULL PAPER

Modeling of Electrical Properties of $Bi_2Sr_2Ca_{1-x}Zn_xCu_{1.75}Na_{0.25}O_y$ (x = 0.00, 0.0125, 0.025, 0.050 and 0.075) Superconductors

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ABSTRACT

In the presented study, the electrical properties of nano-sized Zn doped Bi-2212 superconductor materials were modeled using the Curve Fitting method via the Matlab program. $Bi_2Sr_2Ca_{1-x}Zn_xCu_{1.75}Na_{0.25}O_y$ (x = 0.00, 0.0125, 0.025, 0.050 and 0.075) ceramic superconductor samples were produced using the solid state reaction method. The superconductivity transition temperature values of the produced samples were determined using PPMS measurement. As a result of the measurement, the T_c^{onset} values of the samples were found to be 78.06 K, 75.96 K, 70.08 K, 76.05 K and 70.11 K, respectively, according to the doping values (x = 0.00, 0.0125, 0.025, 0.050 and 0.075). The T_c^{ofset} values were obtained as 51.10 K, 41.01 K, 44.03 K, 40.11 K and 28.12 K, respectively, according to the doping values (x = 0.00, 0.0125, 0.025, 0.050 and 0.075). A model was developed in the Matlab environment to estimate the electrical properties of the unproduced doping rates of the nano-sized Zn doping following the completion of the experimental measurement and characterization studies. Mathematical formulations for both onset and offset transition temperatures were obtained by curve fitting method. As a result of these formulations, the onset and offset transition temperatures of the untested doping values were estimated. By modeling the formulations, the onset and offset transition temperature values for the estimated doping values (x = 0.1, 0.25, 0.30 and 0.35) were calculated. As a result of the modeling, according to the doping values (x = 0.1, 0.25, 0.30 and 0.35), the onset temperature values were calculated as 77.13 K, 70.04 K, 69.07 K and 69.25 K, respectively, while the offset temperature values were calculated as 41.35 K, 44.00 K, 45.32 K and 45.79 K, respectively. Thus, the superconductivity transition temperature values of the unstudied doping values of the $Bi_2Sr_2Ca_{1-x}Zn_xCu_{1.75}Na_{0.25}O_y$ system were estimated by mathematical modeling without carrying out experimental studies.

Keywords: *$Bi_2Sr_2Ca_{1-x}Zn_xCu_{1.75}Na_{0.25}O_y$, Curve Fiting Tools, Superconducting Transition, Temperature*

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INTRODUCTION

Due to the special electrical and magnetic characteristics of these materials, research on high-temperature superconductors (HTS) has accelerated recently. Bi-Sr-Ca-Cu-O (BSCCO) systems in particular are of interest due to their low energy losses and high superconducting transition temperatures (Tc). The Bi-2212 structure, one of the most prevalent phases of this system, is frequently selected in both fundamental research and practical domains due to the stability of its crystal structure and ease of manufacture [1,2]. The electrical and magnetic performance of BSCCO ceramic superconductor materials can be significantly improved by the addition/doping of elements with different atomic radii [3,4]In this context, nano-sized zinc (Zn) doping impacts the electrical characteristics of the Bi-2212 system by modifying the carrier density and crystal structure. Zn atoms modify the carrier dynamics by settling on the Cu-O planes and transform the critical temperature and conductivity behavior [5]. Especially Zn-doped structures at nano-

sized can exhibit different electrical characteristics compared to conventional sizes due to the increased surface/volume ratio and changing microstructure [6]. In the previous work, the effect of nano-sized Zn particles (< 100 nm) on calcium sites in the sodium-doped Bi-2212 superconductor system was investigated. It was found that the superconducting properties gradually deteriorated with increasing nano-sized Zn doping [7]. In this study, the electrical data of Zn-doped Bi-2212 superconductor materials ($Bi_2Sr_2Ca_{1-x}Zn_xCu_{1.75}Na_{0.25}O_y$, x = 0.00, 0.0125, 0.25, 0.5 and 0.75) were modeled by curve fitting methods using MATLAB software. In this way, the effects of the doping ratios on the superconducting behaviour of the material were quantitatively revealed and a significant correlation between the experimental data and theoretical models was established. Electrical properties were modeled using the findings obtained in the experimental study.

MATERIALS AND METHODS

Ceramic superconductors with the structure of $Bi_2Sr_2Ca_{1-x}Zn_xCu_{1.75}Na_{0.25}O_y$ (x = 0.00, 0.0125, 0.025, 0.050 and 0.075) were produced by solid state reaction method [7]. To determine the superconductivity properties of the samples produced by the solid-state reaction method, resistivity measurements were carried out at varying temperatures (150 K - 20 K) in the PPMS measurement system. After determining the T_c^{onset} and T_c^{offset} temperatures, the mathematical functions of the electrical values obtained were determined by the curve fitting method in the Matlab environment. These functions determine the relationship between transition temperature values and nano-sized Zn doping rates. Thus, the electrical properties of the non-produced doping values can be estimated depending on the experimental results. Ceramic superconductor samples produced by the solid reaction method are named Sample A (x = 0.00), Sample B (x = 0.0125), Sample C (x = 0.0250), Sample D (x = 0.050) and Sample E (x = 0.1) according to the different nano-sized Zn doping ratios.

RESULTS AND DISCUSSION

In the presented study, when the electrical and magnetic properties of ceramic superconductors were evaluated in the previous study and analyzed in terms of morphology and phase structure, the best superconductivity results were observed in the undoped sample [7]. The T_c^{onset} and T_c^{offset} values obtained from the R-T measurements performed to characterise the superconductivity transition temperatures of the samples as a function of temperature are shown in Table 1.

Table 1. Electrical values of ceramic superconductors obtained from experimental results [7]

Sample	T_c^{onset} *(K)*	T_c^{offset}*(K)*	ΔTc *(K)*
Sample A	78.069	51.103	26.966
Sample B	75.960	41.011	34.949
Sample C	70.088	44.031	26.057
Sample D	76.053	40.103	35.950
Sample E	70.115	28.120	41.995

The onset transition temperature is the region where the first transition to superconductivity begins and a rapid decrease in the resistivity temperature value begins. This temperature is related to the formation of superconducting phases in the material [2,8] The offset value is the first temperature at which the rapid reduction in resistance is complete and the materials exhibit zero resistance. This temperature value is related to the quality of the connections between the superconductor phases [9]. When the values in Table 1 are examined, the best superconducting conductivity properties (highest transition temperature value) are observed in the undoped sample. Although improvements in offset and onset temperatures were observed in samples C and D respectively, the nano-sized Zn doped sample showed lower value compared to the undoped sample. Especially in experimental studies involving different element doping processes, the number of doping values of the elements is limited in terms of both material possibilities and

measurement and characterization costs. For this reason, the effects of the elements added to the system are as much a matter of curiosity as the effects of the additive values that cannot be added. Predictions made using mathematical equations can provide guidance on whether contribution rates should be maintained. In this study, the mathematical formulation of the $Bi_2Sr_2Ca_{1-x}Zn_xCu_{1.75}Na_{0.25}O_y$ (x = 0.00, 0.0125, 0.025, 0.050 and 0.075) system was obtained by modelling the experimental data because of characterisation using the curve fitting method in the Matlab environment.

The polynomial is obtained as Correlation equation with contribution values of onset temperature.

f(x) = p1*x^4 + p2*x^3 + p3*x^2 + p4*x + p5 (1)

In the equation;

p1 = -1431

p2 = 1871

p3 = -665.4

p4 = 39.87

p5 = 78.07 are the coefficients.

The onset transition temperature value is shown with x. On the other hand, the offset equation;

f(y) = p1*y^4 + p2*y^3 + p3*y^2 + p4*y + p5 (2)

p1 = -1431

p2 = 1871

p3 = -665.4

p4 = 39.87

p5 = 78.07 are the coefficients**.** The offset transition temperature value is shown with y.

The graphs of mathematical functions obtained for onset and offset temperatures from the Matlab environment are shown.

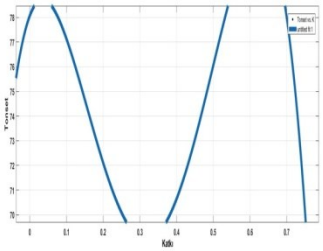

Figure 1. Graph of the function for onset temperatures

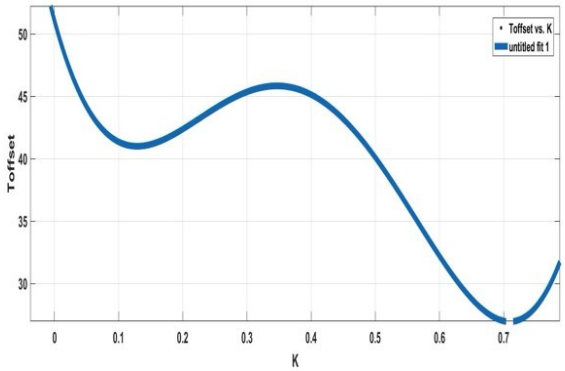

Figure 2. Graph of the function for offset temperatures

Table 2 shows the estimation results of the doping values [7] preferred for Bi-2212 superconductor samples in the literature, such as x = 0.1, 0.25, 0.30 and 0.35, as a result of modeling [10,11]

Table 2. Electrical results calculated from the modeled function

Doping	$T_c^{onset}(K)$	$T_c^{offset}(K)$	$\Delta Tc\ (K)$
0.1	77,139	41,350	35,789
0.25	70,049	44,000	26,049
0.30	69,079	45,320	23,759
0.35	69,258	45,790	23,468

When comparing the values obtained as a result of the mathematical function obtained by using the curve fitting method in the Matlab environment, the onset temperatures tend to decrease as the contribution value increases. On the other hand, the offset temperatures tend to increase.

CONCLUSION

In the present study, the electrical properties of the $Bi_2Sr_2Ca_{1-x}Zn_xCu_{1.75}Na_{0.25}O_y$ (x = 0.00, 0.0125, 0.025, 0.050 and 0.075) system were formulated using the curve fitting method in the matlab environment. After obtaining the mathematical formulas of the onset and offset transition temperatures, the experimental workability was investigated by estimating the doping values commonly used in the literature such as x = 0.1, 0.25, 0.30 and 0.35 for the nano-sized Zn-doped Bi-2212 superconductor system. After obtaining estimated values, the onset temperature value of the contribution values of 0.1, 0.25, 0.30 and 0.35 were estimated as 77.139, 70.049, 69.079, 69.0258, respectively. The offset transition temperature value was estimated as 41.350, 44.00, 45.320 and 45.790 for contribution values of 0.1, 0.25, 0.30 and 0.35, respectively. The observation of this behavior at the onset temperature value related to the formation of the superconducting phase shows that the phase structure deteriorates with increasing Zn doping. However, the increase in the offset temperature, which indicates an increase in the quality of the phase bonds, is not a sufficient parameter for the development of superconductivity compared to the decrease in the offset temperature value, which indicates a decrease in the number of superconducting phases. Therefore, the estimation results indicate that there will be a loss of financial resources and time for the production and characterization processes of the new dopping value in the laboratory environment.

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REFERENCES

[1]Çalış M, Özkurt B, Aytekin ME, Gün E, Kır ME, Öztornacı U. Enhancement of superconducting properties of Bi-2212 ceramics by vanadium–sodium co-doping. Journal of Materials Science: Materials in Electronics. 2016;27:2670-5.
[2] Abdelhaleem S, Noun M, Yousif NM, Shalaby MS. Impact of carbon nanotubes on superconducting properties and ferromagnetism of indium-doped Bi-2212 superconductors: Critical current density enhancement. Physica B: Condensed Matter. 2025;697:416704.
[3]Al Azzawi ANS, Türköz MB, Erdem Ü, Yildirim G. Improvement in organization of Cu–O coordination and super-electrons in Bi-2212 ceramic matrix with Ag/Sr partial substitution. Journal of Materials Science: Materials in Electronics. 2024;35(18):1261.
[4]Aytekin M, Özkurt B, Sugözü K, Köse E, Sugözü İ. The effect of different dwell times at a constant pelletization pressure of 6 GPa on superconducting properties of BiSrCaCuO ceramics. Journal of Materials Science: Materials in Electronics. 2016;27(8).
[5]Wang ZL, Kong XY, Ding Y, Gao P, Hughes WL, Yang R, et al. Semiconducting and piezoelectric oxide nanostructures induced by polar surfaces. Advanced Functional Materials. 2004;14(10):943-56.
[6]Özkurt B. Effect of nano-sized metallic Au additions at large scale on the phase stability of Bi-2212 ceramics. Journal of Materials Science: Materials in Electronics. 2019;30:14547-53.
[7]Aytekin ME. Change in Physical, Electrical and Magnetic Properties of Bi-2212 Superconducting Materials Co-Substituted with Nano-Sized Zinc and Sodium. Transactions on Electrical and Electronic Materials. 2024:1-13.
[8]Özkurt B. Improvement of the critical current density in Bi-2223 ceramics by sodium–silver co-doping. Journal of Materials Science: Materials in Electronics. 2014;25:3295-300.
[9]ÖZTORNACI U, Özkurt B. The effect of nano-sized metallic Au addition on structural and magnetic properties of Bi1. 8Sr2 AuxCa1. 1Cu2. 1Oy (Bi-2212) ceramics. Ceramics International. 2017;43(5):4545-50.
[10]Aytekin ME, Akyol M, Özkurt B. Improvement in electrical properties of Bi-2212 superconducting materials substituted with large-scale nano-sized tin. Applied Physics A. 2024;130(2):78.
[11]Özkurt B. A Significant Enhancement in J c Values Through Excessive Na Doping in Bi 2 Sr 2 Ca 1 Cu 2− x Na x O y Superconductors. Journal of Superconductivity and Novel Magnetism. 2015;28:1501-6.

FULL PAPER

$Bi_2Sr_2Ca_{1-x}Sb_xCu_{1.75}Na_{0.25}O_y$ (x = 0.0, 0.0125, 0.0250, 0.050, 0.075, 0.1) Investigation of Phase Formation of Superconductors

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ABSTRACT

Nano-sized doping and additional studies carried out in recent years to improve the physical and magnetic properties of BSCCO ceramic superconductors may lead to improvements in the superconductivity properties of the materials. In this study, the effect of nano-sized antimony doping on calcium sites in sodium-doped Bi-2212 superconductor system was investigated. Ceramic superconductor materials produced by the solid-state reaction method were characterized by X-ray powder diffraction measurements (XRD) for phase formation and crystal structure analysis. Although some impurity phases were formed in the phase analysis performed by XRD measurement, it was determined that the basic phase structure in all samples was the Bi-2212 high temperature phase. The crystal structure of the samples was calculated from the XRD results as tetragonal structure. When the grain thickness values calculated with the Debye-Scherrer equation were examined, it was determined that the 0.0250 doped sample had the largest grain size of 40nm.

Keywords: *Bi-2212 superconductors, X-Ray diffraction measurements, Lattice, Crystal size*

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INTRODUCTION

Since the discovery of high-temperature superconductors, they are widely used in many technological and commercial applications today due to their zero resistance, critical current density and diamagnetic solutions. High temperature superconductor properties are promising methods for applications such as technologically high-power current capacity carrying cables, high-capacity magnetic capacitances, magnetic resonance imaging systems, superconductor fault stop limiters (SFCL) and magnetic sensors [1-2]. Superconductor families include cuprate structures such as YBa2Cu3O7-x (YBCO), $Bi_2Sr_2CaCu_2O_x$ (BSCCO), $TaBa_2Ca_2Cu_3O_9$ (TBCCO) and $HgBa_2CaCu_2O_{6+x}$. Among these families, the BSCCO superconductor system has the advantages of not containing toxic substances, being easy to synthesize and having thermodynamic stability. In addition, significant improvements can be achieved in critical current density (Jc) and critical magnetic field (Hc) values with morphological and phase developments. With the general formula $Bi_2Sr_2Ca_{n-1}Cu_nO_{2n+4+y}$, the BSCCO system has three different phase arrangements called Bi-2201 (n = 1), Bi-2212 (n = 2) and Bi-2223 (n = 3) according to the copper oxide layer structure per unit (in value) [3-5]. Among the BSCCO superconductor family, Bi-2212 phase is preferred by many working groups due to its advantages such as phase structure with 90 K transition temperature, high phase stability and easy production processes [6-7]. However, to meet the capacities such as high-capacity energy consumption or high-capacity magnetic field carrying capacity of the technology, it is necessary to improve the magnetic and critical current density values of BSCCO superconductors with the developments in their structure and morphological structure. Many methods and techniques such as LFZ (Laser Floating Zone), hot pressing and high pelletization pressure are used to improve the electrical and magnetic properties of BSCCO superconductor materials and to create more uniform grain structures [9-11]. As is well known from the literature, when Type II superconductor systems are exposed to a magnetic field between the critical magnetic fields Hc_1 and Hc_2, the partial penetration of magnetic flux into the material is called the vortex (mixed) state. In this case, the magnetic field partially penetrates the material. The penetration of the magnetic field into the material can cause a drastic decrease in the critical current density value (Jc), which is the maximum current that the material can carry. Flux pinning centers created in the material are a useful method to prevent flux movements [12]. Flux pinning centers are formed by impurity phases formed in the material and by doping/adding elements with different ionic radii [13]. As is known from the literature, it has been reported that the doping/addition of elements such as Ag, Na, B, Li, La, Cd and Pb with different radii into BSCCO superconductor systems significantly improves and develops the electrical and magnetic properties [13-18]. Addition/doping of nano-sized particles into superconductors can support the formation of Cooper pairs and at the same time create stronger forces in stabilizing magnetic fields. In many studies, addition of nano-sized particles has played an important role in flux stabilization and increasing critical current density. As is known from the literature, addition/doping of Sb instead of Pb, Bi or Sr in Bi-systems has been reported to improve critical temperature, critical current density and critical magnetic field [20-26]. Many study groups have done different rates of antimony doping and additional studies on different sites. In the study conducted by Kocabaş et al., different rates of Sb were doped to Cu sites in the Bi-2223 structure, and it was reported that low rates of antimony doping improved the critical temperature value [23]. Altın et al. observed that adding Sb_2O_3 to the Bi-2223 phase at appropriate rates improved the superconductivity properties but also increased the formation of undesirable phases [20]. In the study conducted by Cevizci et al., it was reported that adding nano-sized Sb_2O_3 and nano-sized Y_2O_3 to the Bi-2223 structure at certain rates created a stronger flux pinning center and higher critical current density in nano-sized Sb_2O_3 samples [24]. When nano-sized particle doping/additions made at appropriate rates into the BSCCO system enter the material, it can increase the particle properties and critical current density value by settling the inter-grain gaps. In the study conducted by Özkurt, significant increases in the critical current density value of the improvements in the morphological structure were reported with Na doping to Cu-O layers in the Bi-2212 superconductor system. Due to the positive developments of sodium (x=0.25 Na) doping to Cu-O layers on the morphological structure and charge carrier properties of BSCCO superconductors, the composition with 0.25 sodium doping to Cu-O layers was preferred in this study [18]. In this study, different amounts of nano-sized Sb_2O_3 particles (x = 0.0, 0.0125, 0.0250, 0.050, 0.075, 0.1) will be doped to the calcium sites in the superconductor system in the initial composition of $Bi_2Sr_2Ca_1Cu_{1.75}Na_{0.25}O_y$. The effect of nano-sized Sb_2O_3 (50nm) doping on ceramic superconductor samples prepared by solid state reaction method was analyzed by XRD measurements.

MATERIALS AND METHODS

In this study, calcium sites will be doped with antimony at different rates. This composition; Bi_2O_3 + $SrCO_3$ + $CaCO_3$ + CuO + Na_2CO_3 => $Bi_2Sr_2Ca_1Cu_{1.75}Na_{0.25}O_y$ was determined according to the equation.Within the scope of this project, 50 nm Sb_2O_3 nano particles will be doped into the $Bi_2Sr_2Ca_1Cu_{1.75}Na_{0.25}O_y$ structure obtained using the above-mentioned reaction equation consisting of high purity Bi_2O_3, $SrCO_3$, $CaCO_3$, Na_2CO_3 and CuO powders. At this stage, six different samples will be produced with each doping ratio (x = 0.0, 0.0125, 0.0250, 0.050, 0.075 and 0.10) using the solid-state reaction method with the reaction equation Bi2O3 + SrCO3 + CaCO3 + Sb2O3 +CuO + Na_2CO_3 => $Bi_2Sr_2Ca_{1-x}Sb_xCu_{1.75}Na_{0.25}O_y$. The powders that will form the composition will be weighed and ground in an agate mortar to make the powders homogeneous. The homogenized powders will be turned into tablets with a diameter of 1.3 cm by applying 375 MPa pressure. The tablets will be calcined at 700 °C for 12 hours for the first heat treatment. The calcined samples will be repeated several times for grinding, pressing and calcining (720-850). The final process, sintering, will be done by re-grinding, pressing and heating at 850 °C for 120 hours to reach a purer Bi-2212 phase. The purpose of this sintering process is to reduce lattice defects, support the formation of polycrystals and strengthen the bonds between the atoms forming the superconducting phases. The temperature of the tablets will be increased by 5 °C per minute and heated from room temperature to 850 °C, and after baking at this temperature for 120 hours, the temperature will be reduced by 5 °C per minute again and the cooling process will be applied to room temperature. The formed tablets will be ready for experimental measurements. Within the scope of this study, X-ray diffraction (XRD) analysis was performed to examine the crystal structure of the materials, lattice parameters, impurity phases and the changes in the crystal structure of the material as a result of doping.

RESULTS AND DISCUSSION

In this study, XRD measurements were performed to observe the phase formations of the superconductor samples in the produced ceramic structure. The X-Ray Powder Diffraction Measurement (XRD) results obtained from samples A, B, C, D, E and F are shown in Figure 1, Figure 2, Figure 3, Figure 4, Figure 5 and Figure 6, respectively. The XRD measurement results clearly show that the Bi-2212 phase, indicated by the + symbol, was formed as the main phase in all samples. In addition, ●CaBi2O2 and ■Bi4Ca1Cu3O14Sr4 impurity phases were also detected. The impurity phases do not contain antimony, in this case, the Bi-2212 phase shows that the doped antimony is completely included in the unit cell. The impurity phases formed in BSCCO superconductor ceramic materials can disrupt the superconducting properties by creating a barrier between the superconducting regions. It is also known from literature that the characteristic peaks of the Bi-2212 phase are observed at 2θ=5.7^o, 24.8^o, 27.5^o, 31.1^o end 35^o values [4]. When all samples were examined, it was seen that characteristic peaks were formed in accordance with the literature. In addition, the intensities of the characteristic peaks show significant changes with the contribution of nano-sized Sb at different rates. It is clearly seen that the peaks are intense between 27^o and 35^o in all samples. When the XRD graphs are examined, the value of the 33.15^opeak in sample E decreases while the values of the other peaks increase. The increase in peak intensities may be due to the transformation of impurity phases into the Bi-2212 phase, which may indicate the development of superconductivity properties. In samples B and C, it is observed that the densities of impurity phases such as $CaBi_2O_2$ and $Bi_4Ca_1Cu_3O_{14}Sr_4$ gradually increase. The increase in the formation of impurity phases may cause deterioration of superconductivity properties. In Sample D, the decrease in these impurity phases may indicate a more homogeneous structure.

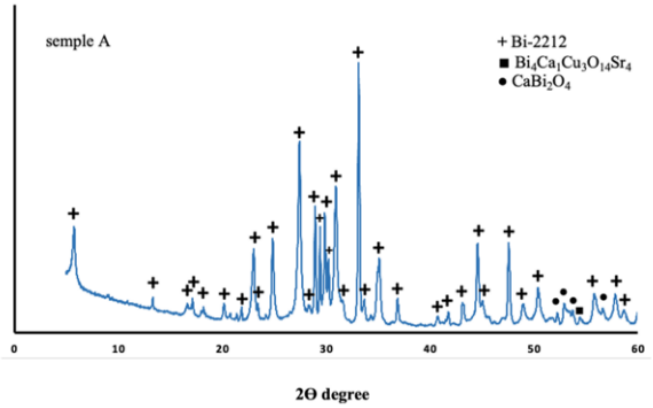

Figure 1: X-Ray diffraction measurement results of Sample A.

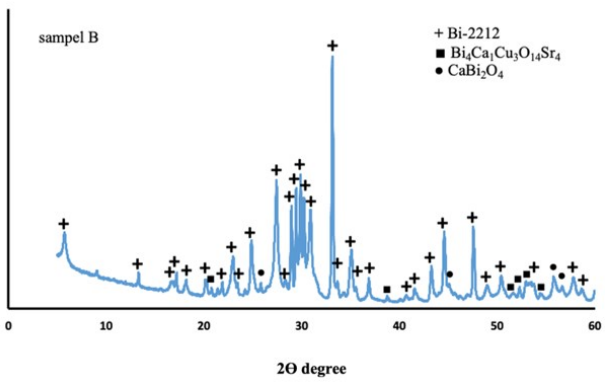

Figure 2: X-Ray diffraction measurement results of Sample B.

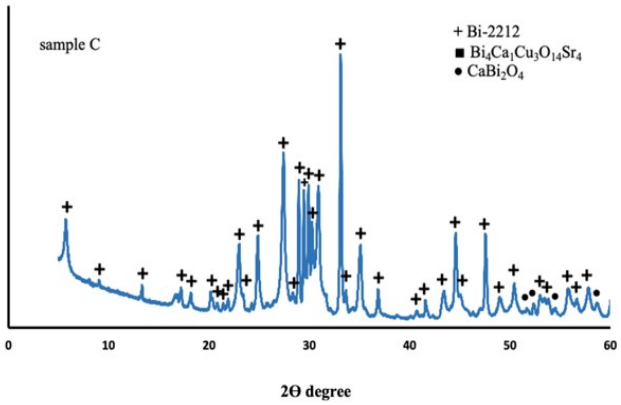

Figure 3: X-Ray diffraction measurement results of Sample C.

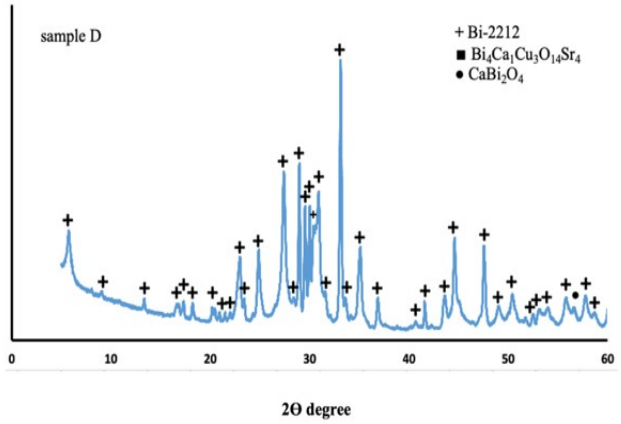

Figure 4: X-Ray diffraction measurement results of Sample D.

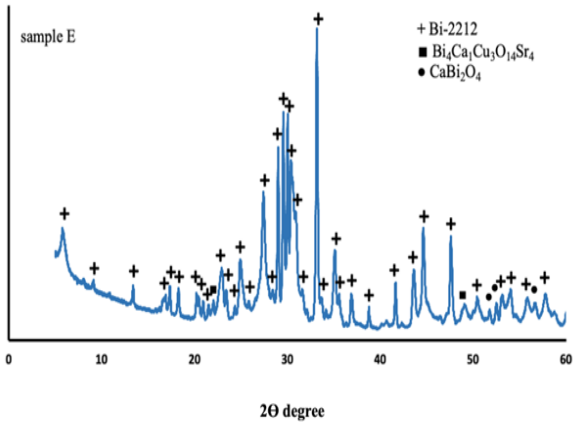

Figure 5: X-Ray diffraction measurement results of Sample E.

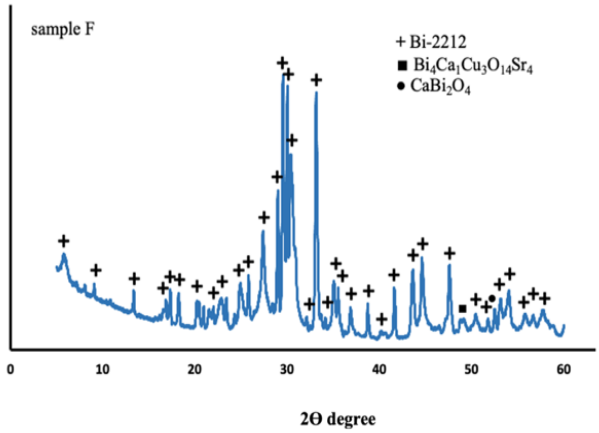

Figure 6: X-Ray diffraction measurement results of Sample F.

Using the XRD results of all samples, a, b and c parameters were calculated and have a tetragonal structure. The lattice parameters of all samples are given in Table 1.

Table 1. Lattice parameters of samples A, B, C, D, E and F.

SAMPLE	A (Å)	B (Å)	C (Å)
SAMPLE A	3.8165	3.8165	30.4930
SAMPLE B	3.8210	3.8210	30.4194
SAMPLE C	3.8232	3.8232	30,7699
SAMPLE D	3.8224	3.8224	30,4929

SAMPLE E	3.8180	3.8180	30.0829
SAMPLE F	3.8180	3.8180	29.8140

The lattice parameters of the samples were calculated from the obtained XRD measurement results and using the least squares method. When the lattice parameters in Table 1 were examined, a significant increase was observed in the c lattice parameter value of the C sample containing 0.0250 nano Sb compared to the samples. The grain thickness of all samples was calculated using the Debye-Scherrer equation.

$$t = \frac{0.9\lambda}{B\cos\theta_B}$$

Here t is the thickness of the crystal, λ is the wavelength, Θ_B is the Bragg angle and B is the line broadened with reference to a standard, which is.
$B^2=Bm^2-Bs^2$, Bs (in radians) is the half width of the standard material. Thus, the grain thickness values calculated with the Debye-Scherrer equation for samples A, B, C, D, E and F were found to be approximately 38.58, 40, 37.52, 33.73, 34.5 and 29.1nm, respectively. It is well known from the literature that the sequential alignment of BSCCO grains and the increase in grain size positively affect the Jc values. However, randomly oriented large grains can cause large gaps between neighboring grains, which can negatively affect the intergranular conductivity.

CONCLUSION

In the presented study, $Bi_2Sr_2Ca_{1-x}Sb_xCu_{1.75}Na_{0.25}O_y$ (x = 0.0, 0.0125, 0.0250, 0.050, 0.075 and 0.10) ceramic structured superconductor samples were prepared by solid state reaction method. According to XRD measurement results, it was determined that the basic phase structure of all samples was Bi-2212 high temperature phase and small amount of impurity phases. Compared to other samples, less impurity phase and high amount of Bi-2212 superconductivity phase formation was observed in the x=0.050 antimony doped sample. When the crystal structure of all samples was examined, it was determined that they had tetragonal structure. When the grain thickness values calculated with Debye-Scherrer equation were examined, the 0.0250 doped sample had the widest grain size with 40nm. It is known that increasing the grain sizes can improve the critical current density value.

REFERENCES

[1] Çelik, K. (2017) Topolojik Yalıtkanların Ve Topolojik Süperiletkenlerin Manyetik Özelliklerinin Taramalı Uç Mikroskopları (Tum) Teknikleri İle Araştırılması. Doktora Tezi, İstanbul Teknik Üniversitesi, İstanbul.
[2] https://tr.wikipedia.org/wiki/S%C3%BCperiletkenlik
[3]Michel, C., Hervieu, M., Borel, M.M., Grandin, A., Deslandes, F., Ppovost, J. and Raveau, B. 1987. Superconductivity in the Bi-Sr-Cu-O System, Z. Physica B: Condensed Matter 68; 421.
[4] Maeda, H., Tanaka, Y., Fukutomi, M. and Asano, T. (1988). A New High Tc Oxide Superconductor Without a Rare-Earth Element. Japanese Journal of Appl. Phys. 27; L209.
[5] Tarascon, J.M., Lepage, Y., Greene, L.H., Bagley, B.G., Barboux, P., Hwang, D.M., Hull, G.W., McKinnon, W.R. and Giroud, M. 1988. Origin of the 110 K Superconducting Transition in the Bi-Sr-Ca-Cu-O System. Phyical Review B, 38; 2504.
[6] Zhang, Y., Zhang, S., Li,C., Liu,X., He,Y., Liu, J., Feng, J. ve Zhang P. (2024) Synergism effect of Pb doping and microstructure optimization on the superconducting properties of Bi-2212 ceramics .J Mater Sci: Mater Electron (2024) 35:816
[7] Jin, L.H., Liu G.Q., Feng J.Q., Xu X.Y., Jiao G.F., Zhang S.N., Hao Q.B., Zhang P.X., Li C.S.(2023). Dominant effect of residual secondary phase of powders on Jc and microstructure of Bi-2212 superconducting wires. Superconductivity 8 (2023) 100060
[8] Demirdiş, S., ”Vorteks Mekanizmasının Süperiletkenliğe Etkileri” Çukurova Üniversitesi ,Yüksek Lisans Tezi, 2008
[9] Sotelo A., Madre MA., Rasekh S., Diez JC., Angurel LA. Floating zone Ag doped (Bi1.6Pb0.4)Sr2CaCu2O8+δ textured rods. Advances in Applied Ceramics 2009; 108(5): 285-289.
[10] Öner B., Özkurt P., Madre MA., Özkurt B., Sotelo A. Enhanced superconducting properties in Bi2Sr2Ca1Cu1.75Na0.25Oy ceramics prepared by hot-pressing under different pressures and temperatures. Journal of Superconductivity and Novel Magnetism 2022; 1-8.

[11] Aytekin ME., Özkurt B. The influence of nano-sized SnO2 doping on physical and magnetic properties of the Bi2Sr2-x(SnO2)xCa1Cu1.75Na0.25Oy superconductors. Journal of Superconductivity and Novel Magnetism 2020; 33: 965-970.
[12] Özçelik B., Ergin I., Madre MA., Sotelo A. Effect of rubidium substitution on the physical and superconducting properties of textured high-Tc BSCCO samples. Journal of Superconductivity and Novel Magnetism 2020; 33: 1285-1292.
[13] Özkurt B. Effect of annealing conditions on the superconducting properties of nano-sized metallic Au-added Bi1.8Sr2Au0.2Ca1.1Cu2.1Oy (Bi-2212) ceramics. Journal of Materials Science: Materials in Electronics 2020; 31(14): 11448-11456.
[14]. Bilgili, O., Selamet, Y. ve Kocabas, K. (2008). Effects of Li substitution in Bi-2223 superconductors. J. Supercond. Nov. Magn., 21 (8), 439–449.
[15] Öztürk, H. ve Safran S. (2018). Effects of carbon-encapsulated nano boron addition on superconducting parameters of BSCCO. Journal of Alloys and Compounds 731 (2018) 831e838
[16] Çimen, G. (2006). Bizmut tabanlı süperiletken seramiklerde katkı atomları ile yapı analizi. Yüksek Lisans Tezi, Dokuz Eylül Üniversitesi, İzmir.
[17] Abou-Aly, A. I., AbdelGawad, M. M. H., Awad, R. ve G-Edeen, I. (2011). Improving the physical properties of (Bi,Pb) 2223 phase by SnO2 nano-particles addition. J.Supercond. Nov.Magn., 24 (7), 2077–2084.
[18] Özkurt, B. (2013). Enhancement in superconducting transition temperature and J_c valuesin Na-doped $Bi_2Sr_2Ca_1Cu_{2-x}Na_xO_y$superconductors. J. Mater. Sci.: Mater. Electron., 24, 2426–2431.
[19] Özkurt B, "Structural and magnetic properties of Li and Na added Bi1.8Sr2.1(Li,Na)xCa1.1Cu2.2Oy (Bi-2212) ceramics" (x = 0, 0.05, 0.1 and 0.2)". Journal of Materials Science: Materials in Electronics, 28(12), 8857-8863, 2017.
[20] Altin, S., Aksan, M.A. ve Yakinci, M.E. (2011), Fabrication of singlecrystalline Bi-2212 whiskerwithaddition of SbO_3intotheBi2Sr2Ca2Cu3Ox systemandtheirthermal, structuralandsuperconductingproperties, 1293-2558/$ e seefrontmatter Ó 2011 ElsevierMasson SAS. Allrightsreserved. doi:10.1016/j.solidstatesciences.2011.03.001
[21] Metskhvarishvili, I.R., Dgebuadze, G.N., Bendeliani, B.G., Lobzhanidze, T.E., Metskhvarishvili, M.R. ve Mumladze, G.N.,(2014), Lowacfieldresponse of Bi-basedsuperconductorswithaddition of Antimonyoxide, Journal of Physics: Conference Series 507 (2014) 012032
[22]Iqbal, M. J. ve Mehmood, R. (2006), Synthesisandcharacterization of antimony-dopedBi-basedsuperconductingmaterials, MaterialsScienceandEngineering B 135 (2006) 166–171
[23]Kocabaş, K. ve Çiftçioğlu,M. (2000), TheEffect of SbSubstitution of Cu in Bi1.7Pb0.3Sr2Ca2Cu3ÿxSbxOy Superconductors,phys. stat. sol. (a) 177, 539 (2000)
[24] Cevizci, E. B. ve Kocabas K.(2023). Comparative investigation of magnetic and mechanical properties of nano-Sb2O3 and nano-Y2O3 addition on bismuth-based superconducting materials. J Mater Sci: Mater Electron (2023) 34:657
[25] Romero-Sanchez M., Sanchez-Mera T., Santos-Cruz J., Perez-García C.E.,Olvera M. de la L. , Santill´an-Rodríguez C.R., Matutes-Aquino J., Contreras-Puente G. ve Moure-Flores F.(2022). Effect of sintering time on structural, morphological and electrical properties of Sb-doped Bi1.6Pb0.4Sr2Ca2Cu3Oy superconductor. Ceramics International 48 (2022) 16049–16053
[26] Çam, E. K. ve Kocabaş, K. (2016), Effects of Sb substitution on structural and superconducting properties of Bi in $Bi_{1.752x}Pb_{0.25}Sb_xSr_2Ca_2Cu_3O_y$ superconductor, J Mater Sci: Mater Electron DOI 10.1007/s10854-016-4888-4