FunMat 2026

ABSTRACT & FULL TEXT PROCEEDINGS BOOK

International 4th Conference on Functional Materials Science and Engineering

(FunMat-2026)

04-05 June 2026

International 4th Conference on Functional Materials Science and Engineering (FunMat-2026)

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FunMat 2026

International

4TH CONFERENCE on

FUNCTIONAL MATERIALS

SCIENCE and ENGINEERING

June 4-5, 2026

Tarsus University,
Tarsus, Türkiye

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CONFERENCE MAIN TOPICS

NANO-FUNCTIONAL MATERIALS
- Nano Structured Materials
- Nanomaterials for Magnetic, Optic, Energy Electronic Devices
- Nanomaterials for Photovoltaics and Solar Cells
- Nanofabrication and Nanopatterning of Organic Materials
- Nanolithography. Nanofabrication, Micro & Nano Fluidics
- Micro/Nano Materials
- Quantum Dots, Nanopowders
- Smart and Functional Materials
- Nanostructure Semiconductor Materials
- Nanostructure Smart Materials
- Nanostructure Thin Film Transistors
- Intelligent Materials Systems
- Semiconductor Materials Manufacturing
- And Related Topics

ELECTRIC, MAGNETIC AND SUPERCONDUCTING MATERIALS
- Magnetic Materials
- Magnetic Thin Films
- Magnetocaloric Effect
- Dielectric, Ferroelectric and Piezoelectric Materials
- Nanostructure Piezoelectric Materials
- Superconductors
- Shape Memory Polymers
- Shape-Memory Alloys
- Spintronics
- And Related Topics

ELECTRONIC AND PHOTONICS MATERIALS, METAMATERIAL
- Metamaterial
- Electronic and Optoelectronic Device Applications of Materials
- Thin Films for Optoelectronics, Nanoelectronics and Spintronics
- Nano-optics, Nano-optoelectronics, Nano-Photonics and Nano-Photonic
- Nanostructure Light Emitting Diode
- Nanostructure Organic Electronics
- Optical Materials
- Optical Thin Films
- And Related Topics

2D-MATERIALS
- Synthesis and Growth
- Graphene
- Van der Waals Heterostructures
- Carbon and carbon-based materials
- Electronic Transport Properties
- Devices
- Optoelectronic Properties
- Chemical Functionalization
- Catalysis
- Surface Science of 2D Material
- And Related Topics

CERAMICS AND GLASSES
- Advanced Ceramic Materials
- Ceramics, Electroceramics
- Nanostructure Dielectric Materials
- Synthesis of Ceramics
- And Related Topics.

COMPOSITE MATERIALS
- Nanocomposites
- Coatings and Surface Engineering
- Composites
- Fibers
- And Related Topics

BIO-MATERIALS
- Artificial Organs and Tissue Engineering
- Innovative Biomaterials for Organ and Tissue Repair
- Advances in Bioelectronics
- Bioceramics and Biocomposites
- Bioengineering Sciences
- Biomaterials
- Biomedical and Medicine of Polymers
- Biomedical Manufacturing
- Biosensors and Advances in Biosensors
- Biotechnology Sciences
- Functional Biomaterials for Drug Delivery
- Thin Films in Biological and Environmental Applications
- Nanomaterials in Bioapplications
- Nanomedicine and Nanobiotechnology
- Nanostructure Biosensor, Gas Sensor,
- Humidity Sensor, Photosensor
- Nanostructure Bio Nanomaterials
- And Related Topics

MATERIALS FOR ENERGY
- Batteries, Lithium Ion Batteries
- Fuel Cells
- Supercapacitors
- Thin films in Energy Harvesting and Storage
- Advanced Nuclear Materials
- Nanostructure Dye Sensitized Solar Cells
- And Related Topics

IMPORTANT DATES

Abstract Submission Deadline: **08 May 2026**
Announcement of the Program: **29 May 2026**

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TOROS UNIVERSITY 2009

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4th International Conference on Functional Materials Science and Engineering

(FunMat-2026)

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Foreword

It is with immense pride and a profound sense of accomplishment that we present the Book of Abstracts for the 4th International Conference on Functional Materials and Technologies, FunMat'26. This event, held at Tarsus University between June 4-5, 2026, marks a significant milestone in our ongoing journey of scientific exploration and collaboration.

Our story began in 2023 as the SFME, a modest workshop led by the Toros University Faculty of Engineering. It was a small seed planted with big ambitions. Today, we are thrilled to see that seed blossom into a globally prestigious platform, having grown exponentially in both scale and scientific rigor. The success of FunMat'26 is a testament to the vibrant and dynamic research community that has formed around functional materials science.

This year's conference program reflects the high quality and diversity of research being conducted worldwide. We are honored to have hosted 156 researchers from 7 different countries; Türkiye, Japan, Italy, Spain, France, the UK, and Iraq. Representing 33 universities and 5 prestigious research centers, institutions, and industrial organizations, these participants have contributed a total of 65 scientific papers, delivered through both oral (41) and poster (24) presentations. The depth of knowledge shared over these two days has been truly inspiring.

Furthermore, we were privileged to have 4 distinguished invited speakers, global pioneers in their respective fields, who graced us with their presence and shared their latest, cutting-edge research. Their contributions have immensely enriched the scientific discourse of our conference.

This Book of Abstracts serves as a permanent record of the remarkable work presented at FunMat'26. It is a compilation of ideas, discoveries, and innovations that we believe will contribute significantly to the advancement of functional materials and technologies.

Behind an international organization of this scale lies immense effort, a strong vision, and a unique spirit of collaboration. We express our deepest thanks to all our stakeholders: the dedicated organizing committee, the diligent reviewers, the invaluable session chairs, and the hardworking staff who ensured the seamless execution of this event.

Our heartfelt gratitude also goes to our host, Tarsus University, and our co-organizers, Toros University, Cukurova University, and Mersin University, for their unwavering support and commitment. It is through such collaborative partnerships that we can build a stronger, more interconnected scientific community.

We hope you find this collection of abstracts as stimulating and inspiring as we did. We look forward to building on this momentum for future FunMat conferences and continuing our shared journey of discovery.

With warm regards,

The FunMat'26 Organizing Committee

INVITED SPEAKERS

Assoc. Prof. Dr. Hidetoshi MIYAZAKI

Nagoya Institute of Technology, Nagoya, JAPAN

Title: Design and Development of Ru-based Heusler-type Thermoelectric Materials for High-Temperature Energy Conversion.

Dr. Mamatimin ABBAS

Lab. IMS, CNRS, U. Bordeaux, Bordeaux INP, UMR 5218, Pessac, FRANCE

Title: Organic Transistors as Light Sources and Biosensors.

Prof. Dr. Mahmut KUŞ

Konya Technical University, Konya, TÜRKİYE

Title: From Functional Interfaces to Scalable Modules: Advancing Perovskite Solar Cells through Clay-Based Engineering and Sustainable Manufacturing.

Prof. Dr. Mustafa AKYOL

Adana Alparslan Türkeş Science and Technology University, Adana, TÜRKİYE

Title: Beyond Conventional Shielding: Advanced Concepts in Electromagnetic Wave Absorption

Symposium on Functional Materials Science and Engineering 2026 (FunMat 2026) — Conference Program

Two parallel halls · Oral presentations: 15 minutes each · Invited lectures are plenary (joint session)

DAY 1 — Thursday, 4 June 2026

Time / Saat	HALL A — Magnetic, Superconducting & Energy Materials	HALL B — Computational, Catalytic & Applied Materials
08:30 - 09:30	**Registration**	
09:30 - 10:00	**Opening Ceremony | Prof. Dr. Omer Arioz - Rector, Toros University & Prof. Dr. Ali Ozen - Rector, Tarsus University**	
10:00 - 10:20	**Opening Speech | Prof. Dr. Osman Murat Ozkendir (Organizing Committee)**	
	SESSION I — Invited Speakers (Plenary) Chair: Prof. Dr. Osman Murat Ozkendir	
10:20 - 10:45	[I1] INVITED LECTURE (Plenary) · Hidetoshi Miyazaki — Nagoya Institute of Technology, Nagoya, Japan Design and Development of Ru-based Heusler-type Thermoelectric Materials for High-Temperature Energy Conversion	
10:45 - 11:10	[I2] INVITED LECTURE (Plenary) · Mamatimin Abbas — Lab. IMS, CNRS, U. Bordeaux, Bordeaux INP, UMR 5218, Pessac, France Organic Transistors as Light Sources and Biosensors	
11:10 - 11:35	**Coffee Break & Poster Session 1 (see Poster Sessions sheet)**	
11:35 - 12:00	[I3] INVITED LECTURE (Plenary) · Mahmut Kus — Konya Technical University, Konya, Turkiye From Functional Interfaces to Scalable Modules: Advancing Perovskite Solar Cells through Clay-Based Engineering and Sustainable Manufacturing	
PARALLEL ORAL SESSIONS — Block 1 · 12:00 - 12:30		
	Session A-I: Thermoelectric & Energy Materials (Chair: Prof. Dr. Ahmet Ekicibil)	**Session B-I: Catalysis & Surface Engineering (Chair: Assoc. Prof. Dr. Didem Demir)**
12:00 - 12:15	A1 · Tomoko Mizuguchi (Kyoto Institute of Technology, Japan) Design and Development of Ru-based Heusler-type Thermoelectric Materials for High-Temperature Energy Conversion	B1 · Gediz Korkmaz (Cukurova University, Adana) Synthesis of Pt-Co-Ni Ternary Catalyst for Oxygen Reduction Reaction

12:15 - 12:30	A2 · Sevda Saran (Selcuk University, Konya) The Effect of LLZO Content on the Phase Transformation of LLZO in PEO/LiTFSI Solid Electrolytes	B2 · Emre Ozer (Osmaniye Korkut Ata University, Osmaniye) Immersion Corrosion and Antibacterial Behavior of NaOH Conversion-Coated HA/Si3N4-Reinforced Mg2Zn1Mn-Based Nanocomposites with and without Ag Addition
12:30 - 13:30	**Lunch Break**	
	SESSION (Plenary) — Invited Speaker Chair: Prof. Dr. Faruk Karadag	
13:30 - 13:55	[I4] INVITED LECTURE (Plenary) · Mustafa Akyol — Adana Alparslan Turkes Science and Technology University, Adana, Turkiye Beyond Conventional Shielding: Advanced Concepts in Electromagnetic Wave Absorption	
PARALLEL ORAL SESSIONS — Block 2 · 13:55 - 15:10		
	Session A-II: Magnetism & Superconductivity (Chair: Prof. Dr. Faruk Karadag)	**Session B-II: Computational & Bio-Functional Materials (Chair: Assoc. Prof. Dr. Dogan Kaya)**
13:55 - 14:10	A3 · Mehmet Selim Aslan (Cukurova University, Adana) Structural, Magnetic and Magnetocaloric Properties of La0.67Ca0.27Sr0.06MnO3 Perovskite Manganite	B3 · Yeliz Gurdal (Adana Alparslan Turkes Science and Technology University, Adana) A Computational Study of the Effect of an External Electric Field on H2S Adsorption in ZIF-71
14:10 - 14:25	A4 · Emre Can Tayfun (Cukurova University, Adana) Comprehensive Magnetic Investigation of Pd-Ni Nanoparticles Prepared by a Modified Polyol Method	B4 · Gullusum Tunc (Adana Alparslan Turkes Science and Technology University, Adana) Investigation of the Structural Dynamics of ZIF-80 Under an External Electric Field via Ab-Initio Molecular Dynamics and Metadynamics
14:25 - 14:40	A5 · Arda Kandemir (Cukurova University, Adana) Magnetic and Magnetocaloric Behavior of the PrBa0.9Ca0.1Mn2O6 Double Perovskite	B5 · Derya Yetkin (Mersin University, Mersin) Graphene-Like Carbon Materials Derived from Olive Pits for Promoting Human Dermal Fibroblast Proliferation and Enhancing Wound Healing
14:40 - 14:55	A6 · Veysi Guckan (Cukurova University, Adana) Superconducting Properties of YBCO Nanofibers by Electrospinning	B6 · Muge Asik (Cukurova University, Adana) Investigation of the Effects of Heat Treatments on the Microstructure and Mechanical Properties of Additively Manufactured Inconel 718 and Ti-6Al-4V Alloys
14:55 - 15:10	A7 · Muammer Hacisalihoglu (Ankara University, Ankara) Temperature Effects on Local Disorder and Interlayer Bonding in the Layered van der Waals Superconductor NaSn2As2	B7 · Mustafa Ugurlu (Cukurova University, Adana) Effect of Post-Weld Heat Treatment on the Microstructural and Mechanical Properties of Dissimilar Al-Ti Welded Joints
15:10 - 15:30	**Coffee Break & Poster Session 2 (see Poster Sessions sheet)**	

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PARALLEL ORAL SESSIONS — Block 3 · 15:30 - 16:15		
	Session A-III: Magnetocaloric & Low-Dimensional Materials (Chair: Assoc. Prof. Dr. Ali Kemal Havare)	**Session B-III: Structural & Manufacturing Materials (Chair: Assoc. Prof. Dr. Evrim Ersin Kangal)**
15:30 - 15:45	A8 · Hasan Huseyin Isik (Cukurova University, Adana) Effect of Ni/Co Ratio on the Structural Properties of Spinel NiCoFe2O4 Ferrites	B8 · Ibrahim Umut Yurtsever (Osmaniye Korkut Ata University, Osmaniye) Hot-Dip Aluminum Coating of Low-Carbon Steels Using Aluminum Recovered from Smelted Aluminum Dross
15:45 - 16:00	A9 · Gizem Cetin (Cukurova University, Adana) Magnetocaloric Applications of Oxide Materials for Low-Temperature Cooling	B9 · Huseyin Firat Kayiran (Provincial Coordinatorate, ARDSI, Mersin) Thermomechanical Displacement Analysis of Rotating Hollow Hybrid Composite Cylinders
16:00 - 16:15	A10 · Emre Bolen (Aksaray University, Aksaray) Two-Dimensional CaZn2Sb2: Stability and Lattice Thermal Conductivity	B10 · Alvand Moshfeghi (Istanbul Nisantasi University, Istanbul) From Marine Waste to Concrete: Utilization of Ghost Fishing Nets in Sustainable Concrete
16:15	**End of Day 1**	

DAY 2 — Friday, 5 June 2026		
Time / Saat	**HALL A — Magnetic, Superconducting & Energy Materials**	**HALL B — Computational, Catalytic & Applied Materials**
PARALLEL ORAL SESSIONS — Block 4 · 09:00 - 10:30		
	Session A-IV: Functional & Optical Materials (Chair: Prof. Dr. Zehra Yegingil)	**Session B-IV: Applied Materials & Industry (Chair: Mehmet Ersin Aytekin)**
09:00 - 09:15	A11 · Ozkan Ozgur Topal (Mersin University, Mersin) Why Image Processing and Topological Analysis?	B11 · Gorkem Kemal Ermurat (Tarsus University, Tarsus [Host]) Geometrical Investigation of TPMS-Based Gyroid Structure: A Case Study for Unmanned Aerial Vehicles
09:15 - 09:30	A12 · Cihan Gecgel (Mersin University, Mersin) Cytotoxic Effects of Green-Synthesized Magnetic Nanoparticles Using Lemon Peel Extract on Cancer Cells and Their Potential for Drug Delivery	B12 · Dogan Kaya (Cukurova University, Adana) Electrocatalytic HER/OER Performance of PdCo/CoFe2O4/Carbon Black Nanocomposites in Alkaline Media
09:30 - 09:45	A13 · Oskay Kahraman (Tarsus University, Tarsus [Host]) Preparation and Characterization of Biofunctional Graphene Quantum Dots	B13 · Zeynep Bilici (Mersin University, Mersin) Investigation of Treatment Performance of Oil-Containing Wastewater by Membrane Distillation Bioreactor

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09:45 - 10:00	A14 · Osman Murat Ozkendir (Tarsus University, Tarsus [Host]) Turning Waste Heat into Advantage: Thermoelectric Bi2Te3 Composites for Thermally Stable NaFeO2 Battery Cathodes	[SPONSOR] B14 · Ali Baran Narin (Koluman Otomotiv Endustri A.S.) Evaluation of the Carbon Emission Reduction Potential of a MOF-Based Modular Exhaust Cartridge Approach in Tactical Wheeled Vehicles
10:00 - 10:15	A15 · Arzu Poyraz (Toros University, Mersin [Host]) Energy- and Composition-Dependent Investigation of Mass Attenuation Coefficient in Ti-Doped Ceramic Materials via XCOM	[SPONSOR] B15 · Sefa Altintas (Koluman Otomotiv Endustri A.S.) Mechanical Evaluation of Hardfacing Coating Applied by the MMA Method on S690QL Steel
10:15 - 10:30	A16 · Volkan Altunal (Cukurova University, Adana) Current Status and Future Perspectives of Beryllium Oxide (BeO) Based Optically Stimulated Luminescence Dosimeters	[SPONSOR] B16 · Ezgi Ozdemir (Berdan Civata A.S.) Heat Treatment Processes in Fasteners and Their Effect on Mechanical Properties
10:30 - 10:50	**Coffee Break & Poster Session 3 (see Poster Sessions sheet)**	
PARALLEL ORAL SESSIONS — Block 5 · 10:50 - 11:50		
	Session A-V: Luminescence & Semiconductor Materials (Chair: Assoc. Prof. Dr. Sevda Ildan Ozmen)	**Session B-V: Industrial Materials & Sponsor Presentations (Chair: Kayhan Dagidir)**
10:50 - 11:05	A17 · Ikra Yener (Cukurova University, Adana) Luminescence Investigations on Doped LiAlO2 Ceramics Produced by Green Synthesis	[SPONSOR] B17 · Omer Faruk Yasak (Berdan Civata A.S.) A Study on Crack Defects Occurring in Fasteners
11:05 - 11:20	A18 · Bashar Al-Ogaidi (University of Technology, Baghdad, Iraq) Fabrication and Characterization of ZnTe/Si Nanostructure for Visible Light Photodetector by PLD	[SPONSOR] B18 · Ummugulsum Basaran (Berdan Civata A.S.) Comparison of Surface Cleaning Methods Before Hot-Dip Galvanizing: Acid Cleaning vs. Sandblasting
11:20 - 11:35	A19 · Ayse Gul Catalbas (Mersin University, Mersin) Investigation of the Antimicrobial Properties of Zinc Oxide Nanoparticles Obtained from Waste Solution via Anodization of Zinc	[SPONSOR] B19 · Omer Faruk Yasak (Berdan Civata A.S.) Use of SAE4140 Material in Sucker Rod Production
11:35 - 11:50	A20 · Selcuk Poyraz (Adiyaman University, Adiyaman) One-step Preparation and Characterization of Conducting Polymer Nanofiber-Coated Carbon Nanotube Yarns for Smart Textile Production	[SPONSOR] B20 · Adnan Baday (Berdan Civata A.S.) Effects of Mold Design Improvement on Production Performance
11:50 - 12:20	**Closing Ceremony | Assoc. Prof. Dr. Ali Kemal Havare - Chair of Scientific Organization Committee, Toros University**	
12:20	**End of Day 2**	
FunMat 2026 — Poster Sessions		

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Chair: Assist Prof. Dr. Merve Ozcan, Toros University		
A Coffee Break & Poster Sessions ***Şehit İstihkam Üsteğmen Ozan Olgu Köreke Conference Hall***		
Code	**Poster Title**	**Authors & Affiliations**
P1	Temperature-Driven Phase Evolution in MnO2 Nanostructures for Supercapacitor Applications	**Atalay Bozdogan, Huseyin Emre Aktas, Mustafa Akyol** Department of Materials Science and Engineering, Faculty of Engineering, Adana Alparslan Turkes Science and Technology University
P2	Preparation and Characterization of PdCo Magnetic Alloy Nanoparticles	**Ruveyda Beyza Uguz, Emre Can Tayfun, Zafer Eroglu, Onder Metin, Faruk Karadag, Ahmet Ekicibil, Dogan Kaya** Department of Physics, Faculty of Art and Sciences, Cukurova University | Department of Chemistry, Faculty of Sciences, Koc University | Department of Chemistry, Faculty of Art and Sciences, Kocaeli University | Koc University Surface Science and Technology Center (KUYTAM) | Department of of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Cukurova University
P3	Development and Application of a Machine Learning Pipeline for Automated Materials Discovery: A Study in ZnO Nanoribbons	**Berna Uyanik, Ramazan Esen** Independent Researcher | Department of Physics, Faculty of Science and Letters, Cukurova University
P4	Computational Study of Pyrene and Hydroxypyrene Complexes with Porphyrin and Protoporphyrin	**Zeliha Gamze Ayanoglu, Nursel Acar Selcuki** TUBITAK Bursa Test and Analysis Laboratory (BUTAL) | Department of Chemistry, Faculty of Science, Ege University
P5	Green Synthesis of PtNi Nanoparticles Using Rosemary Extract and Investigation of Their Catalytic Properties	**Selin Karavul, Emre Can Tayfun, Dogan Kaya, Faruk Karadag, Ahmet Ekicibil** Department of Physics, Faculty of Art and Sciences, Cukurova University | Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Cukurova University
P6	The Photocatalytic Role of Next-Generation Hybrid Systems in Organic Dyes Removal	**Gul Kaya, Zeynep Bilici, Ali Can Dogan, Irem Cerci, Nadir Dizge, Kasim Ocakoglu** Department of Fundamental Engineering Sciences, Faculty of Engineering, Tarsus University | Department of Environmental Engineering, Faculty of Engineering, Mersin University
P7	Synthesis and Structural Characterization of Ni2FeO4 Nanoparticles Prepared by the Sol-Gel Method	**Mehmet Eren Mercanli, Hasan Huseyin Isik, Dogan Kaya, Faruk Karadag, Ahmet Ekicibil** Department of Physics, Faculty of Art and Sciences, Cukurova University | Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Cukurova University
P8	Dewetting Instability in Polymer Thin Films: A Comparative Analysis of Solvent Vapour and Thermal Annealing Methods	**Refik Alp Cagdas, N. Burak Kiremitler, M. Serdar Onses** Department of Metallurgy and Materials Engineering, Faculty of Engineering, Erciyes University

P9	Ti-doped NCM811 Cathode Materials for Lithium-Ion Batteries: Solid-State Synthesis and Characterization	**Kubra Kesen, Sule Ates, Hadi Baveghar** Department of pyhsics, Faculty of Sciences, Selcuk University
P10	External Electric Field Effects on H2O Adsorption in ZIF-90: An Ab-Initio Investigation	**Fehime Hayal Gecit, Yeliz Gurdal** Department of Bioengineering, Graduate School, Adana Alparslan Turkes Science and Technology University
P11	Evaluating the Reliability of Automated MOF Databases: A Comparative Study of Structural Integrity and Adsorption Performance	**Bugrahan Karlilar, Yeliz Gurdal** Department of Bioengineering, Graduate School, Adana Alparslan Turkes Science and Technology University
P12	Metal-Organic Framework Embedded Cryogels: Preparation and Characterization	**Ceyda Emrullah, Oskay Kahraman, Fatih Tezcan, Seda Ceylan, Didem Demir** Department of Chemistry and Chemical Process Technologies, Tarsus University | Department of Bioengineering, Adana Alparslan Turkes Science and Technology University
P13	H2S Adsorption and Diffusion Potentials of Zeolites Investigated Through Molecular Simulations	**Kerim Can Ozalp, Yeliz Gurdal** Department of Bioengineering, Graduate School, Adana Alparslan Turkes Science and Technology University
P14	Green Synthesis of PdCo Nanoparticles Using Olive Leaves Extract: Investigation of Structural and Catalytic Properties	**Nurhan Kaya, Batuhan Berk Sahin, Emre Can Tayfun, Faruk Karadag, Ahmet Ekicibil, Dogan Kaya** Department of Physics, Faculty of Science and Letters, Cukurova University | Department of Advance Materials and Nanotechnology, Institute of Natural and Applied Sciences, Cukurova University
P15	Experimental Investigation of CFRP-Aluminum Single-Lap Joints (SLJ) Bonded with Structural Epoxy and Mechanical Joints	**Gurkan Atas, Murat Aydeniz, Esmanur Etli, Utku Uzun** Department of Mechanical Engineering , Faculty of Engineer, Tarsus University | Department of Mechanical Engineering , Faculty Of Aeronautics and Astronautics, Tarsus University
P16	Annealing Effect on Nanorod CdTe Thin Films Deposited by CBD on ITO Substrates	**Zeynep Karabacak, Sevda Ildan Ozmen, Hulya Metin Gubur** Department of Physics, Faculty of Science, Mersin University | Advanced Technology Education Research and Application Centre, Mersin University | Technical Science Vocational School, Department of Chemistry and Chemical Processing Technologies, Mersin University
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		of Department of Chemistry, Institute of Science Tokyo
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The 4th International Conference on Functional Materials Science and Engineering was organized and hosted by Tarsus University on 4–5 June 2026 in Tarsus/Mersin. 65 scholars presented papers and posters which are published in the FUNMAT 2026 E-Proceedings Book.

Poster Presentations

CHAPTER 1

ABSTRACTS

4th International Conference on Functional Materials Science and Engineering

(FunMat-2026)

INVATED

Design and Development of Ru-based Heusler-type Thermoelectric Materials for High-Temperature Energy Conversion

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ABSTRACT

Heusler-type Fe_2VAl alloys feature a sharp pseudogap near the Fermi level and are promising thermoelectric materials via electronic structure control [1]. Ru_2TiSi alloys, composed of heavier elements with a predicted wider and sharper pseudogap, potentially exhibit superior thermoelectric performance at higher temperatures than Fe_2Val [2]. This study investigates Ta doping on Ti-sites in Ru_2TiSi to simultaneously achieve electron doping and heavy-element substitution. We report the resulting electronic structure, crystal structure, and thermoelectric properties.

$Ru_2Ti_{1-x}Ta_xSi$ compounds were prepared by repeated arc melting in an Ar atmosphere. Electronic and crystal structures were evaluated using HAXPES at SPring-8 BL09XU and SR-XRD at SPring-8 BL02B2, respectively. The Seebeck coefficient, electrical resistivity (ZEM-3), and thermal conductivity (laser flash method) were measured from room temperature to 1000 K.

SR-XRD measurements revealed $L2_1$ peaks in all samples, indicating the formation of highly crystalline $Ru_2Ti_{1-x}Ta_xSi$ polycrystals. HAXPES confirmed that R $Ru_2Ti_{1-x}Ta_xSi$ exhibits a rigid-band-like electronic structure shift due to electron doping. The power factor of p-type Ru_2TiSi increased significantly with temperature, reaching 4.4×10^{-3} W/mK^2 at 830 K. The thermal conductivity of Ru_2TiSi (~20 W/mK at 300 K) dramatically decreased to 4.5 W/mK in $Ru_2Ti_{0.8}Ta_{0.2}Si$, alongside a high n-type power factor of 2.4×10^{-3} W/mK^2. Thus, partial Ta substitution enhanced the n-type power factor by optimizing the Fermi level and reduced thermal conductivity by introducing heavier atoms. The ZT values reached 0.42 for p-type Ru_2TiSi at 1000 K and 0.42 for n-type $Ru_2Ti_{0.8}Ta_{0.2}Si$ at 900 K. These rank among the highest values achieved in bulk thermoelectric Heusler compounds, demonstrating the effectiveness of Ta substitution [3].

Keywords: *Thermoelectric materials, Heusler alloys, Ru_2TiSi*

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4th International Conference on Functional Materials Science and Engineering

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INVATED

Organic Transistors as Light Sources and Biosensors

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ABSTRACT

Devices based on organic semiconductors offer several advantages, such as easy processing, flexibility, printability, large-area, low weight, and tunability via chemical synthesis etc. Among extensively studied devices, organic transistors show atypical properties and applications besides being building blocks for circuits. In this talk, I will present our studies exploring their use as light sources and biosensors. Light emitting transistors can simplify the design of active matrix displays and also can be suitable structures for electrically pumped organic laser. I will describe our approach to drastically reduce the turn-on voltage of light emitting transistors using polymer/small molecule blends.[1] I'll also show that wide range color tuning (from blue to red) can be achieved with a single emitting layer through a cavity structure.[2] As biosensors, I will present several examples based on organic electrochemical transistors (OECTs). Their applications in chemical/biological sensing and neuromorphic circuits are particularly appealing due to high transconductance, efficient electron-ion coupling, compatibility with aqueous media, conformability, and low-voltage operation. These properties come from the channel material, organic mixed ionic-electronic conductors (OMIECs), which support simultaneous electronic and ionic transport and can be directly processed by electropolymerization. I will discuss OECTs incorporating various electropolymerized channels, highlighting the versatility of electropolymerization and the importance of OMIEC engineering for next-generation bioelectronic devices. I'll describe first, devices with a conventional PEDOT channel for dopamine detection;[3] then PEDOT:N_3, a clickable OMIEC whose threshold voltage can be finely tuned via electropolymerization parameters, crucial for adaptable biosensors and neuromorphic elements;[4] and finally, P-tri-DPA-based OECTs for zinc ion detection demonstrating low detection limits and high specificity for Zn^{2+}, which is highly relevant for insulin secretion in β cells.[5]

Keywords: *Organic transistor, Light emitting transistor; Electrochemical transistor, Bio-sensor*

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INVATED

From Functional Interfaces to Scalable Modules: Advancing Perovskite Solar Cells through Clay-Based Engineering and Sustainable Manufacturing

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ABSTRACT

Perovskite solar cells (PSCs) have emerged as one of the most promising next-generation photovoltaic technologies due to their remarkable power conversion efficiencies, low-temperature processing, and compatibility with scalable fabrication routes. However, challenges related to long-term stability, environmental durability, and industrial upscaling remain major barriers toward commercialization. This invited talk will present our recent research efforts focused on overcoming these limitations through innovative interface engineering and sustainable device design.

A particular emphasis will be given to the use of naturally abundant functional clay materials as scaffold and interfacial modifiers in PSC architectures. Our studies demonstrate that clay-derived nanostructures can significantly enhance perovskite crystallization, suppress ion migration, improve moisture resistance, and increase operational stability while simultaneously reducing material cost. The role of different clay systems such as montmorillonite, halloysite, and laponite in device performance enhancement will be discussed.

In addition, scalable fabrication strategies including fully wet-processed deposition methods, carbon-electrode integration, and large-area module manufacturing will be highlighted. These approaches aim to bridge the gap between laboratory-scale high-efficiency cells and industrial-scale perovskite solar modules. Finally, the talk will address sustainability considerations such as green solvents, lead management, lifecycle assessment, and pathways for commercialization.

This presentation provides a comprehensive perspective on how functional materials science and engineering can accelerate the transition of perovskite photovoltaics from laboratory innovation to real-world energy solutions.

Keywords: *Perovskite Solar Cells, Clay-Based Nanostructures, Interface Engineering, Scalable Manufacturing*

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INVATED

Beyond Conventional Shielding: Advanced Concepts in Electromagnetic Wave Absorption

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ABSTRACT

The rapid expansion of high-frequency electronic systems and wireless technologies has intensified the demand for advanced electromagnetic wave (EMW) management strategies that go beyond conventional shielding approaches. Traditional EMW shielding materials, while effective, often suffer from limitations such as high density, narrow bandwidth, and limited tunability. In this context, recent research has shifted toward the development of next-generation EMW absorbers capable of lightweight design, broadband operation, and adaptive functionality.

Emerging material platforms—including carbon-based nanostructures, two-dimensional materials, conducting polymers, and magnetic–dielectric hybrids—offer enhanced dielectric and magnetic loss mechanisms, enabling superior attenuation performance across a wide frequency spectrum. In parallel, innovative design concepts such as metamaterial engineering, hierarchical and porous architectures, and gradient impedance matching have significantly improved absorption efficiency. Beyond passive absorption, advanced concepts focusing on tunable and stimuli-responsive EMW absorbers have opened new pathways for dynamic control of electromagnetic properties. These systems, responsive to external stimuli such as electric fields, temperature, and mechanical deformation, provide opportunities for the development of adaptive and multifunctional devices.

This talk highlights recent progress in material innovations, design strategies, and underlying absorption mechanisms, with an emphasis on moving beyond traditional shielding toward intelligent, high-performance EMW absorption systems. The discussion aims to provide insights into current challenges and future research directions in this rapidly evolving field.

Keywords: *Electromagnetic wave absorbers, 2D materials, Tuning electromagnetic wave absorbing*

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4th International Conference on Functional Materials Science and Engineering

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ORAL

Current Status and Future Perspectives of Beryllium Oxide (BeO) Based Optically Stimulated Luminescence Dosimeters

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ABSTRACT

This study provides an overview of the optically stimulated luminescence (OSL) properties of beryllium oxide (BeO) ceramics, their advantages in dosimetry applications, and recent developments in new BeO-based systems. BeO is a promising material candidate for personal, environmental, and medical dosimetry applications due to its effective atomic number close to that of human tissue, high thermal/chemical stability, and low energy dependence. Its usability, particularly with OSL techniques, makes BeO a strong alternative to common dosimetry materials such as Al_2O_3:C. This study addresses the fundamental TL/OSL mechanism of BeO, its characteristic trap structure, and OSL signal behavior. The relationship between TL peaks observed in BeO ceramics around approximately 75, 200, and 310 °C and OSL signal components is discussed in terms of optically active traps, deep traps, and the thermal transfer OSL mechanism. Furthermore, the luminescence performance of commercial Thermalox 995 BeO ceramics, as well as doped BeO systems synthesized by methods such as sol-gel and precipitation, were comparatively evaluated. Recent studies have shown that BeO ceramics doped with Na and lanthanide ions offer promising results in terms of OSL signal intensity, dose response, reproducibility, and fading properties. However, the complex trap structure of BeO, light scattering effects, and difficulties in separating signal components are still important issues that need to be resolved. Overall, this study summarizes the current state of BeO-based OSL dosimeters and reveals the future potential of this material, especially in medical dosimetry, personal dosimetry, two-dimensional dose mapping, and fiber-based real-time dosimetry applications.

Keywords: *Beryllium Oxide, Ceramic Production, Dosimetric Applications, Thermoluminescence, Optically Stimulated Luminescence*

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ORAL

Magnetic and Magnetocaloric Behavior of the PrBa0.9Ca0.1Mn2O6 Double Perovskite

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ABSTRACT

Developments in technology increase energy needs. One of them is refrigeration technology which reached its limit in terms of efficiency. The conventional cooling technologies contribute to global warming and greenhouse gas emissions which require more environmentally sustainable alternatives [1]. These problems directly threaten our health and life which need permanent solutions. [2, 3]. Environmentally friendly solutions, green technologies, are getting attention to becoming a candidate to solve this problem. The magnetic refrigeration system is a great alternative to conventional cooling technology. It is cheaper, green, and efficient technology compared to the current refrigeration system. The magnetocaloric effect is the main phenomenon of this alternative technology. It can be explained by the reversible temperature variation of a material triggered by an external magnetic field. The important parameters of the magnetocaloric effect are the magnetic entropy change and the magnetic phase transition temperature and both depend on the selection of the compound. In the light of these properties, we have studied the magnetic and magnetocaloric features of the PrBa0.9Ca0.1Mn2O6 double perovskite compound. This sample has been synthesized by using sol-gel method. For structural, morphological, and elemental analysis, Xray diffraction, Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy were used respectively at room temperature. Revealing the sample's magnetic properties, temperature-dependent magnetization and magnetic field-dependent magnetization were examined. According to magnetization analyses, the sample shows a magnetic phase transition from ferromagnetic to paramagnetic around 173.9 K and has a maximum magnetic entropy variation at 2.03 Jkg-1K-1 at 5T external magnetic field. These results indicate that our sample may be suitable for applications in the medium-to-low temperature range for magnetic cooling.

Keywords: *Double Perovskite, Magnetic cooling systems, Magnetocaloric effect, Refrigerants, Affordable and clean energy.*

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4th International Conference on Functional Materials Science and Engineering

(FunMat-2026)

ORAL

Turning Waste Heat into Advantage: Thermoelectric Bi_2Te_3 Composites for Thermally Stable $NaFeO_2$ Battery Cathodes

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ABSTRACT

Thermal stress is one of the major causes of cathode material deterioration through mechanical and electrochemical instability. In this study, research about degradation mechanisms at multi-scales for different polymorphs of $NaFeO_2$ (α, β, γ), which are cheaper and non-toxic alternatives to the widely used cathode material due to their absence of cobalt is presented. By utilizing atomic scale DFT calculation, local structure XAFS/XAS, and macroscopic EIS characterization techniques, thermal stress arises due to weakening Na–O bonding in β-$NaFeO_2$ without influencing Fe–O bonds, leading to mobility of ions which increase ionic resistance and decrease the battery's overall performance is revealead. On the other hand, γ-$NaFeO_2$ has strong Fe-O bonding and a direct band gap (0.701 eV), resulting in excellent stability and thermal properties. In order to tackle the problem of waste heat generation, a paradigm shift is proposed with the development of novel thermoelectric composites of Bi_2Te_3 in cathode materials, where the material absorbs waste heat energy via Seebeck effect and provides free electrons to generate current density, as confirmed in increased ionic conductivity of β-$NaFeO_2$:Bi_2Te_3 composites from 50–70°C.

Keywords: *Thermal Degradation; Sodium-ion Batteries; Multi-scale Characterization; Bond Weakening; Waste Heat Recovery*

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4th International Conference on Functional Materials Science and Engineering

(FunMat-2026)

ORAL

Light Emitting Field Effect Transistors: A new avenue for disruptive Technologies

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ABSTRACT

Perovskite The rapid development of charge transport and light emission in organic materials over the last two decades has advanced the field of organic optoelectronics, highlighting the high potential of light-emitting devices for industrial applications. Demonstrated for the first time over 15 years ago, light-emitting field-effect transistors (LEFETs) have evolved from an optoelectronic curiosity into a serious contender in the race for cheaper, more efficient displays, and they also show promise for injection lasers. Thus, what is LEFET, how does it work, and what are the current challenges for its integration into mainstream technologies? The talk will shed some light on these questions. The fundamental working principles of LEFETs, the materials used, and the device physics and architecture involved in the progression of LEFET technology for displays will also be discussed. Finally, the state-of-the-art development of LEFETs will be presented, highlighting prospective avenues for research and applications in this area.

Keywords: *Based Nanostructures; Interface Engineering; Scalable Manufacturing*

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4th International Conference on Functional Materials Science and Engineering

(FunMat-2026)

ORAL

Analysis of Hydrogen Bonds Inside Span 80 Reverse Micelles by Molecular Dynamics Simulations

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ABSTRACT

Micrometer-sized water-in-oil droplets (microdroplets) stabilized by Span 80 were widely used for bioengineering applications. In these applications, Span 80 reverse micelles (RMs) started to be utilized for the selective enrichment of solutes in microdroplets. Although it has been suggested that the water content in RMs affects enrichment selectivity, the underlying details remain unclear. In this study, we focus on the hydrogen bonds (HBs) within Span80 RMs, hypothesizing that those HB-mediated structures vary depending on both the water content and the type of organic solvent. We believe that clarifying these structural changes will provide key insights into the mechanisms of molecular transport from microdroplets to RMs. We carried out molecular dynamics simulations for mixtures of Span 80, organic solvent, and water. We prepared four systems containing different numbers of water molecules: 70 and 140, and different organic solvents: octane and hexadecane. The system was equilibrated in the NPT ensemble with T = 298 K and P = 1 bar. To investigate the microstructure of the aqueous phase inside RMs, we calculated the lifetime of HBs. Our results show that lower water content prolongs HB lifetimes, which contributes to a more rigid RM structure. Furthermore, the HB lifetime between water molecules is longer than that in bulk water, indicating that water molecules in the RM center are less likely to break HBs [1]. To gain further insight, free energy profiles were calculated for the transport of a water molecule from a hexadecane solvent into RMs with varying water contents. Consequently, it was found that a water molecule is more stable inside RMs with lower water content than in those with higher water content [2].

Keywords: revirse micelle, molecular dynamics simulation, hydrogen bonds, free energy profile

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4th International Conference on Functional Materials Science and Engineering

(FunMat-2026)

ORAL

Ti-Katkılı Seramik Malzemelerde Kütle Zayıflatma Katsayısının Enerjiye ve Kompozisyona Bağlı Değişiminin XCOM ile İncelenmesi

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ABSTRACT

İyonlaştırıcı radyasyona karşı etkin zırhlama malzemelerinin geliştirilmesi, özellikle nükleer tıp, radyoterapi ve endüstriyel uygulamalarda büyük önem taşımaktadır. Bu çalışmada, farklı oranlarda Ti katkısı içeren seramik malzemelerin gama ışınlarına karşı zayıflatma özellikleri teorik olarak incelenmiştir. Kütle zayıflatma katsayıları (μ/ρ), 511 keV, 662 keV, 1173 keV ve 1332 keV enerjilerinde XCOM veri tabanı kullanılarak hesaplanmıştır. Hesaplanan kütle zayıflatma katsayısından lineer zayıflatma katsayısı, HVL, MFP değerleri elde edilecektir. Ti katkı oranının artışı ile kütle zayıflatma katsayısında meydana gelen azalma, kompozitin etkin atom numarasındaki değişim ve yoğunluk etkileri ile ilişkilendirilebilir. Düşük Ti oranlarında daha yüksek zayıflatma kapasitesi elde edilirken, yüksek katkı oranlarında bu etkinin azaldığı tespit edilmiştir.

Keywords: Gamma radyasyon, XCOM, Ti- katkılı seramik

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4th International Conference on Functional Materials Science and Engineering

(FunMat-2026)

ORAL

Temperature Effects on Local Disorder and Interlayer Bonding in the Layered van der Waals Superconductor $NaSn_2As_2$

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ABSTRACT

The layered van der Waals Zintl phase $NaSn_2As_2$ has attracted significant interest due to its superconductivity, low thermal conductivity, and mechanically exfoliable crystal structure. In this work, we investigate the temperature-dependent local structure of $NaSn_2As_2$ using extended x-ray absorption fine structure (EXAFS) spectroscopy at both the As K-edge and Sn K-edge. The analysis reveals substantial intrinsic local disorder while preserving the average crystallographic symmetry. The nearest-neighbor Sn–As bond is found to be the strongest interaction in the system with predominantly covalent character, whereas the interlayer As–Na and Sn–Sn(i) interactions are considerably weaker, consistent with the van der Waals nature of the layered structure. Temperature-dependent mean square relative displacement analysis based on the Einstein model reveals anomalous behavior in the interlayer atomic correlations around 200 K, particularly for the As–Na bond. This anomaly suggests the presence of a charge-density-wave-like instability or charge redistribution process affecting the local lattice dynamics. The extracted bond force constants indicate that the interlayer interactions are highly sensitive to temperature and may strongly influence thermal transport, exfoliation behavior, and electronic properties. These findings provide new insight into the relationship between local disorder and emergent phenomena in layered superconducting van der Waals materials [1].

Keywords: Functional Materials, Superconductivity, Local Structure, X-ray Absorption Spectroscopy

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4th International Conference on Functional Materials Science and Engineering

(FunMat-2026)

ORAL

Effect of Ni/Co Ratio on the Structural Properties of Spinel $NiCoFe_2O_4$ Ferrites

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ABSTRACT

The compositional engineering plays a critical role in tailoring the structural properties of $NiCoFe_2O_4$ ferrites for potential magnetic, catalytic, and electronic applications [1]. This study investigates the structural properties of $NiCoFe_2O_4$ ferrite nanoparticles with different Ni/Co ratios, namely $Ni_{25}Co_{75}Fe_2O_4$, $Ni_{50}Co_{50}Fe_2O_4$, and $Ni_{75}Co_{25}Fe_2O_4$. All samples were synthesized and subsequently sintered at 800 °C to evaluate the influence of compositional variation on their structural characteristics. X-ray diffraction (XRD) analyzes confirmed the formation of a single-phase cubic spinel structure for all compositions without detectable secondary phases. The diffraction peaks indicated good crystallinity and successful incorporation of Ni and Co ions into the spinel lattice. Crystallite size calculations revealed average particle sizes of approximately 30 nm for $Ni_{25}Co_{75}Fe_2O_4$, 19.2 nm for $Ni_{50}Co_{50}Fe_2O_4$, and 21.8 nm for $Ni_{75}Co_{25}Fe_2O_4$. The observed variation in particle size suggests that the Ni/Co ratio significantly affects crystal growth behavior during the sintering process. Structural parameter analyzes also indicated slight lattice modifications depending on cation distribution within the ferrite structure. Morphological observations showed that the nanoparticles exhibit nanoscale grain formation with partial agglomeration due to magnetic interactions between particles.

Keywords: Spinel $NiFe_2O_4$, Structural Properties, Catalytic Properties

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ORAL

Magnetocaloric Applications of Oxide Materials for Low-Temperature Cooling

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ABSTRACT

Oxide materials have attracted significant interest for magnetocaloric applications due to their low toxicity, chemical stability and environmentally friendly nature. In addition, their magnetic and structural properties can be effectively tuned through cation substitution, enabling the control of magnetic phase transitions and operating temperature ranges. At the same time, oxide-based magnetocaloric materials show great potential for applications in cryogenic electronics, gas liquefaction, and energy-efficient cooling technologies. They are also considered promising candidates for environmentally friendly magnetic refrigeration systems operating over selected low-temperature ranges.

In this work, the magnetocaloric potential of oxide materials is presented, focusing particularly on how cation substitution can tailor magnetic interactions and phase transitions. This directly influences the magnitude of the magnetic entropy change ($-\Delta S_M$) as well as the relative cooling power (RCP). The results indicate that second-order magnetic phase transitions are favorable for achieving reversible and efficient magnetocaloric performance.

Overall, this study establishes a clear structure–property–performance relationship in oxide-based systems and demonstrates that controlled compositional engineering offers a viable pathway for optimizing environmentally friendly magnetocaloric materials for solid-state refrigeration technologies.

Keywords: Oxide materials, Magnetocaloric, magnetic refrigeration, magnetic entropy change, relative cooling power

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ORAL

Two-Dimentional $CaZn_2Sb_2$: Stability and Lattice Thermal Conductivity

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ABSTRACT

Bulk Zintl materials are widely recognized as promising thermoelectric systems owing to their intrinsically low lattice thermal conductivity; however, the two-dimensional (2D) form of $CaZn_2Sb_2$ remains unexplored. In this work, 2D $CaZn_2Sb_2$ is studied using first-principles calculations with emphasis on its stability and lattice thermal transport. Our results show that the isolated 2D phase remains stable, supporting the viability of this reduced-dimensional structure. More importantly, the calculated lattice thermal conductivity is remarkably low. At 300 K, 2D $CaZn_2Sb_2$ exhibits a lattice thermal conductivity of only 0.22 $Wm^{-1}K^{-1}$, which is dramatically lower than the reported bulk value of 2.46 $Wm^{-1}K^{-1}$. This pronounced suppression of phonon-mediated heat transport is highly significant from a thermoelectric perspective, since reducing the lattice contribution to thermal conductivity is one of the key routes toward improving performance. These findings establish 2D $CaZn_2Sb_2$ as a stable Zintl phase with exceptionally low lattice thermal conductivity and highlight dimensional reduction as an effective strategy for improving thermoelectric functionality in layered Zintl compounds.

Keywords: *Lattice Thermal Conductivity, 2d, Zintl, Thermoelectric*

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ORAL

Neden Görüntü İşleme ve Topolojik Analiz?

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ÖZET

Bu çalışma, ince film yüzeylerinin çok ölçekli morfolojik özelliklerini hem dokusal hem de topolojik düzeylerde bütüncül olarak karakterize eden gelişmiş bir hesaplamalı analiz yöntemi sunmaktadır. İlk aşamada, SEM görüntüleri Local Binary Pattern (LBP) yöntemiyle işlenerek yüzey dokusunun lokal parlaklık geçişlerine duyarlı istatistiksel temsili oluşturulmuş; radius, threshold ve minimum parçacık alanı gibi parametrelerin optimize edilmesiyle yüzey dokusunu en kararlı biçimde yansıtan partikül maskeleri elde edilmiştir. Bu maskelerden çıkarılan alan, çevre, dışbükey alan ve solidlik gibi morfometrik ölçütler yüzeyin mikro yapısal heterojenliğini kantitatif biçimde değerlendirmiştir. İkinci aşamada partikül merkezlerinden elde edilen nokta bulutu Persistent Homology yöntemiyle analiz edilerek bağlantılı bileşenlerin (β_0) ve halka yapıların (β_1) ölçek-parametre uzayındaki doğuş–ölüm davranışları hesaplanmıştır. Böylece yüzeyin süreklilik özellikleri, topolojik kararlılığı ve morfolojik kompleksliği matematiksel olarak ortaya konmuştur. Sonuçlar, LBP ve TDA yöntemlerinin birlikte kullanılmasının ince film yüzeylerinde hem mikroskobik dokusal geçişleri hem de makroskobik topolojik yapıyı bütüncül bir yaklaşımla çözümlediğini göstermektedir.

Keywords: *Texture Analysis, Local Binary Patterns, Persistent Homology, Surface Morphology, Topological Data Analysis*

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ORAL

Preparation and Characterization of Biofunctional Graphene Quantum Dots

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ABSTRACT

Curcumin, a naturally occurring bioactive compound derived from *Curcuma longa L.*, has attracted considerable attention due to its broad therapeutic potential. Recent studies have demonstrated that curcumin plays a significant role in the prevention and treatment of various pathological conditions, including diabetes, cancer, Alzheimer's disease, cardiovascular disorders, neurological diseases, tumors, and inflammatory disorders. Graphene quantum dots (GQDs), carbon-based nanomaterials with sizes ranging from 1 to 20 nm, have emerged as promising candidates in biomedical applications owing to their high biocompatibility, low toxicity, and superior optoelectronic properties. In this study, eco-friendly GQDs were synthesized and functionalized with nanocurcumin, and biofunctional nanocomposite structures (GQDs–CurNCs) were successfully prepared. The GQDs–CurNCs were characterized using UV–Vis spectroscopy, X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FT-IR), and scanning electron microscopy (SEM). The UV-Vis spectrum of GQDs-CURNCs has two absorption peaks at 260 nm and 385 nm. The XRD pattern of the GQDs-CURNCs has an amorphous structure. The antioxidant potential of the synthesized nanocomposites was evaluated through various *in vitro* assays, including DPPH radical scavenging, superoxide radical scavenging, nitric oxide scavenging, and lipid peroxidation inhibition tests. The results revealed that GQDs–CurNCs exhibited significantly antioxidant activity. Furthermore, antimicrobial studies demonstrated that the nanocomposite showed improved inhibitory effects against selected bacterial strains when compared to curcumin nanoparticles, indicating a synergistic interaction between GQDs and curcumin. MIC value of the GQDs–CurNCs has obtained 12.20 µg/mL and 11.02 µg/mL against *Staphylococcus aureus* and *Escherichia coli.* Overall, these findings suggest that GQDs–CurNCs hold great promise as biofunctional nanomaterials for biomedical applications.

Keywords: *Curcumin, Graphene quantum dot, Nanocomposite, Characterization, Biological properties*

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ORAL

Structural, Magnetic and Magnetocaloric Properties of $La_{0.67}Ca_{0.27}Sr_{0.06}MnO_3$ Perovskite Manganite

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ABSTRACT

The magnetic cooling technology is based on the magnetocaloric effect (MCE), characterized by reversible temperature change under an adiabatically varying magnetic field [1]. In recent years, manganite-based materials have attracted great interest due to their remarkable physical properties, including colossal magnetoresistance and significant MCE performance [2]. In this study, the structural, magnetic, and magnetocaloric properties of $La_{0.67}Ca_{0.27}Sr_{0.06}MnO_3$ (LCSM) manganite were systematically investigated. The sample was synthesized via the sol–gel method. The crystal structure and microstructural properties were analyzed using X-ray diffraction (XRD), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDS). Rietveld refinement of the XRD data revealed that the LCSM compound crystallizes in a rhombohedral structure with the (R-3c) space group. Temperature-dependent magnetization measurements indicated that the Curie temperature (T_C) of the LCSM compound is 274 K. Arrott analysis reveals a positive slope, indicating that the compound undergoes a second-order magnetic phase transition. The maximum magnetic entropy change (ΔS_M) was found to be 7.14 $Jkg^{-1}K^{-1}$ under an applied magnetic field of 5 T. In addition, the relative cooling power (RCP) was calculated as 176.48Jkg^{-1} at 5 T.

Keywords: *Magnetocaloric effect, manganite, Rietveld refinement, Curie temperature, magnetic entropy change, relative cooling power*

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ORAL

Optical Characterization of Spin-Coated CA-CN Thin Films by UV–Vis Spectroscopy

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ABSTRACT

In this study, the optical properties of Coumarin–Anthracene–Dicyanomethylene conjugate (CA-CN) based organic thin films were investigated by UV–Vis spectroscopy. CA-CN, an asymmetric coumarin-anthracene conjugate molecule, has attracted attention as a wide band-gap fullerene-free acceptor material for organic optoelectronic applications due to its strong absorption and suitable energy levels.

CA-CN thin films were deposited on soda-lime glass substrates via spin coating under different annealing conditions to examine the effect of thermal treatment on their optical behavior. The absorbance spectra were used to calculate the transmittance (T), absorption coefficient (α), extinction coefficient (k), refractive index (n), and dielectric constants (ε′ and ε″). The optical band gap (E_g) values were determined using the Tauc relation.

The results showed that CA-CN thin films exhibit strong absorption in the visible region and semiconductor-like optical behavior with wide band-gap characteristics (~1.9 eV). In addition, the optical constants were strongly influenced by annealing conditions, indicating that molecular ordering and film morphology play an important role in the optical transitions. These findings suggest that CA-CN thin films are promising candidates for organic photovoltaic and photodetector applications.

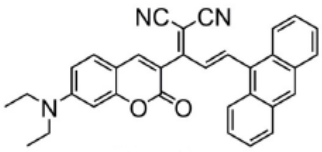

Figure 1. CA-CN chemical structure.

Keywords: CA-CN, UV–Vis spectroscopy, optical band gap, refractive index, dielectric properties, organic semiconductor, spin coating

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ORAL

Comprehensive Magnetic Investigation of Pd–Ni Nanoparticles Preparedby a Modified Polyol Method

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ABSTRACT

Pd-Ni nanoparticles (NPs) exhibit a synergistic blend of superparamagnetism and high surfacereactivity, offering a versatile solution for applications ranging from high-density magneticstorage devices and magnetically recoverable catalysts to targeted magnetic hyperthermia [1,2]. In this study, Pd-Ni NPs were successfully synthesized using modified polyol method andcompared. Structural morphologies and magnetic behaviors. X-ray diffraction and Rietveldrefinement analyses revealed that the NPs formed single phase face centered cubic crystalstructure and have exhibit crystal sizes of 4.86 nm. Scanning electron microscopy images showthat the average particle size of the NPs is below 10 nm. Furthermore, to determine the magneticbehavior of the NPs, magnetization-temperature (M-T) curves under zero-field cooling andfield-cooled conditions were analyzed under a constant 250 Oe magnetic field in thetemperature range of 5-380 K. The M-T analysis determined that the material has a blockingtemperature of approximately 9.6 K. Additionally, magnetization-field (M-H) hysteresis curveswere measured under a magnetic field of ±5 T at different temperatures. M-H hysteresis loopsdemonstrated a significant reduction in saturation magnetization from 5.6 emu/g at 5 K to 0.24emu/g at 320 K. The observed decrease in coercive field from 255 Oe to 23.2 Oe confirms atemperature-dependent transition from a ferromagnetic to a paramagnetic state, offeringpotential for superparamagnetic applications at ambient temperatures, ranging from targeteddrug delivery and MRI contrast enhancement to magnetically recoverable catalysis.

Keywords: *Bimetallic NPs, Structural and Magnetic Properties, Modified Polyol SynthesisMethod*

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ORAL

Superconducting Properties of YBCO nanofiber by Electrospinning

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ABSTRACT

$YBa_2Cu_3O_{7-x}$ (YBCO), a high-temperature superconductor, holds significant importance in both fundamental research and technological applications due to its critical temperature (T_c) value, which is close to the liquid nitrogen temperature [1,2]. In this study, YBCO nanofiber structures were produced by electrospinning, and a superconducting YBCO crystalline phase was obtained by subjecting them to appropriate burning, calcination, and sintering processes. The structural, morphological, and electrical properties of undoped and 0.5% (by weight) graphene-doped samples were comparatively investigated. The crystalline structures of the obtained samples were analyzed using X-ray diffraction (XRD), and their morphological properties were evaluated using Scanning Electron Microscopy (SEM). Furthermore, their superconductivity properties were determined by resistance-temperature (R–T) and magnetization-temperature (M–T) measurements. In conclusion, this study shows that low-rate graphene doping provides better grain connectivity in the fiber structure, resulting in improved superconducting transition temperature (T_c) and transition sharpness (ΔT).

This work demonstrates that low-rate graphene doping, after appropriate heat treatments, positively affects the superconductivity properties of YBCO nanofibers produced by electrospinning, and that this approach has potential in advanced functional superconducting material designs.

Keywords: *YBCO, Superconductivity, critical current density, magnetization, critical temperature*

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ORAL

Fabrication and Characterization of ZnTe/Si nanostructure for visible light photodetector by PLD

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ABSTRACT

Nanostructured semiconductors demonstrated an outstanding optical, electrical, and opto-electrical performance specifically Photodetectors for many application such as Communications, Biomedical, Imaging and Sensing [1,2]. Self-powered visible light photodetector based nanostructured ZnTe/Si geometry was fabricated using pulsed laser deposition (PLD). Herein, a detailed microstructural investigation was demonstrated in conjunction with the overall device photo responsive performance. In this work, ZnTe thin films were grown by pulsed laser deposition technique with the aim of study their structural and optical behaviors by optimizing energy and pulses for optoelectronic devices. Characterization results, X-ray diffraction is indicate increasing a nanocrystalline phase in high energy. And reveals that deposited films nanostructured, uniform and monophasic deposits of ZnTe with a strong preferential orientation in the (111) plane. The Raman data proves the ZnTe thin film nanocrystalline composite structure increases in 180 and 220 mJ energy laser beam. The deposited layer topographies were determined through field emission scanning electron microscopy (FE-SEM) images show that the average particle size of the ZnTe thin film range of 20-50 nm. Lastly, UV–Vis spectroscopy results indicate that band gap values of ZnTe films can be tuned in the range of 2.3–2.56 eV as function of energy and pulses laser.

Keywords: *ZnTe /Si, Self-powered, Pulsed laser deposition, photodetector*

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ORAL

Investigation of Cytotoxic Effects of Green-Synthesized Magnetic Nanoparticles Using Lemon Peel Extract on Cancer Cells and Their Potential for Drug Delivery

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ABSTRACT

In recent years, the production of magnetic nanoparticles via green synthesis methods has become a significant area of research due to their environmentally friendly production processes and biocompatibility. Magnetic nanoparticles (MNPs) synthesized using plant extracts are attracting attention because they reduce the need for toxic chemicals and demonstrate suitability for biological applications. Citrus peels, in particular, are known to contain bioactive compounds that are effective in reducing metal ions and stabilizing nanoparticles, thanks to their rich structure of polyphenols, flavonoids, terpenes, and limonoids [1–3]. Furthermore, these bioactive compounds have been reported to minimize the risk of metabolic syndrome, including cardiovascular disease, diabetes, and cancer, by reducing inflammatory mediators and reactive oxygen species in the body [3]. Flavonoids such as hesperidin, naringin, and tangeretin, commonly found in lemon peel, as well as phenolic acid derivatives such as ferulic acid, caffeic acid, and p-coumaric acid, are known to possess strong antioxidant properties [4]. In this study, magnetic nanoparticles were produced via green synthesis using the extract of Lamas lemon peels grown in the Erdemli region of Mersin, and their cytotoxic effects on cancer cells were investigated. Characterization of the synthesized nanoparticles was performed using SEM-EDS, FTIR, XRD, and nitrogen adsorption-desorption analyses. The biological efficacy of the obtained nanocarrier systems was evaluated through their antiproliferative effects on breast cancer and ovarian cancer cell lines, as well as healthy dermal fibroblast cells. The data obtained reveal that the synthesized MNPs exhibit selective cytotoxicity toward cancerous cells and demonstrate biosafety in healthy cell lines. In conclusion, this study provides significant preliminary data to the literature on the development of environmentally friendly, highly efficient next-generation smart drug delivery platforms that minimize side effects in the treatment of chronic diseases.

Keywords : Green Synthesis, Magnetic Nanoparticles, Drug Delivery Systems, Anti-cancer, Lemon Peel

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ORAL

Çinkonun Anodizasyonu ile Atik Çözeltiden Elde Edilen Çinko Oksit Nanopartiküllerinin Antimikrobiyal Özelliklerinin İncelenmesi

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ÖZET

Bakteri ve mantar kaynaklı enfeksiyonlar, özellikle immün sistemi baskılanmış bireylerde ciddi klinik sonuçlara yol açabilmektedir. Bu nedenle enfeksiyonların kontrolünde etkili antimikrobiyal ajanların kullanımı büyük önem taşımaktadır [1]. Ancak bu ajanların yaygın ve kontrolsüz kullanımı, mikroorganizmaların direnç geliştirmesine neden olmuş ve mevcut tedavi seçeneklerinin etkinliğini azaltmıştır [2]. Bu durum, alternatif yaklaşımlara olan ihtiyacı artırmış ve son yıllarda nanoteknoloji temelli çözümler ön plana çıkmıştır. Bu kapsamda çinko oksit (ZnO) nanopartikülleri, geniş spektrumlu antimikrobiyal etkileri ile dikkat çekmektedir [3]. Çalışmada, ZnO nanopartiküllerinin antimikrobiyal aktivitesi, modifiye mikrodilüsyon yöntemi ile referans suşlar üzerinde değerlendirilmiştir. Elde edilen sonuçlara göre MİK değerleri; Staphylococcus aureus için 125 µg/mL, Enterococcus faecalis için 62,5 µg/mL, Acinetobacter baumannii, Escherichia coli ve Pseudomonas aeruginosa için 62,5 µg/mL olarak belirlenmiştir. Maya suşlarında (Candida albicans, Candida glabrata, Candida parapsilosis) ise MİK değeri 31,25 µg/mL olarak saptanmıştır. Bulgular, ZnO nanopartiküllerinin konsantrasyona bağlı inhibitör etki gösterdiğini ortaya koyarken, özellikle maya suşlarında düşük MİK değerleri antifungal potansiyelini desteklemektedir. Ayrıca fibroblast hücreleri üzerindeki biyolojik etkilerle birlikte değerlendirilmesi, ZnO nanopartiküllerinin biyomedikal kullanım potansiyeline işaret etmektedir.

Anahtar Kelimeler: Çinko oksit, Nanopartikül, Antimikrobiyal.

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ORAL

One-step Preparation and Characterization of Conducting Polymer Nanofiber Coated Carbon Nanotube Yarns for Smart Textile Production

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ABSTRACT

In this study, various characterization applications were conducted to evaluate both the potential and performance of carbon nanotube (CNT) yarns coated with conductive polymer (CP) nanofibers (NFs) that are synthesized through "one-step NF seeded in-situ oxidative polymerization" method for their applications in advanced fields such as smart textile production, energy harvesting, and sensors. Here, the in-situ synthesis of CP (polypyrrole (PPy), polyaniline (PANI)) NFs were achieved whilst coating the CNT yarn that is present in the reaction medium during the NF seeded oxidative polymerization reaction of relevant monomers, which resulted in hybrid and functional textile products' formation with improved mechanical (tensile strength and modulus of elasticity) and conductivity (electrical, thermal) properties. Subsequently, comprehensive structural (Fourier transform infrared (FT-IR) spectroscopy), morphological (scanning electron (SEM) and polarized light microscopy), thermal (thermogravimetric analysis (TGA)), mechanical (single fiber strength), and electrical (resistance (2-probe digital multimeter), conductivity and strain sensitivity) characterization studies were conducted both to reveal the potential of these products in smart textiles' production, which are widely used in energy harvesting and sensor applications, and to evaluate their performances.

Keywords *Carbon nanotube yarn, Conducting polymer nanofiber, Smart textiles*

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ORAL

Synthesis of Pt-Co-Ni Ternary Catalyst for Oxygen Reduction Reaction

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ABSTRACT

Platinum is the leading catalytic material in Proton Exchange Membrane Fuel Cells (PEM-FC) for oxygen reduction reaction (ORR) process [1]. On the other hand, due to its scarcity and increasing number of applications, Pt prices exhibit the major bottleneck in fuel cell economics. One of the most applied improvement strategy on Pt catalyst is to produce alloys with transition metals such as Co, Ni, Cu, etc. [2]. Alloying Pt with other transition metals improves the catalytic activity by i) ligand effect, ii) strain effect and iii) ensamble effect [3]. In this study PtCoNi ternary nanoalloy synthesized using polyol method. In proposed method Pt, Co and Ni salts are reduced using Ethylene Glycol and Sodiumborohydrate at moderate temperature, 160 ℃, and 1 hour reduction time. Polyvinylpyrrolidone, (PVP) having average molecular weight of 40.000 amu, is used as dispersion agent. The point of the study is to explore the crystal structure of Pt0.4Co0.3Ni0.3 ternary nanoalloy, the effect of compression strain and electronic effects of two transition metals, Co and Ni, having smaller atomic radii than Pt, on Pt-alloy ORR catalyst.

Keywords: PdCoNi NPs, XRD. Rietveld, SEM, catalytic properties

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ORAL

Immersion Corrosion and Antibacterial Behavior of NaOH Conversion-Coated HA/Si3N4-Reinforced Mg2Zn1Mn-Based Nanocomposites with and without Ag Addition

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ABSTRACT

Biodegradable magnesium-based materials are attracting significant attention for orthopedic implant applications because of their bone-like density, suitable elastic modulus, and potential to eliminate secondary surgical procedures. Despite these advantages, their high corrosion rate remains the primary limitation hindering practical clinical use. In this study, magnesium-based composites reinforced with hydroxyapatite (HA) and silicon nitride (Si3N4) nanoparticles, at total reinforcement contents of 20 and 24 wt.%, with and without 0.5 wt.% silver (Ag), were fabricated via mechanical alloying, cold compaction, and two-stage conventional sintering. To improve surface properties, a single-step NaOH conversion coating was applied by immersing the bulk samples in NaOH solution at 65 C for 24 h. The corrosion resistance of the coated samples was evaluated by in vitro immersion testing, while their antibacterial activity against Staphylococcus aureus (S. aureus) and Escherichia coli (E. coli) was assessed using the agar diffusion method. The immersion results revealed that the corrosion rate decreased over time for all tested samples. By day 7, the lowest corrosion rate was observed for MHS20-OH (14.00 mm/year), whereas the highest was recorded for MHS24-0.5Ag-OH (28.44 mm/year). Following corrosion product removal, weight loss values for MHS20-OH, MHS24-OH, MHS20-0.5Ag-OH, and MHS24-0.5Ag-OH were 29.0%, 32.1%, 23.7%, and 31.8% on day 3, and 21.4%, 27.4%, 34.1%, and 43.3% on day 7, respectively. Material loss became more pronounced by day 7, especially in the Ag-containing samples. The pH initially increased to 8.02–8.20 and then stabilized at 7.71–7.77 by day 7. The antibacterial tests showed that all coated samples inhibited both bacterial species, with a slightly stronger effect against E. coli. In conclusion, the single-step NaOH conversion coating imparted antibacterial functionality to this composite system but was insufficient to enhance its corrosion resistance.

Keywords: Mg2Zn1Mn biocomposite, Conversion coating, Immersion corrosion resistance, Antibacterial properties

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ORAL

A Computational Study of the Effect of an External Electric Field on H_2S Adsorption in ZIF-71

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ABSTRACT

Metal-organic frameworks (MOFs) are highly versatile porous materials for gas adsorption and storage due to their exceptional surface areas, tunable pore structures, and functionalizable chemical compositions.[1] Among their diverse applications, the selective capture and storage of industrially relevant gases particularly hydrogen sulfide (H_2S) hold critical importance for both sustainable energy and environmental remediation. H_2S a corrosive and toxic byproduct in natural gas, petroleum refining, and biogas production, poses significant challenges due to its detrimental effects on catalysts, pipelines, and emission control systems[2]. Effective removal of H_2S is essential not only for process efficiency but also for reducing sulfur-related environmental pollution. Zeolitic imidazolate frameworks (ZIFs) with their tailorable host-guest interactions, offer a promising platform for addressing these challenges through optimized adsorption performance[3]. This study investigates the potential of ZIF-71 for H_2S capture, leveraging computational modeling to evaluate its adsorption behavior under varying thermodynamic conditions and investigate its behavior under external stimuli. ZIF-71, containing dichloroimidazolate ligands, is predicted that the H atoms in H_2S could potentially adsorb onto the Cl groups. Additionally, Cl halogens attached to the imidazolate ligands in ZIF-71 may trigger ligand rotation under an applied electric field.[4] 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_2S adsorption at lower temperatures and higher pressures, reaching up to 25.88 mg/g at 193 K and 50 bar, exceeding previously reported values for related frameworks[5]. Furthermore, ab initio molecular dynamics simulations (AIMD) show that external electric fields influence the distribution of dihedral angles of ZIF-71 ligands. While field strength of 1 and 2 V/nm induces minor changes, a stronger field of 3 V/nm causes a more noticeable structural shift, suggesting tunability of the framework under external stimuli. We further investigated the free energy landscape associated with these conformational changes using metadynamics simulations (MTD). This combined approach allows us to quantify the energy barriers governing framework distortions and assess their implications for adsorption and stimuli-responsive behavior. Our AIMD results further reveal that the applied electric field modulates the molecular orientation and transport dynamics of H2 S within the ZIF-71 pores. While H2S molecules initially exhibit a stable configuration with hydrogen atoms oriented toward the chlorine groups, consistent with DFT-optimized geometries, the application of an electric field induces a pronounced reorientation. As the field strength increases, molecules in weakly bound regions exhibit enhanced mobility, migrating across periodic unit cell boundaries to less dense regions, suggesting that external stimuli can trigger macro-scale transport dynamics. The analysis of framework to adsorbate provides physical insights into how electric fields reshape the adsorption energy landscape and dictate preferred binding modes. These findings reveal the potential of utilizing external fields as a dynamic tool for controlling gas separation and transport in functionalized nanoporous materials. We appreciate the support provided by TÜBİTAK within TÜBİTAK-1001 the Scientific and Technological Research Projects Funding Program (Grant agreement no: 124Z002). All reported simulations were carried out using TRUBA HPC resources.

Keywords: Physisorption, ab initio molecular dynamics, metadynamics, Monte Carlo, H2S adsorption, electric field response.

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ORAL

Investigation of the Structural Dynamics of ZIF-80 Under an External Electric Field via Ab Initio Molecular Dynamics and Metadynamics

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ABSTRACT

Metal-organic frameworks (MOFs) are among the most promising candidates for smart material applications due to their tunable pore characteristics and their structural response to external stimuli [1,2]. ZIF-80 is a porous structure formed by the coordination of Zn atoms through imidazolate (Im) linkers and has attracted significant attention for gas storage applications owing to its high surface area [3]. In this study, the structural and electronic behavior of ZIF-80 under different temperature and electric field conditions were investigated for the first time using ab initio molecular dynamics (AIMD), metadynamics (MTD), and density functional theory (DFT) methods. The relationship between electric-field-induced polarization and conformational dynamics was examined, the effect of field direction on material behavior was evaluated, and the reversibility of structural changes was analyzed. Thus, the potential of ZIF-80 in smart material applications was revealed. This study provides a theoretical framework for conformational dynamics in ZIF-80 under external electric field using advanced quantum-based simulation methods. The findings contribute to the design principles of tunable porous materials for smart applications. We appreciate the support provided by TÜBİTAK within TÜBİTAK-1001 the Scientific and Technological Research Projects Funding Program (Grant agreement no: 124Z002). All computations were performed using the TRUBA High-Performance Computing Center infrastructure.

Keywords: Electric field, Ligand Rotation, Density Functional Theory, ZIF-80

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ORAL

Investigation of Graphene-like Carbon Materials Derived from Olive Pits for Potential of Promoting Human Dermal Fibroblast Cell Proliferation and Enhancing Wound Healing

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ABSTRACT

Complex and non-healing skin wounds represent a critical global challenge, leading to severe health complications such as infection, amputation, and mortality while imposing a significant economic burden [1]. The management of these wounds necessitates the development of multifunctional skin grafts and biomaterials that actively support tissue regeneration [2]. This study aims to synthesize graphene-like carbon materials from olive stones, an agricultural waste product, through sustainable methods and evaluate their potential in wound healing processes by examining their effects on dermal fibroblast proliferation. In this work, graphene-like carbon materials were produced by carbonizing olive pits, an agricultural waste, at 900 °C for 2 h under a CO2 atmosphere [3,4]. Following the morphological and surface area characterization of the synthesized materials, their biological effects on healthy human dermal fibroblast cells were tested under in vitro conditions. The potential cytotoxicity and the impact on cell proliferation were statistically evaluated. The data revealed that olive stone-derived graphene-like carbon materials exhibit remarkably low cytotoxicity toward dermal fibroblasts. More importantly, it was observed that these carbon materials significantly enhanced cell proliferation and maintained cell viability even at low concentrations compared to the control group. This study presents a "green synthesis" based approach, proving that agricultural waste can be upcycled into high-tech biomaterials. The cytocompatible nature and proliferation-inducing effects of the resulting graphene-like materials indicate that these structures can be integrated into complex skin regeneration systems, hydrogels, or nanofiber scaffolds. In conclusion, olive stone-derived carbon structures emerge as high-potential, cost-effective, and sustainable active components for regenerative medicine applications and the development of next-generation wound dressings.

Keywords: Olive Stone, Graphene-like Carbon, Dermal Fibroblasts, Wound Healing, Regenerative Medicine, Green Synthesis.

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ORAL

The Effect of LLZO Content on the Phase Transformation of LLZO in PEO/LiTFSI Solid Electrolytes

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ABSTRACT

Solid-state electrolytes stand out as critical components for next-generation lithium-ion batteries due to their advantages, such as high energy density, improved safety, and broad electrochemical stability. Particularly because of their ability to replace flammable liquid electrolytes, they play a significant role in the development of safe energy storage systems. In this context, polyethylene oxide (PEO)-based composite solid electrolytes, when combined with Li^+ conductive ceramic fillers such as $Li_7La_3Zr_2O_{12}$ (LLZO), offer promising properties. In literature, cubic LLZO is generally preferred in composite solid electrolytes for its high ionic conductivity, whereas the tetragonal phase is used only to a limited extent in composite electrolyte studies due to its low conductivity. However, in our preliminary studies, we determined that t-LLZO can unexpectedly transform into the cubic phase at room temperature upon interaction with a PEO/LiTFSI system, and this transformation depends on a critical threshold doping amount [1].

In this study, the phase transformation behavior of the PEO/LiTFSI matrix has been systematically investigated as a function of the In-doped LLZO content.

Keywords: Phase transformation, LLZO, PEO flexible solid electrolytes, Energy materials

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ORAL

Investigation of the Effects of Heat Treatments on the Microstructure and Mechanical Properties of Additively Manufactured Inconel 718 and Ti-6Al-4V Alloys

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ABSTRACT

Additive manufacturing technologies have been widely utilized in aerospace, energy, and biomedical industries due to their ability to produce complex geometries with high precision [1]. In particular, Inconel 718 and Ti-6Al-4V alloys fabricated by selective laser melting (SLM/LPBF) have attracted significant attention because of their high strength, low density, and excellent high-temperature performance [2]. However, rapid solidification during the manufacturing process results in columnar grain structures, residual stresses, texture formation, segregation, and the formation of secondary phases such as Laves and δ phases, which may lead to anisotropic mechanical behavior and reduced ductility [3,4]. Therefore, post-processing heat treatments play a critical role in improving the performance of additively manufactured alloys. In this study, recent literature on SLM-fabricated Inconel 718 and Ti-6Al-4V alloys was comprehensively reviewed to evaluate the effects of different heat treatment processes on microstructure, hardness, tensile strength, ductility, and fracture behavior. The reviewed studies demonstrated that homogenization, solution treatment, aging, and sub-β-transus annealing significantly influence the mechanical properties of these alloys. In Inconel 718, controlled precipitation of γ′ and γ″ strengthening phases enhanced tensile strength and hardness, while an appropriate amount of δ phase improved high-temperature performance by stabilizing grain boundaries. In Ti-6Al-4V alloys, the transformation of martensitic α′ structure into an α + β lamellar microstructure increased ductility and fracture toughness. The findings indicate that additively manufactured alloys exhibit distinct microstructural characteristics compared with conventional wrought materials, thereby necessitating the development of process-tailored heat treatment strategies to achieve superior mechanical properties.

Keywords: Additive Manufacturing, Selective Laser Melting (SLM), Inconel 718,Ti-6Al-4V, Heat Treatment

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ORAL

Effect of Post Weld Heat Treatment on the Microstructural and Mechanical Properties of Dissimilar Al-Ti Welded Joints

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ABSTRACT

The 7075-T6 aluminum alloy is indispensable in the aerospace and defense sectors owing to its superior strength-to-weight ratio, while the Ti6Al4V titanium alloy is extensively utilized for critical components across industries ranging from biomedical to aviation due to its exceptional corrosion resistance and high-temperature stability. However, the joining of these two dissimilar materials via conventional fusion welding techniques remains significantly hindered by profound metallurgical incompatibilities and the inevitable formation of brittle intermetallic compounds within the fusion zone. In this context, Friction Stir Welding (FSW) emerges as a robust solid-state joining alternative. Although FSW is a solid-state joining method that occurs below the melting temperature of the base material, the frictional heat and high plastic deformation generated during the process lead to inevitable microstructural changes that compromise the joint's integrity. To overcome these variations and restore microstructural stability, post-weld heat treatment (PWHT), such as solutionizing and artificial aging, is applied to re-establish a uniform distribution of secondary phase precipitates and normalize the grain structure. This study investigates the influence of PWHT on the metallurgical and mechanical properties of dissimilar Al 7075-T6 and Ti-6Al-4V joints produced via FSW. For the purpose of determining the effect of post-weld heat treatment three distinct conditions were evaluated. As-welded (AW), artificial aging (AA), and a combined solution heat treatment followed by artificial aging (STA). Characterization of the interfaces and stir zones was conducted using optical microscopy to observe grain refinement, while the mechanical response was quantified through Vickers microhardness profiles. The investigation found that PWHT, specifically the STA significantly improve the microstructural consistency and mechanical properties of Al-Ti dissimilar welds. While as-welded specimens exhibited erratic hardness (150-250 HV) and irregular grain structures, the STA process promoted a uniform hardness profile (averaging 175 HV) and a refined, equiaxed grain microstructure through the redistribution of strengthening precipitates. These findings highlight STA as a vital thermal process for enhancing the structural integrity and reliability of high-strength welds in aerospace applications.

Keywords: Friction stir welding, Post weld heat treatment, 7075-T6, Ti6Al4V

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ORAL

ALÜMİNYUM DROSSUNUN ERGİTİLMESİYLE ELDE EDİLMİŞ ALÜMİNYUM KULLANILARAK DÜŞÜK KARBONLU ÇELİKLERE SICAK DALDIRMA ALÜMİNYUM KAPLAMA YAPILMASI

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ÖZET

Alüminyum üretimi sırasında yan ürün olarak ortaya çıkan alüminyum drossu, çevreye olan etkileri ve içerdiği metal miktarı nedeniyle geri kazanımı kritik önem taşıyan bir endüstriyel atıktır. Bu atığın tekrar ekonomiye kazandırılması, hem birim hammadde maliyetlerini düşürmekte hem de sürdürülebilir üretim süreçlerini desteklemektedir. Bu çalışmanın amacı, endüstriyel bir atık olan alüminyum drossundan elde edilen ikincil alüminyumun sıcak daldırma yöntemiyle alüminyum kaplama prosesinde kullanılması ve düşük karbonlu çeliklerin korozyon direncine etkisinin incelenmesidir. Deneysel süreçte, alüminyum drossları grafit potada ergitilmiş, NaCl ve KCl kullanılarak cüruf temizliği yapılmış ve banyo kaplama için hazır hale getirilmiştir. Altlık malzeme olarak seçilen düşük karbonlu çeliklerin yüzeyleri, aderansı artırmak amacıyla 1200 grit seviyesine kadar zımparalanmış ve ardından %5'lik HCl çözeltisinde yüzey aktivasyonu sağlanmıştır. Hazırlanan numuneler 750 °C sıcaklıktaki ergiyik Al banyosuna 15 ve 30 saniyelik sürelerle daldırılmış, işlem sonrası oda sıcaklığında soğumaya bırakılmıştır. Oluşan kaplama tabakasının mikroyapısal karakterizasyonu SEM yöntemiyle gerçekleştirilmiştir. Kaplamanın korozyon performansı Elektrokimyasal Empedans Spektroskopisi (EIS) yöntemiyle değerlendirilmiş; anot-katot potansiyelleri, yıllık korozyon miktarları ve Tafel eğrileri üzerinden analiz edilmiştir. Korozyon ürünleri ve kaplamanın faz bileşimi XRD yöntemi kullanılarak belirlenmiştir.

Anahtar Kelimeler: Alüminyum Drossu, Sıcak Daldırma Alüminyum Kaplama, Korozyon Direnci, Tafel Eğrileri, Mikroyapı Karakterizasyonu

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ORAL

Thermomechanical Displacement Analysis of Rotating Hollow Hybrid Composite Cylinders

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ABSTRACT

This study presents a detailed thermomechanical displacement analysis of rotating hollow hybrid composite cylinders subjected to combined thermal gradients and centrifugal forces. An integrated analytical–computational framework is developed, where the structure is modeled as a multilayered composite system to capture coupled thermoelastic effects under elevated rotational speeds. Based on the plane strain assumption, closed-form solutions are derived to characterize the radial displacement distribution across the cylinder thickness. The formulation incorporates the interaction between thermal expansion and rotational inertia, which governs the deformation behavior of layered composite configurations. The model is evaluated at angular velocities of 125 rad/s and 250 rad/s to represent different operating conditions. The results indicate that increasing rotational speed, together with thermal loading, leads to a noticeable amplification of radial displacement throughout the structure. The findings highlight that thermomechanical coupling plays a key role in displacement behavior, with more pronounced radial expansion occurring in the outer regions at higher speeds. The hybrid configuration provides improved deformation resistance through a balanced mechanical response. Overall, the proposed framework offers a reliable and efficient tool for displacement analysis and design of rotating composite cylinders.

Keywords: Thermomechanical analysis, radial displacement, hybrid composite cylinders, rotating structures

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ORAL

From Marine Waste to Concrete: Utilization of Ghost Fishing Nets in Sustainable Concrete

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ABSTRACT

The International Convention for the Prevention of Pollution from Ships (MARPOL) Annex V addresses marine pollution caused by garbage, including plastic-based fishing nets, commonly referred to as ghost nets. These abandoned or lost nets, primarily composed of high-molecular-weight polymers such as nylon, pose significant threats to marine ecosystems due to their persistence and harmful interactions with marine life. This study explores the reuse of ghost fishing nets in the production of sustainable concrete. Nylon fibers recovered from waste nets collected from the Marmara Sea were used as reinforcement in cementitious mortars and concrete for reinforced concrete (RC) and masonry applications. The research also addresses the environmental impacts of ghost nets in marine ecosystems. Experimental results, based on a 1% fiber-to-cement weight ratio, show measurable improvements in mechanical performance. Tensile strength increased by up to 10%, while toughness improved significantly, reaching enhancements of up to 400% compared to reference specimens. The findings indicate that recycled nylon fibers from ghost nets exhibit mechanical behavior comparable to conventional synthetic fibers, highlighting their potential as an effective and sustainable alternative in green concrete production. The study highlights both the environmental and engineering benefits of repurposing ghost fishing nets in cement-based materials. Their use not only contributes to waste reduction and marine ecosystem protection but also supports the development of low-cost, lightweight, and durable construction materials with favorable thermal and electrical insulation properties. Furthermore, it reduces reliance on clinker production, thereby lowering associated carbon emissions and contributing to global sustainability efforts.

Keywords: Marine, Ghost Net, Sustainable Concrete, Fishing lines, Reinforcement fibers

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ORAL

Geometrical Investigation of TPMS-Based Gyroid Structure: A Case Study for Unmanned Aerial Vehicles

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ABSTRACT

Triply Periodic Minimal Surface (TPMS) based lattice structures, especially gyroids, have recently gained significant popularity due to their balanced strength-to-weight ratio and good thermal management capabilities [1]. The use of gyroid materials is also attracting increasing interest in aviation and unmanned aerial vehicle (UAV) applications. Since weight reduction is a critical design constraint for UAV technologies, TPMS-based materials can enable the creation of lightweight components without compromising structural stability. In this context, it is considered that gyroid geometries can be used as an alternative heat sink design material for cooling systems used in power-dense UAV electronic systems. This idea is further reinforced by the development of additive manufacturing techniques, which have made it possible to produce complex materials that were previously impossible to manufacture using traditional methods. Therefore, this study focuses on the geometric characteristics of gyroid structures, which are crucial in the design process, specifically for use in UAV cooling systems. In this study, all geometric characteristics of a gyroid-shaped cooling block design are considered, and heat sink designs are created with various porosities and unit cell lengths. Ultimately, the effects of these design parameters on the specific surface area were reported, providing insights into the designs.

Keywords: Lattice structure, TPMS, Gyroid, UAV applications

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ORAL

Electrocatalytic HER/OER Performance of PdCo/CoFe2O4/Carbon Black Nanocomposites in Alkaline Media

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ABSTRACT

Developing low-cost and efficient bifunctional electrocatalysts for alkaline water splitting is critical for sustainable hydrogen production [1]. Pd-decorated CoFe2O4/carbon black nanocomposites were synthesized via combined sol–gel and polyol methods and evaluated for HER and OER performance in 1 M KOH at room temperature. TEM analyses confirmed homogeneous nanoparticle dispersion on the carbon support, with Pd nanoparticle sizes decreasing from ~7–9 nm to ~2–3 nm as Pd content increased, while CoFe2O4 particle sizes remained below 40 nm. Among the investigated compositions, Pd5+(CoFe2O4)95/C exhibited the most favorable morphology and was selected for detailed electrochemical evaluation [2]. The catalyst showed a HER onset potential of 12 mV versus RHE and achieved 62 mV overpotential at 50 mA cm-2, indicating competitive high-current-density activity compared with commercial Pt/C catalysts. However, the HER Tafel slope was measured as 395 mV dec-1, suggesting relatively slow reaction kinetics. For OER, the catalyst exhibited an onset potential of 1.595 V versus RHE and approximately 659 mV overpotential at 50 mA cm-2. The results demonstrate that PdCo/CoFe2O4/C nanocomposites can operate under demanding alkaline electrolysis conditions, although further optimization is required to improve charge-transfer kinetics and reduce overpotentials.

Keywords: PdCo; CoFe2O4; HER; OER; electrocatalysis; water splitting

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ORAL

Membran Distilasyon Biyoreaktör ile Yağ İçerikli Atıksuların Arıtım Performansının Araştırılması

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ÖZET

Endüstriyel faaliyetler sonucunda oluşan yağ içerikli atıksular, yüksek kimyasal oksijen ihtiyacı, emülsifiye yağ yapıları ve arıtım süreçlerinde neden oldukları kirlenme problemleri nedeniyle çevresel açıdan önemli bir sorun oluşturmaktadır. Geleneksel arıtma yöntemleri bu tür atıksuların etkin arıtımında sınırlı kalabilmekte, özellikle yüksek saflıkta su geri kazanımının hedeflendiği uygulamalarda alternatif teknolojilere ihtiyaç duyulmaktadır. Bu kapsamda membran distilasyon biyoreaktör (MDBR) sistemleri, biyolojik arıtma ile membran distilasyon prosesini entegre ederek organik kirleticilerin giderimi ve yüksek kaliteli su geri kazanımını bir arada sağlayabilen yenilikçi hibrit sistemler olarak öne çıkmaktadır.

Bu çalışmada, yağ içerikli atıksuların arıtımında doğrudan temaslı membran distilasyon biyoreaktör sisteminin performansı incelenmiştir. Çalışmada hidrofobik özelliğe sahip polimerik membran kullanılarak farklı işletme parametrelerinin sistem performansı üzerindeki etkileri değerlendirilmiştir. Besleme sıcaklığı, akış hızı, başlangıç yağ konsantrasyonu ve işletme süresi gibi parametrelerin süzüntü akısı, iletkenlik değişimi ve organik madde uzaklaştırma verimi üzerindeki etkileri araştırılmıştır. Sistem performansının optimize edilmesine yönelik olarak farklı işletme koşulları altında membran davranışı karşılaştırmalı olarak analiz edilmiştir. Ayrıca biyoreaktör ile membran distilasyon sisteminin entegre çalışması sırasında membran yüzeyinde meydana gelen kirlenme mekanizmaları incelenerek sistemin uzun süreli işletme kararlılığı değerlendirilmiştir.

Çalışma sonucunda, membran distilasyon biyoreaktör sisteminin yağ içerikli atıksuların arıtımında yüksek kaliteli su geri kazanımı açısından önemli bir alternatif olduğu belirlenmiş olup, elde edilen bulguların hibrit membran proseslerinin geliştirilmesine ve yağ içerikli atıksuların sürdürülebilir arıtımına katkı sağlayacağı değerlendirilmiştir.

Anahtar Kelimeler: Membran Distilasyon Biyoreaktör, Atıksu, Su Geri Kazanımı, Membran Kirlenmesi

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ORAL

BAĞLANTI ELEMANLARINDA ISIL İŞLEM SÜREÇLERİ VE MEKANİK ÖZELLİKLERE ETKİSİ

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ÖZET

Günümüzde cıvata, somun, saplama ve ankraj gibi bağlantı elemanlarının performans gereksinimlerinin artmasıyla birlikte, bu elemanların mekanik özelliklerinin geliştirilmesinde ısıl işlem uygulamaları büyük önem kazanmıştır. Isıl işlemin temel amacı; çeliğin sertlik, süneklik, akma dayanımı, çekme dayanımı ve darbe dayanımı gibi mekanik özelliklerini kullanım amacına uygun seviyelere ulaştırmaktır.

Bu çalışmada, uygulanan ısıl işlemlerin çeliğin mekanik özellikleri ve mikroyapısı üzerindeki etkileri deneysel olarak araştırılmıştır. Çalışma kapsamında seçilen numuneler, östenitleme sıcaklığının üzerindeki belirli bir sıcaklıkta ısıtılmış ve ardından yağ ortamında su verilerek hızlı soğutma işlemine tabi tutulmuştur. Su verme işlemi sonrasında numunelere, hedeflenen kalite sınıfına uygun şekilde menevişleme işlemi uygulanmıştır.

Isıl işlemleri tamamlanan numuneler üzerinde çekme testi, çentik darbe testi ve mikroyapı incelemeleri gerçekleştirilmiştir. Elde edilen sonuçlar, ısıl işlem uygulanmamış numuneler ile karşılaştırılarak değerlendirilmiş; mekanik özelliklerde meydana gelen değişimler ile mikroyapısal dönüşümler detaylı olarak incelenmiştir.

Çalışma sonuçları, düşük karbonlu/yumuşak çeliklerin uygun ısıl işlem prosesleri ile bağlantı elemanlarında kullanılabilecek seviyede mekanik özelliklere ulaştırılabildiğini ve malzeme performansının önemli ölçüde iyileştirilebildiğini ortaya koymuştur.

Anahtar Kelimeler: Isıl İşlem, Mekanik Özellik, Mikroyapı, Çekme Testi

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4th International Conference on Functional Materials Science and Engineering

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ORAL

Bağlantı Elemanlarında Gerçekleşen Çatlak Kusurları Hakkında Bir Çalışma

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ÖZET

Bağlantı elemanları (cıvatalar, somunlar, vidalar, perçinler ve saplamalar), yapısal ve mekanik sistemlerin bütünlüğünü sağlayan en kritik bileşenlerdir. Bu elemanlarda meydana gelen çatlaklar, çıplak gözle fark edilemeyen mikro düzeyde başlayıp, zamanla felaketle sonuçlanan ani yapısal kırılmalara (katastrofik hasar) yol açabilir. Üretim esnasında döküm, dövme veya ısıl işlem aşamalarında oluşan hatalar çatlak riskini doğrudan artırır. Malzeme içindeki metal dışı kalıntılar (inklüzyonlar), yüzeyde meydana gelen karbonsuzlaşma (dekarbürizasyon) tabakası, yanlış ısıl işlem sonucu oluşan aşırı sertlik veya heterojen mikroyapı, malzemenin çatlama direncini düşürür. Bu çalışmada çatlak oluşan bağlantı elemanlarında gerçekleşen çatlak durumları incelenmiştir. Çatlak oluşumu gerçekleşen bağlantı elemanlarında alınan numunelerde inceleme amacıyla haddelemeye paralel ve dik doğrultularda kesit numuneleri çıkarılmıştır. Çıkarılan numuneler kalıplanmış, 180-1200 grit arasında değişen SiC zımpara kağıtları ile zımparalanmış ve 3-1 mikron arasında değişen elmas süspansiyonlar ile uygun parlatma kumaşlarında parlatılmışlardır. Parlatılan numunelerde mikroyapıyı ortaya çıkarmak ve segregasyon durumunu ortaya koymak için pikral çözeltisi ile dağlanmıştır. Su verilmiş ve temperlenmiş numunelerdeki başlangıç (su verme öncesi) ostenit tane büyüklüğünü ortaya çıkarmak için dağlama amacıyla modifiye edilmiş pikral çözeltisi kullanılmıştır. Çatlakların mikroyapı incelemelerinde çatlakların ağırlıklı olarak tane sınırlarından ilerlediğini söylemek mümkündür. Bunun nedeni, yüzeydeki çatlak profilinin (üst kenar) tane içinden geçen bir kırılmanın aksine düz ve kesintisiz bir hat izlememesidir. Bunun yerine, oldukça zikzaklı ve pürüzlü bir yol izlemektedir. Haddeleme yönüne paralel uzanan, birbirini takip eden açık renkli ve koyu renkli bantlar segregasyon oluşumunun tipik bir göstergesidir. Bu durum genellikle döküm sırasında C, P, S, Mn, Si, Cr, Mo gibi elementlerin dendritler arası bölgelerde toplanmasından kaynaklanır.

Anahtar Kelimeler: Bağlantı Elemanı, Çatlak, Mikroyapı, Numune, Element

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ORAL

Sıcak Daldırma Galvaniz Öncesi Yüzey Temizleme Yöntemlerinin Karşılaştırılması: Asitle Temizleme ve Kumlama Uygulamaları

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ÖZET

Sıcak daldırma galvaniz prosesinde kaplama kalitesini doğrudan etkileyen en önemli aşamalardan biri yüzey hazırlığıdır. Yüzey üzerinde bulunan pas, tufal, yağ ve oksit tabakalarının uygun şekilde temizlenmemesi kaplama hatalarına neden olmaktadır. Sıcak daldırma galvaniz işlemi, çelik malzemelerin korozyona karşı korunması amacıyla yaygın olarak kullanılan bir kaplama yöntemidir. Kaplama kalitesinin yüksek olması için çelik yüzeyin galvaniz öncesinde tamamen temizlenmesi gerekmektedir. Sanayide en yaygın kullanılan yüzey hazırlama yöntemleri asitle temizleme ve kumlama uygulamalarıdır. Asitle temizleme yönteminde çelik yüzeyler genellikle hidroklorik asit (HCl) veya sülfürik asit (H_2SO_4) banyolarına daldırılarak yüzeydeki pas ve oksit tabakaları çözündürülmektedir. Kumlama işleminde yüzeye yüksek basınçla aşındırıcı malzeme püskürtülerek pas, tufal ve kir tabakası mekanik olarak temizlenmektedir. Asitle temizleme yönetimi karmaşık parçalara kolay bir şekilde etki etmesi, işçilik ihtiyacının düşük olması, büyük hacimli işlerde hızlı sonuç sağlaması avantaj iken atık oluşumu ve asit buharının oluşması en önemli dezavantajıdır. Kumlama işleminde yüzey pürüzlülüğünün etkili olması, asit buharı gibi korozif ve zararlı bir gazın çıkmaması ve kimyasal kullanımının olmaması avantaj iken işçilik ve enerji maliyetinin yüksek olması ve toz oluşumu nedeniyle filtrasyon sisteminin olması dezavantajdır. Sıcak daldırma galvaniz öncesi yüzey temizleme yöntemi seçimi; üretim kapasitesi, parça geometrisi, yüzey durumu ve maliyet kriterlerine göre belirlenmelidir. Asitle temizleme yöntemi seri üretim ve karmaşık geometrili parçalar için avantaj sağlarken, kumlama yöntemi ağır paslı ve yüksek yüzey tutunması istenen uygulamalarda daha başarılı sonuçlar vermektedir.

Anahtar Kelimeler: Galvaniz, Asit, Temizleme, Kumlama, Asitle temizleme, Yüzey

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ORAL

Use of SAE4140 Material in Sucker Rod Production

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ÖZET

Türkiye'de üretimi bulunmayan ve yurtdışından temin edilmekte olan Petrol Kuyularında arama ve üretim faaliyetlerinde kullanılan 1 inç çapında ve Grade D kalitesinde "sucker rod ve kaplin" güç aktarım bağlantı parçalarını API 11B standardı çerçevesinde üretimi gerçekleştirilmektedir. Sucker Rod ve kaplinden oluşan mekanik bağlantı ve güç aktarım sistemi petrol arama ve üretim faaliyetlerinin aksamadan yürütülmesi için ihtiyaç duyulan sistemin kritik parçalardan biridir. Çalışma şartlarının ağır olması ve parça geometrisi sucker rodların tasarım ve üretim süreçlerinin her aşamasında Ar-Ge ve mühendislik çalışmalarını gerekli kılmaktadır. Parçanın kullanımı sırasında maruz kaldığı mekanik zor koşullara ek olarak korozyona sebep olabilecek birçok etken bir arada bulunmaktadır. Üretim aşamasının en önemli bölümü ürünü üretirken kullanılacak hammadde cinsinin belirlenmesidir. API 11B standartı sucker rod ürünleri için alaşımlı çelik kullanımını söylemektedir. SAE 41xx ile başlayan ürünleri kullanılması önermektedir. Kullanılan hammaddenin Cr, Ni, Mo alaşımlarının toplam alaşım içerisinde kullanımı minimum %1,15 olması gerekmektedir. Mekanik özellikler bakımında akma gerilmesinin minimum 586 Mpa, Çekme gerilmesinin minimum 793 Mpa olması gerekmektedir. Alaşımlı çeliklerde gerçekleştirdiğimiz araştırmalarda en uygun hammadde cinsinin SAE 4140 malzeme olduğu karar verilmiştir. SAE4140 malzemenin uygunlugu için bu hammadde üzerinde kimyasal analizi gerçekleştirilmiştir. Kimyasal analiz sonucunda Cr oranı %1,077 Mo oranı %0,174 Ni oranı da %0,059 olarak görülmüştür. Bu oranlar standartta belirtilen değerler arasındadır. Hammadde üzerinde gerçekleştirilen mekanik testlerde minimum çekme gerilmesinin 850-950 Mpa arasında olduğu görülmüştür. SAE41XX malzemelerinden; 4140(42CrMo4) kimyasal, mekaniksel ve metalografik kontroller yapılmış ve API standartları kriterlerini de karşıladığından dolayı bu malzemenin kullanıma karar verilmiştir. Sahada da denemesi yapılan Sucker Rod'lar, testlerden başarı ile geçmiştir.

Anahtar Kelimeler: Sucker Rod, Çekme, Malzeme, Alaşım, API 11B

Sucker Rod, Çekme, Malzeme, Alaşım, API 11B

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ORAL

Kalıp Tasarım İyileştirmesinin Üretim Performansına Etkileri

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ÖZET

Bu çalışmada, sıcak cıvata dövme prosesinde kullanılan üst kalıp tasarımının geliştirilmesi ve yeni tasarımın üretime sağladığı katkılar incelenmiştir. Çalışma, CD-06 sıcak dövme tezgahında kullanılan üst kalıpların kullanım ömrünü artırmak, kalıp tüketimini azaltmak ve üretim verimliliğini yükseltmek amacıyla gerçekleştirilmiştir. Mevcut üretim sisteminde kalıp kovanı C45 çelik malzemeden, matris ise 1.2367 sıcak iş takım çeliğinden üretilmektedir. Üst kalıp hazırlama sürecinde kovan iç çapı matrise göre dar toleranslı işlenmekte, ardından kovan şalama ile ısıtılarak matris kovana çakılmaktadır. Bu yöntemle hazırlanan kalıplarda ortalama kalıp ömrü yaklaşık 3500 adet seviyesinde kalmakta, kullanım ömrü sonunda ise hem matris hem de kovan hurdaya ayrılmaktadır. Ayrıca kalıp değişim süreleri, yüksek işçilik ihtiyacı ve üretim duruşları önemli proses kayıplarına neden olmaktadır.

Geliştirilen yeni tasarımda matris ve kovan yüzeyleri konik geçme geometrisine uygun şekilde işlenmiş, montaj işlemi ise ısıtma yöntemi yerine 100 tonluk hidrolik pres kullanılarak gerçekleştirilmiştir. Sistem stabilitesini artırmak amacıyla ayrıca flanş destekli mekanik kilitleme yapısı uygulanmıştır. Gerçekleştirilen saha uygulamalarında yeni tasarımın kalıp kullanım performansını önemli ölçüde iyileştirdiği belirlenmiştir. Son bir yıllık üretim verileri incelendiğinde toplam 90.324 adet üretim için mevcut sistemde 25 adet kovan ve matris tüketilirken, yeni kalıp sisteminde yalnızca 6 adet matris kullanıldığı tespit edilmiştir. Böylece kalıp tüketiminde yaklaşık %76 oranında azalma sağlanmıştır. Ayrıca yeni sistem ile kovanların tekrar kullanılabilir hale gelmesi sayesinde sarf maliyetleri, kalıphane işçilikleri ve kalıp değişimlerinden kaynaklanan duruş süreleri azaltılmıştır. Elde edilen sonuçlar doğrultusunda geliştirilen yeni üst kalıp tasarımının; üretim sürekliliği, maliyet optimizasyonu, enerji verimliliği ve sürdürülebilir üretim açısından sıcak dövme proseslerine uygulanabilir alternatif bir çözüm sunduğu değerlendirilmiştir.

Anahtar Kelimeler: Functional, Materials, Science, R-T

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POSTER

Temperature-Driven Phase Evolution in MnO_2 Nanostructures for Supercapacitor Applications

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ABSTRACT

This study explores the systematic control of phase evolution and morphological transitions in manganese dioxide (MnO_2) nanostructures for high performance solid state energy storage. MnO_2 samples were synthesized via a temperature controlled hydrothermal method at 110, 120, and 140 °C. Structural analysis revealed a critical phase transition from layered δ-MnO_2 to tunnel-structured α-MnO_2 with increasing reaction temperature, confirming that hydrothermal conditions govern the thermodynamic stability of specific MnO_2 polymorphs [1]. Scanning electron microscopy (SEM) identified a morphological shift from hierarchical nanoflowers to dense nanorod bundles. This transition significantly impacts the ion diffusion pathways and surface-to-volume ratio essential for pseudocapacitive charge storage [2]. Electrochemical assessments in a three-electrode method identified the 120 °C synthesized sample as the superior performer, yielding a specific capacitance of 118 F g^{-1} at 5 5 mV s^{-1}. To demonstrate practical utility, symmetric solid state supercapacitors integrated with a PVA/KOH gel electrolyte were fabricated. Recent advances in gel-electrolyte systems emphasize the importance of interfacial compatibility between hierarchical metal oxides and polymer matrices for stable wearable power sources [3]. The 110 °C based device exhibited a stable capacitance of 307 mF g^{-1} and remarkable electrochemical activation over 1,000 cycles. These findings demonstrate that precise phase engineering through temperature control is a key strategy for optimizing MnO_2 electrodes in the next generation of wearable and portable electronics.

Keywords: 2D materials, MnO_2, Hydrothermal, Supercapacitor, Nanoflower

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POSTER

Preparation and Characterization of PdCo Magnetic Alloy Nanoparticles

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ABSTRACT

Alloying noble metals with low-cost 3d metals (such as Fe, Co, Ni, Cu, etc.) is a successful method that modify structural properties, control magnetic properties, magnetoresistive sensor technology and data recording media [1]. In this study, Pd0.8 Co0.2 magnetic alloy nanoparticle (NP) were prepared by the modified polyol process and stabilized by polyvinylpyrrolidone capping agents, annealed at 160 ℃ for 1 h to form desired NPs [2]. We have a detailed investigation of structural and magnetic properties for Pd0.8 Co0.2 NPs. X-ray diffraction and Rietveld refinement analyses were performed to determine the crystal structure of PdCo NP, revealing a face-centered cubic structure with a space group of fm-3m and a crystallite size of 8 nm and lattice parameters are fm-3m a=b=c=4.0100 A°. The morphology of the PdCo NPs were determined using Scanning Electron Microscopy as spherical shape with an average particle size of 16.7 nm. The M–T measurements revealed the temperature dependence of magnetization and confirmed the magnetic ordering behavior of the Pd–Co NPs. Magnetic properties of the PdCo NP were determined as a function of temperature between 5 K and 300 K and applied field between ±5 T. The M–H curves indicate that the sample exhibits ferromagnetic behavior. From the analysis, the saturation magnetization, coercivity, and remanent magnetization values were obtained as 3.40 emu/g, 98.35 Oe, and 0.21 emu/g, respectively. These results indicate that the synthesized Pd–Co nanoparticles exhibit notable superparamagnetic properties.

Keywords: *PdCo NPs, XRD, Rietveld refinement, SEM, Magnetic properties*

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POSTER

Development and Application of a Machine Learning Pipeline for Automated Materials Discovery: A Study in ZnO Nanoribbons

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ABSTRACT

Automated data extraction from scientific literature is one of the primary strategies for building machine learning datasets in materials science . In this work, we present an end-to-end pipeline that combines literature mining, density functional theory (DFT) calculations, and a physics-constrained Graph Neural Network (GNN) to predict the Kondo temperature of transition metal-doped ZnO nanoribbons. The dataset construction began with structured extraction of Anderson impurity model parameters from published articles using two complementary approaches: MaterialBERT, a domain-specific language model pre-trained on materials science corpora, was employed for named entity recognition and parameter identification; and the Claude API was used to extract numerical data from PDF sources. This two-stage extraction pipeline allowed us to collect literature-derived seed data without manual transcription. These extracted values were complemented by first-principles DFT calculations performed using Quantum ESPRESSO 7.5 with PBEsol PAW pseudopotentials. The study covered nine transition metal dopants (Co, Cr, Cu, Fe, Nd, Ni, Sc, Ti, V) and four vacancy configurations (V_O, V_Zn, both, and none). To address dataset scarcity, we applied a Haldane-based physical parameter augmentation scheme within DFT-computed bounds, expanding the training set to 500 rows . We developed a custom directional message passing GNN inspired by DimeNet, which we call Lite-DimeNet. It encodes both interatomic distances and bond angles, adapted for ZnO supercell geometries. The model was trained with a physics-constrained loss function comprising three terms: MSE (Mean Square Error), a Kondo condition penalty, and a Haldane consistency term. Lite-DimeNet achieved $R^2 = 0.9978$ and MAE = 0.034 $\log_{10}(K)$ on the test set, substantially outperforming a gradient boosting baseline ($R^2 = 0.963$).

Keywords: *Machine Learning, Kondo Temperature, Graph Neural Network, Anderson Impurity Model, Density Functional Theory*

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4th International Conference on Functional Materials Science and Engineering

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POSTER

Computational Study of Pyrene and Hydroxypyrene Complexes with Porphyrin and Protoporphyrin

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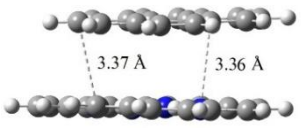
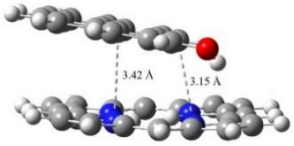
ABSTRACT

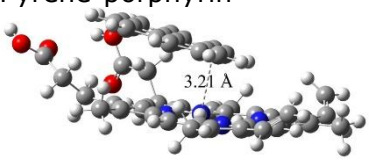
Porphyrins and their derivatives play important roles in living organisms and can form donor–acceptor complexes with PAHs due to their π-electronic systems. Because pyrene and porphyrins exhibit strong fluorescence, they are promising materials for biological probes and organic light-emitting diodes. In this study, the OH group of pyrene was substituted, and protoporphyrin was used instead of porphyrin to investigate charge-transfer complexes using quantum chemical methods. The results provide insights into the intermolecular charge-transfer properties of pyrene–protoporphyrin complexes, which are useful for the development of new organic light-emitting biomaterials. The ground states of all molecules and complexes were optimized using the ωB97X-D/6-31G(d,p) level of theory in Gaussian 09 [1]. Frequency analyses confirmed the stability of the optimized structures. Calculations were performed in vacuum and in solvents of varying polarity, and electronic absorption properties were examined using TD-DFT/B3LYP/6-31G(d,p).



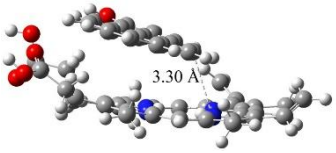
Pyrene-porphyrin



Hydroxypyrene-porphyrin



Pyrene-protoporphyrin



Hydroxypyrene-protoporphyrin

Molecules are in a face-to-face orientation in the minimum energy structure indicating the formation of a π-π complex. There is charge transfer from Py to Protoporphyrin by S0→S3 transition whereas charge transfer from PyOH occurs by S0→S1 transition. These results suggest that the PyOH–Porp complex forms at lower energy, making it a more suitable candidate for photosensitive material design.

Keywords: *Pyrene, Porphyrin, DFT, charge-transfer complexes*

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POSTER

Green Synthesis of PtNi Nanoparticles Using Rosemary Extract and Investigation of Their Catalytic Properties

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ABSTRACT

In fuel cells, hydrogen reacts with oxygen to produce electrical current and water-splitting is a more environmentally friendly option to obtain H2 and O2 gases [1]. Pt–Ni nanoparticles (NPs) exhibit high performance in hydrogen evolution reactions (HER) due to the high catalytic activity of Pt combined with the durability and low cost of Ni [2]. In this study, PtNi NPs were synthesized through a green synthesis approach by reducing Pt(acac)2 and Ni(acac)2 precursors using rosemary extract. The synthesis was carried out in a rosemary extract medium prepared with an 80% ethanol 20% deionized water mixture at ~82 °C for 48 hours, with an inert atmosphere maintained by argon gas during the initial 4 hours. The Raman spectrum exhibited characteristic peaks at 1460 cm-1 (CH2 bending), 1617 cm-1 (aromatic C=C stretching), and 2939 cm-1 (aliphatic C–H stretching), indicating the presence of bioactive compounds such as 1,8-cineole and rosmarinic acid in the rosemary extract. The XRD analysis of the PtNi NPs sample, characteristic peaks corresponding to the cubic (fcc) structure of both PtNi and PtO2 phases were observed for the PtNi NPs. SEM images revealed that the average particle size of the PtNi NPs was calculated to be ~9 nm. Electrocatalytic measurements revealed that the PtNi NPs are active in both HER and OER reactions. The onset potential and overpotential for HER were determined to be 79 mV (vs. RHE) and 174 mV, respectively, whereas for OER they were found to be 1.63 V and 1.83 V. Tafel analysis suggests that the PtNi NPs exhibit favorable reaction kinetics.

Keywords: *Green synthesis, PtNi nanoparticles, Electrocatalysis; Hydrogen evolution reaction (HER); Oxygen evolution reaction (OER).*

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POSTER

The Photocatalytic Role of Next-Generation Hybrid Systems in Organic Dyes Removal

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ABSTRACT

Synthetic azo dyes, such as Basic Red 18 (BR18), originating from the textile industry, cause pollution in aquatic ecosystems due to their low biodegradability and toxic and carcinogenic properties, posing serious threats to the environment and human health. To address this environmental issue, developing effective, sustainable, and readily applicable photocatalytic methods for dye removal is of great importance [1,2]. In this context, V_2AlC MAX phases are among the engineering materials that stand out in photocatalytic applications due to their high conductivity, chemical stability, and layered structure. However, in V_2AlC MAX phases used alone, the rapid recombination of photo-excited electron-hole pairs significantly limits the photocatalytic efficiency. In this study, a V_2AlC MAX@Bor nitride quantum dot (BNQD) hybrid photocatalyst was synthesized, and its effect on the degradation of BR18 dye was investigated. The V_2AlC MAX@BNQD hybrid has shown promise as a material for textile wastewater treatment, achieving a 95% dye removal rate in 120 minutes, an 88.7% removal efficiency under optimized conditions (1.5 g/L catalyst, 10 mg/L BR18), and good reusability (61% efficiency after 7 cycles).

Keywords: *MAX phase, Bor nitride quantum dot, dye removal, photocatalysis, hybrid photocatalyst*

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POSTER

Synthesis and Structural Characterization of Ni_2FeO_4 Nanoparticles Prepared by the Sol–Gel Method

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ABSTRACT

In this study, Ni2FeO4 nanoparticles were successfully synthesized using the sol–gel method followed by calcination and sintering processes to improve crystallinity and phase formation [1]. The structural and morphological properties of the synthesized samples were systematically investigated. X-ray diffraction (XRD) analysis confirmed the successful formation of the crystalline Ni2FeO4 structure without the appearance of noticeable secondary phases, indicating the high purity of the synthesized material. The diffraction peaks observed in the XRD patterns demonstrated good crystallinity and verified the successful development of the desired crystal structure after calcination and sintering treatments. Moreover, the relatively sharp diffraction peaks suggested that the heat-treatment processes significantly enhanced the structural ordering of the material. The surface morphology and particle size distribution were analyzed using scanning electron microscopy (SEM). SEM images revealed that the synthesized particles exhibited a relatively homogeneous distribution with slight agglomeration, which can be associated with the thermal treatment stages during synthesis. The average particle size was calculated from SEM micrographs using the ImageJ software and determined to be approximately 80 nm. The obtained nanoscale particle size indicates that the sol–gel synthesis route combined with calcination and sintering is effective for producing nanostructured Ni2FeO4 materials. Overall, the XRD and SEM results confirmed the successful synthesis of crystalline Ni2FeO4 nanoparticles with nanoscale dimensions and good structural properties. These findings suggest that the synthesized material may be a promising candidate for future catalytic, electrochemical, and functional material applications.

Keywords: *Ni2FeO4 NPs, Sol-gel method, XRD, SEM, Catalytic*

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POSTER

Polimer İnce Filmlerde Islatmama Kararsızlığı: Çözücü Buharı Tavlaması ve Termal Tavlama Yöntemlerinin Karşılaştırmalı Analizi

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ÖZET

Yirmi birinci yüzyılın küresel ekonomik sistemi içerisinde sahtecilik olgusu, giderek karmaşıklaşan tedarik zincirleri ve hızlanan dijitalleşme süreçlerinin etkisiyle yerel bir problem olmaktan çıkarak kritik bir ulusal güvenlik meselesine dönüşmüştür. Bu risklerin azaltılmasına yönelik geliştirilen yaklaşımlardan biri, polimerik ince filmlerin modifiye edilmiş silisyum altlıklar üzerindeki ıslanmama (dewetting) davranışlarının termal tavlama yöntemi ile kontrollü biçimde kullanılmasıdır [1]. Bu çalışma, özellikle Fiziksel Kopyalanamaz Fonksiyonlar (PUF) tabanlı yenilikçi sahtecilik önleme sistemleri için P2VP polimer filmlerinin PS-OH fırça katmanları üzerindeki morfolojik evrimini detaylandırmaktadır. Bu kapsamda, polimer zincir hareketliliğini tetikleyen termal tavlama (TA) ve çözücü buharı tavlaması (SVA) yöntemleri karşılaştırılmıştır. Termal tavlamada uygulanan yüksek sıcaklıklar, polimer-altlık arayüzündeki termal dalgalanmaları artırarak düzensiz, kontrol edilemeyen boşluklara ve termal bozunma riskine yol açmaktadır. Buna karşın SVA metodu, çözücü moleküllerinin polimer matrisine nüfuz etmesiyle efektif camsı geçiş sıcaklığını (Tg) oda sıcaklığının altına düşürür. Viskozitedeki bu azalma, P2VP zincirlerinin PS-OH altlık üzerinde kontrollü bir şekilde toparlanmasını ve yönlendirilmiş ıslatmama davranışı sergilemesini sağlar. Mikroskobik görüntü analizlerinden elde edilen d10, d50 ve d90 parçacık boyutu dağılım verileri, SVA işleminin termal tavlamaya kıyasla çok daha dar bir varyansla, homojen ve yüksek oranda tekrarlanabilir mikro damlacık dizilimleri ürettiğini kanıtlamaktadır. Sonuç olarak, SVA prosesinde çözücü buharı akışının aniden kesilmesiyle (quenching) stabilize edilen bu eşsiz morfolojik yapılar, yüksek rastgelesellik barındıran PUF etiketlerinin üretimi için optimum, düşük enerjili ve güvenilir bir platform sunmaktadır.

Anahtar Kelimeler: *Çözücü Buharı Tavlaması (SVA), Termal Tavlama, Islatmama Kararsızlığı (Dewetting), Polimer İnce Filmler, Mikro Yapı*

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4th International Conference on Functional Materials Science and Engineering

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POSTER

Lityum İyon Piller için Ti Katkılı NCM811 Katot Malzemelerin Katı-hal Sentez Yöntemi ile Üretimi ve Karakterizasyonu

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ABSTRACT

Enerji depolama aracı olarak Lityum iyon piller (LİP'ler), tüketici elektroniği ve elektrikli araçlar için giderek daha yaygın hale gelmiştir. LİP'lerin enerji yoğunluğunu ve döngü performansını iyileştirmek için çeşitli katot malzemeler üzerinde araştırmalar devam etmektedir. Yüksek performanslı LİP'ler için katot malzemelerinin, yüksek enerji yoğunluğu ve gücü, mükemmel çevrim ömrü, yüksek güvenlik ve düşük maliyet sağlaması gerekmektedir. LiNi0.8Co0.1Mn0.1O2 (NCM811) katotlar, LİP teknolojisinde "yüksek enerji yoğunluğu" ile "maliyet etkinliği" arasındaki en optimize noktayı temsil eden, literatürde ve endüstride devrim yaratmış en güçlü adaylarından biridir [1]. Ancak, çevrim sırasında yaşanan yapısal kararsızlık, katyon karışımı, elektrolit ile olan arayüzey reaksiyonları ve sonuçta hızlı kapasite kaybı bu malzemenin ticari ömrünü kısıtlamaktadır. Bu zorlukların üstesinden gelmek için, bu malzemelerin performansını iyileştirmek amacıyla katyonların kafes dopingi (katkılaması) benimsenmiştir. Bilhassa Titanyum (Ti) katkılaması, kristal yapıyı stabilize eden "sütun (pillar) etkisi" ve yüzey koruma potansiyeli ile öne çıkmaktadır [2,3]. Bu çalışmada, katı-hal sentez yöntemi ile katkısız ve Ti katkılı NCM811 katot malzemeleri sentezlenmiştir. Üretilen saf ve Ti katkılı NCM811 katot malzemelerin yapısal ve elektrokimyasal özellikleri karşılaştırmalı olarak incelenmiştir.

Keywords: *Lityum İyon Piller, NCM Katot, Ti katkılama, Katıhal Sentez*

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POSTER

External Electric Field Effects on H_2O Adsorption in ZIF-90: An Ab-Initio Investigation

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ABSTRACT

Metal–Organic Frameworks (MOFs), which belong to the class of nanoporous materials, play a critical role in a wide range of engineering applications such as catalysis, biotechnology, controlled drug delivery, gas separation and purification, microelectronics, and sensor technologies [3]. Through smart material design strategies, the efficiency and selectivity capacities of these materials in engineering processes can be significantly enhanced. Recent theoretical and experimental findings in the literature have demonstrated that an externally applied electric field, acting as an external stimulus, can induce controlled and reversible structural changes in MOF structures. ZIF-90, introduced to the literature by Morris et al. [4], is a zeolitic imidazolate framework crystallized through the coordination of Zn^{2+} ions with 2-carboxaldehyde-imidazole ligands. With a specific surface area of 1270 m^2/g and a homogeneous pore size distribution ranging from 3.5 Å to 11.2 Å, ZIF-90 is considered an ideal candidate for gas adsorption and diffusion-based processes [1]. The most distinctive feature that differentiates ZIF-90 from the widely studied ZIF-8 in the literature is its imidazole-2-carboxaldehyde (ICA) linker. The aldehyde (-CHO) functional groups present on this linker act as polar centers capable of forming hydrogen-bond interactions with water molecules, thereby imparting a pronounced hydrophilic character to the framework. Molecular simulations and experimental data have confirmed that, owing to this polarity, ZIF-90 possesses a remarkable water uptake capacity even under low relative humidity conditions [1,2,4,5,6,7]. In the literature, the effects of external electric fields on MOF structures have been investigated only within a limited scope, and no comprehensive study has yet been reported that analyzes the electric field-material response in the presence of adsorbed molecules using quantum mechanical methods. Within the scope of this study, dynamic and reversible structural changes occurring in the ZIF-90 framework under the influence of an external electric field and a chemical stimulus (H_2O), such as ligand rotation, were theoretically investigated through ab initio Molecular Dynamics (AIMD), Density Functional Theory (DFT), and Grand Canonical Monte Carlo (GCMC) simulations. The originality of this work arises from the simultaneous consideration of H_2O adsorption, characterized by its high dipole moment, together with the self-consistent incorporation of the external electric field into the simulations which represents a first in the literature. This research was supported within the scope of the TÜBİTAK-1001 project (Project No: 124Z002) led by Prof. Dr. Yeliz Gurdal, and all calculations were carried out using the infrastructure of the TRUBA High Performance Computing Center. Dr. F. Hayal Geçit is supported under the YÖK Postdoctoral Researcher Employment (DOSAİ) Program.

Keywords: *Ab initio Molecular Dynamics, Grand Canonical Monte Carlo, Metal Organic Frameworks, Density Functional Theory.*

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POSTER

Evaluating the Reliability of Automated MOF Databases: A Comparative Study of Structural Integrity and Adsorption Performance

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ABSTRACT

The emergence of databases such as "Mosaec" [1] promised to accelerate Metal-Organic Framework (MOF) research by providing computationally ready structures. However, utility of these repositories is often limited by substantial structural inaccuracies, including missing ligands, incomplete framework components, and unassigned occupancy percentages, etc. In this work, we present a comparative analysis between these automated, ready to use structures and manually refined models derived from Cambridge Crystallographic Data Centre, the Cambridge Structural Database [2]. Our refinement workflow involved rigorous manual configuration, including the creation of multiple occupancy structures and meticulous cleaning of solvent structures. To assess the structural stability of these frameworks, Density Functional Theory (DFT) calculations were performed using the CP2K package, and it was verified whether the proposed structures maintained their structural integrity. Furthermore, using proposed structures, the adsorption performances were evaluated for CO2, H2S, Xe, and CH4 through Grand Canonical Monte Carlo (GCMC) simulations implemented in RASPA simulation package. Our results show that errors or simplifications in automatically generated structural databases can significantly reduce the reliability of computational predictions of gas adsorption properties.

Keywords: *Metal-Organic Frameworks (MOFs), Mosaec, DFT, GCMC, Gas Adsorption*

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POSTER

Metal-Organic Framework Embedded Cryogels: Preparation and Characterization

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ABSTRACT

Metal–organic frameworks (MOFs), also known as porous coordination polymers, are an emerging class of materials characterized by tunable pore size and structure, high porosity, and versatile functionality through the modification of organic linkers. Owing to these unique properties, MOFs have attracted considerable attention for applications such as water treatment, drug delivery, sensing, gas separation, energy storage, catalysis, biomedicine, environmental remediation, adsorption, tissue engineering, and antimicrobial applications. Gels are three-dimensional polymeric networks capable of retaining large amounts of liquid within their structure. Hydrogels, in particular, consist of hydrophilic polymer networks swollen with water. However, conventional hydrogels often lack the interconnected macroporosity and mechanical elasticity required for advanced biomedical applications. To address these limitations, cryogels have been developed. Cryogels are synthesized at subzero temperatures and exhibit highly interconnected supermacroporous structures with enhanced mechanical properties. Due to these advantages, cryogels have found increasing applications in biomedical and biotechnological fields, including controlled drug delivery, cell immobilization, bioseparation, purification, and wound healing. In the present study, a calcium–zinc (Ca–Zn) MOF structure was synthesized and characterized using X-ray diffraction (XRD) and scanning electron microscopy (SEM). The XRD patterns confirmed that the synthesized MOF exhibited high crystallinity. Furthermore, the Ca–Zn MOF was successfully integrated into a poly(vinyl alcohol)/gelatin/chitosan cryogel matrix. In conclusion, a novel cryogel scaffold embedded with Ca–Zn MOF particles was developed, showing promising potential for advanced biomedical applications.

Keywords: *Metal–organic framework, Biomaterial, Scaffold, Cryogel, Characterization*

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POSTER

H_2S Adsorption and Diffusion Potentials of Zeolites Investigated Through Molecular Simulations

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ABSTRACT

Biogas is an important renewable energy source, but it contains hydrogen sulfide (H2S), which is a very toxic and corrosive gas. This impurity should be removed to prevent corrosion in pipelines and catalyst poisoning in industrial systems. In this study, H2S adsorption and diffusion performances of 21 zeolite structures were evaluated using Grand Canonical Monte Carlo (GCMC) and Molecular Dynamics (MD) simulations implemented in the RASPA simulation package. To correctly model the electrostatic interactions between the zeolite framework and polar H2S molecules, partial atomic charges were assigned using DDEC charges. Adsorption and diffusion simulations were performed at 298 K and 1 bar conditions. Thermodynamic adsorption capacities were calculated using GCMC simulations, while MD simulations were used to calculate the self-diffusion coefficients of the H2S molecules to understand their kinetic behaviors. The results showed a structural trade-off among the 21 zeolites. Zeolites with large 1D channels, like AEL, showed fast diffusion rates but lower adsorption capacities. The BEA framework, on the other hand, showed the best balance with an adsorption capacity (21.15 molecules/unit cell) and diffusion mobility. In conclusion, the BEA and AEL zeolites were identified as the potential solid membranes for H2S removal through adsorption and diffusion.

Keywords: *Hydrogen Sulfide, Zeolite, Grand Canonical Monte Carlo, Molecular Dynamics*

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POSTER

Green Synthesis of PdCo Nanoparticles Using Olive Leaves Extract: Investigation of Structural and Catalytic Properties

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ABSTRACT

Hydrogen technology stands out as one of the most promising future energy solutions due to its zero carbon emissions and capacity to enable cleaner, more efficient energy systems while reducing fossil fuel dependence. In this context, the development of environmentally friendly and low-cost electrocatalysts is of great importance. This study aims to produce monometallic palladium (Pd) and bimetallic palladium–cobalt (PdCo) nanoparticles (NPs) via a green synthesis approach and to investigate their structural features and electrocatalytic performance toward the hydrogen evolution reaction (HER). Olive leaves were dried and boiled at ~45 °C in ethanol for 5 hours to obtain an extract containing Olea europaea compounds, which served as both reducing and stabilizing agent for $Pd(acac)_2$ and a Pd–Co precursor mixture in the synthesis of Pd and $Pd_{50}Co_{50}$ NPs, respectively. X-ray diffraction (XRD) analysis revealed that the Pd NPs exhibit a face-centered cubic (fcc) structure belonging to the Fm-3m space group; scanning electron microscopy (SEM) indicated an average particle size of ~35 nm, and energy-dispersive X-ray spectroscopy (EDS) confirmed the absence of impurities. In contrast, the $Pd_{50}Co_{50}$ NPs did not display distinct crystalline reflections in their XRD patterns, indicating an amorphous structure under the same conditions. The electrocatalytic activity of both samples toward HER was evaluated by cyclic voltammetry (CV), linear sweep voltammetry (LSV), and Tafel analysis. The fcc-structured Pd NPs exhibited measurable HER activity, while the amorphous PdCo system showed comparatively limited performance. These results demonstrate that olive-leaf-mediated green synthesis is a viable route for producing high-purity Pd NPs with potential applications in hydrogen technologies, whereas bimetallic Pd–Co systems require further optimization to achieve the desired crystalline phase and catalytic performance.

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POSTER

Experimental Investigation of CFRP-Aluminum Single-Lap Joints (SLJ) Bonded with Structural Epoxy and Mechanical Joints

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ABSTRACT

n modern aerospace structures, the integration of composite materials with metallic components is playing an increasingly critical role due to weight optimization and high-strength requirements. This study experimentally investigates two different joining approaches for carbon fiber reinforced polymer (CFRP) composites and aluminum alloy (2024-T3) plates: adhesively bonded single-lap joints (SLJs) and conventional mechanically riveted joints. For the adhesively bonded specimens, a two-component, room-temperature-curing structural epoxy adhesive (Araldite 2015) with high toughness was selected. To improve adhesion quality, wettability, and mechanical interlocking at the interface, a rigorous "Degrease–Abrade–Degrease" surface preparation protocol was applied. Following full room-temperature curing, tensile tests were conducted at a constant quasi-static crosshead speed of 0.05 mm/min. Experimental results revealed that the adhesive bonding method demonstrated higher joint strength and apparent structural stiffness than the riveted joints, owing to the more continuous load-transfer path provided by the adhesive layer. The nominal joint strength of the adhesively bonded configuration was measured as 41.745 MPa, with an apparent elastic modulus of 7.168 GPa, whereas the riveted specimens exhibited a nominal joint strength of 32 MPa and an apparent elastic modulus of 2 GPa. Accordingly, the apparent stiffness of the riveted joints was approximately 72.1% lower than that of the adhesively bonded joints. This lower apparent stiffness was attributed to bearing deformation, local compliance, and clearance take-up in the mechanically fastened joints. Furthermore, the lower nominal strength of the riveted configuration was associated with local stress concentrations and the reduction in the effective net cross-sectional area. Macroscopic failure-mode observations indicated that the adhesively bonded specimens predominantly exhibited failure characteristics consistent with cohesive failure. Overall, the results indicate that structural adhesive bonding can provide strength, stiffness, and potential weight advantages over mechanical riveting for the investigated CFRP–aluminum joint configuration. These findings may contribute to the design and evaluation of lightweight UAV structures and composite–metal repair applications.

Keywords: *CFRP-Aluminum Hybrid Structures, Cohesive Failure, Mechanical Fastening, Single-Lap Joint (SLJ), Structural Adhesives,*

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POSTER

Annealing Effect on Nanorod CdTe Thin Films Deposited by CBD on ITO Substrates

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ABSTRACT

Cadmium telluride (CdTe) is a II–VI group semiconductor with a high optical absorption coefficient (>104 cm-1) and a direct band gap of approximately 1.45 eV, making it a promising material for photovoltaic and optoelectronic applications. In this study, CdTe thin films were deposited on three separate ITO substrates using the chemical bath deposition (CBD) method, which is a simple and cost-effective technique. One sample was kept as-deposited, while the other two were annealed at 150°C and 250°C, respectively. The morphological properties of the CdTe films were investigated by scanning electron microscopy (SEM), and the SEM images showed that the films had a nanorod structure. The optical band gap of the nanorod CdTe films was determined by UV-visible spectrophotometry. X-ray diffraction (XRD) analysis was performed to identify the crystal structure of the CdTe films. The as-deposited and annealed CdTe films exhibited a polycrystalline structure. Hall effect measurements provided detailed information on the conductivity type, carrier concentration, and electrical conductivity of the CdTe films.

Keywords: *CdTe, nanorods, thin-film solar cells, chemical bath deposition, characterization.*

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POSTER

Solution Combustion Synthesis of Alkaline Earth Borate Phosphors for Dosimetric Applications

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ABSTRACT

In this study, boron-based MgB_4O_7, SrB_4O_7, BaB_4O_7, and CaB_4O_7 materials were synthesized using the solution combustion synthesis method, and their radiation dosimetry potential was investigated. The structural properties of the synthesized materials were examined using X-ray diffraction (XRD), their morphological properties using scanning electron microscopy (SEM), and their elemental compositions using energy dispersive X-ray spectroscopy (EDS). The results showed that the target borate phases were successfully synthesized and the prepared samples exhibited characteristic structural/morphological properties. The luminescence behaviour of the materials was evaluated using thermoluminescence (TL) and optically stimulated luminescence (OSL) techniques. When comparing MgB_4O_7, SrB_4O_7, BaB_4O_7, and CaB_4O_7 samples, it was determined that CaB_4O_7 ceramics offered more promising and improvable TL/OSL signals. Therefore, the CaB_4O_7 system was considered a priority candidate material for subsequent optimization studies. To investigate the effect of the fuel/oxidizer ratio used in solution combustion synthesis on luminescence properties, CaB_4O_7 samples were prepared at different urea/boric acid ratios. The obtained TL and OSL results revealed that the synthesis parameters had a significant effect on the trap structure and luminescence yield. In particular, it was observed that samples synthesized under a 1:2 urea/boric acid ratio gave higher and more stable luminescence signals, and also exhibited improvements in physical integrity and morphological properties in pellet form. Overall, this study demonstrates that boron-based materials produced by solution combustion synthesis can be evaluated in terms of TL/OSL dosimetry applications. The findings reveal that CaB_4O_7-based systems, in particular, possess improved luminescence performance with appropriate synthesis parameters and can be considered among promising candidate materials in the field of radiation dosimetry.

Keywords: *Calcium borates, Solution Combustion Synthesis, Fuel/oxidizer ratio, Thermoluminescence, Optically Stimulated Luminescence*

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POSTER

Non-Covalent Phthalocyanine/PCN Hybrids for CO_2 Reduction

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ABSTRACT

Phthalocyanines (Pcs) and related compounds play a crucial role in the development of artificial photosynthetic systems, such as photocatalytic CO2 reduction and H2 production, by mimicking the light-harvesting and charge-separation functions essential for photoinduced charge separation and electron transfer events.1 Their excellent thermal and photochemical stability, strong absorption in the visible and near-infrared regions, and remarkable synthetic versatility make Pcs ideal components for constructing composite catalysts in photocatalytic reactions. As a result, Pc derivatives have been widely used in the photocatalytic and electrochemical reduction of CO2, primarily as catalysts and/or photosensitizers. Herein, we report a simple and efficient self-assembled photocatalytic system composed of PCN as the photo-absorber and tetracationic, non-noble MPc-Im (M = Fe, Co) as catalysts for the photocatalytic reduction of CO2. To enhance water solubility and facilitate interaction with the PCN surface, the Fe and CoPcs were functionalized with cationic imidazolium rings, which can provide π–π stacking and electrostatic interactions with the semiconductor support.2 To ensure the catalytic activity of the MPc-Im for CO2reduction, cyclic voltammetry (CV) measurements were conducted.In summary, we successfully demonstrated CO2 reduction into CO with ≥70% selectivity using cationic imidazolium-functionalized Fe(II) and Co(II) phthalocyanine complexes, which were non-covalently bound on the surface of polymeric carbon nitride. Importantly, CO2-to-CH4 conversion was confirmed by means of isotope tracer experiments with 13CO2.

Keywords: *Phthalocyanines, light-harvesting, CO2 reduction.*

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POSTER

Structural, morphological and luminescence properties of Ag-doped SrSiO3 ceramics

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ABSTRACT

This study investigated the structural, morphological, and luminescence properties of Ag-doped SrSiO3 ceramics developed by solid-state synthesis. X-ray diffraction (XRD) analyses revealed that the synthesized samples showed high compatibility with the SrSiO3 reference phase and that the target phase was successfully obtained. SEM images and EDS analyses showed that the prepared pellet samples had a compact and relatively void-free morphology, and that the Ag doping was successfully incorporated into the ceramic structure. The luminescence properties of the samples were investigated using thermoluminescence (TL) and optically stimulated luminescence (OSL) techniques. In the TL glow curves recorded after a 1 Gy beta dose, five distinct peaks were observed at approximately 100, 150, 200, 250, and 350 °C. In OSL measurements, it was determined that the signal reached the background level in approximately 50 seconds under blue light stimulation. TL measurements performed after OSL showed that the observed TL traps were sensitive to optical stimulation and could be significantly discharged by light. Dosimetric investigations revealed that Ag-doped SrSiO3 ceramics exhibited promising properties in terms of reusability, linear dose response, and optically sensitive trap structure. These findings indicate that this material is a potential candidate for various radiation dosimetry applications, particularly retrospective dosimetry.

Keywords: *Strontium silicates, Silver doping, Solid state synthesis, Thermoluminescence, Optically Stimulated Luminescence*

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POSTER

Sürdürülebilir EPDM Kompozitler İçin Endüstriyel Atıkların Değerlendirilmesi: Silika ve Atık Cüruf

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ÖZET

Otomotiv, yapı ve sızdırmazlık uygulamalarında yaygın olarak tercih edilen Etilen propilen dien monomer (EPDM) kauçuğu, üstün kimyasal, ozon ve hava koşullarına dayanıma sahip bir elastomer türüdür. EPDM kauçuğun mekanik ve fiziksel özelliklerini geliştirmek ve kullanım alanlarını artırma amacıyla geleneksel olarak karbon siyahı ve silika (SiO_2) gibi dolgu maddeleri ilave edilmektedir. Ancak son yıllarda artan çevresel kaygılar, maliyet baskıları ve ekonomik yaklaşımlar doğrultusunda endüstriyel atıkların alternatif dolgu maddesi olarak değerlendirilmesine yönelik çalışmalar hız kazanmıştır. Metalurjik proseslerin bir yan ürünü olan atık cüruf, yüksek sertliği ve mineralojik yapısı sayesinde EPDM kompozitleri için sürdürülebilir ve ekonomik bir alternatif olarak öne çıkmaktadır [1-4]. Bu çalışmada, EPDM esaslı kompozitlere 50phr silika (SiO_2) ve 20phr atık cüruf ilavesinin reolojik ve fiziksel özellikler üzerindeki etkisi deneysel olarak incelenmiştir. 50phr silika ilavesi, ML değerini 1'den 1,16'ya ve MH değerini ise 11,08'den 11,81'e yükselterek çapraz bağ yoğunluğunu artırmış, aynı zamanda kürlenme sürelerini azaltarak daha hızlı bir vulkanizasyon davranışı sağlamıştır. Silika (SiO_2) ve atık cüruf ilavesi ile Mooney viskozite, sertlik (1,038→1,166 g/cm³) ve yoğunluk (58→63 Shore A) değerleri artmıştır. Yağ dayanımı açısından silika katkısı en iyi performansı gösterirken, silika ve atık cüruf ilavesine bağlı olarak yağ dayanımlarının geliştiği belirlenmiştir. Elde edilen bulgular, atık cürufun EPDM kompozitlerde kısmi dolgu olarak kullanılabileceğini ve sürdürülebilir, ekonomik bir alternatif sunduğunu ortaya koymaktadır.

Anahtar Kelimeler: *Silika, Atık cüruf, EPDM, Yanmazlık, Sürdürülebilirlik*

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POSTER

Mikronize Cam Elyaf (GF) ve Karbon Elyaf (CF) Takviyeli EPDM Kompozitlerin Üretimi ve Performans Analizi

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ÖZET

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EPDM kauçuğu genel olarak ana zincirin doymuş yapıda olması sebebiyle ultraviyole ışınları, ozon, oksijen gibi bozucu etkilere karşı yüksek dolgu ve yağ alabilme özelliği ve dayanım ile düşük maliyetli karışımlar oluşturabilme, sulu ve konsantre asit ve alkalilere karşı yüksek dayanım, düşük yoğunluk nedeniyle hafif malzemeler üretilebilmesi ve iyi dielektrik özellikleri nedeniyle conta, hortum, konveyör kayışları, cam fitili gibi çok geniş uygulama alanına sahip bir kauçuk türüdür [1-2]. Ancak, zayıf dinamik ve mekanik özelliklere sahip olması ve 130 °C gibi sıcaklıklarda kullanım alanı bulması spesifik uygulamalarda EPDM kauçuğunun kullanımını sınırlamaktadır [3]. Bu çalışmada, EPDM esaslı kompozitlerin mekanik ve reolojik özellikleri üzerine cam elyaf (GF) ve karbon elyaf (CF) katkılarının etkisi incelenmiştir. 1.5 lt'lik laboratuvar tipi mini banbury kullanılarak üretilen EPDM/CF ve EPDM/GF kompozitleri 180°C'de 20 dakika süre ile preslenerek vulkanize dilmiş ve standartlara uygun deney plakaları elde edilmiştir. Reoloji ve viskozite özellikleri ön sıkıştırma reometrisi (MDR) ve Mooney viskozite testleri ile fiziksel özellikler ise yoğunluk ve Shore A sertlik testleri ile belirlenmiştir. Reoloji testleri sonucunda GF ve CF ilavesi ile minimum tork ve maksimum tork arterken kürlenme sürelerinin etkilenmediği belirlenmiştir. Yağ dayanım testlerinde ise her iki elyaf katkısının da şişme oranlarını azalttığı, özellikle karbon elyaf katkılı EPDM kompozitin her iki yağ türünde de en düşük değişim değerlerini (P1923: 54,66 ve N418: 87,11) göstererek en yüksek yağ direncine sahip olduğu belirlenmiştir. Sonuç olarak, cam elyaf katkısı dengeli bir performans sunarken, karbon elyaf katkısı daha yüksek sertlik ve üstün yağ dayanımı sağlayarak EPDM kompozitlerin performansını önemli ölçüde iyileştirmektedir.

Anahtar Kelimeler: *Cam elyaf, Karbon elyaf EPDM, Reoloji, Mekanik Özellikler*

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POSTER

Seramik Esaslı Mineral Dolguların EPDM Kauçuğunun Özelliklerine Etkisi

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ÖZET

Etilen propilen dien monomer (EPDM) kauçuğu, üstün hava koşullarına, ozon ve kimyasal etkilere karşı direnci nedeniyle otomotiv, sızdırmazlık ve dış ortam uygulamalarında yaygın olarak kullanılan önemli bir elastomerdir. EPDM kauçuğun performansı, ilave edilen dolgu ve katkı maddeleri ile büyük oranda iyileştirilebilmektedir. Geleneksel olarak karbon siyahı ve silika (SiO_2) gibi takviye edici dolgu maddeleri, mekanik dayanım, aşınma direnci ve sertlik gibi özellikleri artırmak amacıyla kullanılmaktadır. Bununla birlikte, son yıllarda sürdürülebilirlik, maliyet ve performans optimizasyonu gereksinimleri doğrultusunda alternatif dolgu maddelerine yönelik çalışmalar artmıştır. Yüksek sıcaklık dayanımı, sertlik ve kimyasal kararlılığı ile bilinen seramik esaslı bir malzeme olan müllit ($3Al_2O_3 \cdot 2SiO_2$), EPDM kompozitleri için potansiyel bir alternatif katkı olarak öne çıkmaktadır [1-3]. Bu çalışmada, EPDM esaslı kompozitlere SiO_2 ve müllit (M) katkılarının etkisi deneysel olarak incelenmiştir. Saf EPDM'ye kıyasla 20phr SiO_2 ilavesi ML değerini 2,79'dan 3,2'ye ve MH değerini 19,16'dan 22,72'ye yükselterek çapraz bağ yoğunluğunu artırmış, Ts_2 süresini 0,32'den 0,29'a düşürerek daha hızlı kürlenme davranışı sağlamıştır. %20 müllit içeren kompozitte ise MH değeri (22,21) silika ile benzer seviyede gerçekleşirken, ML değerinin 2,69 olması işlenebilirliğin daha iyi olduğunu göstermiştir. Mooney viskozitesi silika katkısıyla 133,3 MU'ya yükselirken, müllit katkısında 125,6 MU elde edilmiştir. Dolgu ilavesi yoğunluk (1,054→1,128 g/cm³) ve sertlik (67→71 Shore A) değerlerinde artışa neden olmuştur. Genel olarak silika katkısı daha yüksek mekanik ve reolojik performans sağlarken, müllit katkısı daha düşük viskozite ile işlenebilirliği iyileştiren alternatif bir dolgu olarak öne çıkmaktadır.

Anahtar Kelimeler: *SiO2, Müllit, EPDM, Sürdürülebilirlik*

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POSTER

Farklı Tanecik Boyutundaki Karbon Siyahlarının Fiziksel ve Mekanik Özelliklere Etkisinin İncelenmesi

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ÖZET

Bu çalışmada, farklı yapı ve spesifik yüzey alanına sahip karbon siyahı türlerinin EPDM esaslı kauçuk kompozitlerin fiziksel, mekanik ve reolojik özellikleri üzerindeki etkileri incelenmiştir. Literatürde ASTM sınıflandırmasına göre N220 karbon siyahı yüksek yüzey alanına sahip, küçük tanecik boyutlu (yaklaşık 20–25 nm), N339 karbon siyahı orta düzeyde yüzey alanlı ve orta boyutlu (yaklaşık 26–30 nm) ve N550 karbon siyahı ise daha düşük yüzey alanına sahip, daha büyük tanecik boyutlu (yaklaşık 40–50 nm) dolgu olarak tanımlanmaktadır. Üç farklı karbon siyahı tipi ağırlıkça %25 oranında kullanılarak EPDM esaslı kompozit reçeteler hazırlanmış ve sertlik, çekme dayanımı, kopma uzaması, aşınma direnci, yoğunluk, Mooney viskozitesi ve kür karakteristikleri gibi temel performans parametreleri değerlendirilmiştir. Elde edilen bulgular, karbon siyahının spesifik yüzey alanı ve yapı özelliklerinin kompozit performansı üzerinde belirleyici olduğunu ortaya koymuştur [1-3]. Küçük tanecik boyutuna ve yüksek yüzey alanına sahip N220 karbon siyahı, kauçuk matrisi ile daha güçlü ara yüzey etkileşimleri ve daha etkin yük transferi sağlayarak çekme dayanımı ve aşınma direnci gibi mekanik özelliklerde belirgin iyileşme göstermiştir. Buna karşın, daha büyük tanecik boyutlu ve düşük yüzey alanlı N550 karbon siyahı, zincir hareketliliğini daha az kısıtlaması nedeniyle karışımın işlenebilirliğini artırmış ancak mekanik özelliklerin azalmasına neden olmuştur. Yüksek yüzey alanına sahip karbon siyahlarının, hızlandırıcı ve kükürt sistemi ile daha fazla etkileşime girerek kür hızını artırdığı buna karşılık daha düşük yüzey alanlı karbon siyahlarının daha uzun kür sürelerine yol açtığı gözlemlenmiştir.

Anahtar Kelimeler: *Karbon siyahı, EPDM, Fiziksel özellikler, Reoloji*

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CHAPTER 2

FULL PAPER PROCEEDINGS

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FULL PAPER

Evaluation of the Carbon Emission Reduction Potential of a MOF-Based Modular Exhaust Cartridge Approach in Tactical Wheeled Vehicles

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ABSTRACT

Reducing exhaust-based CO_2 emissions in heavy commercial and tactical wheeled vehicles has become increasingly important in line with sustainable transportation policies and low-carbon targets. In this study, the CO_2 adsorption performance of iron-based metal-organic frameworks was evaluated, and a conceptual MOF-based modular exhaust cartridge approach was examined for tactical wheeled vehicles manufactured by Koluman Otomotiv Endüstri A.Ş.

Within the scope of the study, MOF-235(Fe), Nano MOF-235(Fe), NH_2-MOF-235(Fe), and Nano NH_2-MOF-235(Fe) structures were synthesized and characterized using SEM, EDX, DLS, XRD, FT-IR, TGA, BET surface area, and CO_2 adsorption analyses. The BET surface areas of MOF-235(Fe), Nano MOF-235(Fe), NH_2-MOF-235(Fe), and Nano NH_2-MOF-235(Fe) were determined as 1026, 1433, 478, and 712 m^2/g, respectively. The highest CO_2 adsorption performance was obtained from the Nano NH_2-MOF-235(Fe) sample, with adsorption capacities of 5.03 mmol/g at 25 °C and 6.43 mmol/g at 0 °C. The results indicate that nanoscale structuring and amine functionalization improve CO_2 adsorption performance.

Based on these findings, the use of Nano NH_2-MOF-235(Fe) in a replaceable cartridge structure integrated into the final/cooled section of the exhaust line was conceptually evaluated. In the proposed approach, exhaust gas passes through a cartridge containing MOF filler material, enabling partial retention of CO_2 within the porous structure. TGA results show that the NH_2-MOF-235(Fe) structure maintains thermal stability up to approximately 400 °C. This provides an important advantage for feasibility when the cartridge is positioned in a suitable temperature region of the exhaust line. Although this study does not include on-vehicle validation, it presents a conceptual preliminary feasibility approach for evaluating MOF-based adsorbents in post-exhaust carbon capture applications for tactical wheeled vehicles.

Keywords: *MOF, CO2 Adsorptıon, Carbon Capture, Modular Exhaust Cartrıdge, Tactıcal Wheeled Vehıcles*

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1. INTRODUCTION

CO_2 released into the atmosphere due to fossil fuel consumption is one of the important greenhouse gases associated with global warming and climate change. Carbon capture applications for reducing CO_2 emissions have increasingly been investigated for industrial systems and energy-intensive processes [1]. Heavy commercial and tactical wheeled vehicles are platforms that should be evaluated separately in terms of exhaust-based emission reduction due to their high engine power and demanding mission profiles.

Existing exhaust systems are generally designed to reduce particulate matter, NOx, and harmful gas emissions. However, modular, replaceable, and applicable on-board system approaches for post-exhaust CO_2 capture are still limited. Therefore, material-based carbon capture approaches that can be integrated into the exhaust line, provide maintenance convenience, and allow reuse are needed.

Metal-organic frameworks (MOFs) are crystalline and porous structures formed by metal ions and organic linkers. These materials are considered strong candidates for gas adsorption and separation applications due to their high surface area, adjustable pore size, and tunable surface chemistry [2]. The ability of MOF structures to be designed according to the application area through synthesis parameters and functional groups makes these materials important for carbon capture studies [3].

High surface area alone is not sufficient for CO_2 adsorption. Pore diameter, micropore volume, surface chemistry, functional groups, and operating temperature are also decisive parameters affecting adsorption capacity [2]. Since CO_2 is an acidic gas, it is known that basic surfaces functionalized with amine groups can increase electrostatic interaction with CO_2 [4]. Therefore, amine functionalization is an important approach in MOF-based CO_2 adsorption studies.

In this study, based on the CO_2 adsorption data of previously synthesized and characterized iron-based MOF-235(Fe) structures, the usability of these materials for post-exhaust carbon capture in tactical wheeled vehicles was conceptually evaluated. The main aim of the study is to propose a modular and replaceable exhaust cartridge approach that can be adapted to tactical wheeled vehicles manufactured by Koluman Otomotiv Endüstri A.Ş., considering the CO_2 retention performance of Nano NH_2-MOF-235(Fe). The general workflow and proposed system logic are presented in Figure 1.

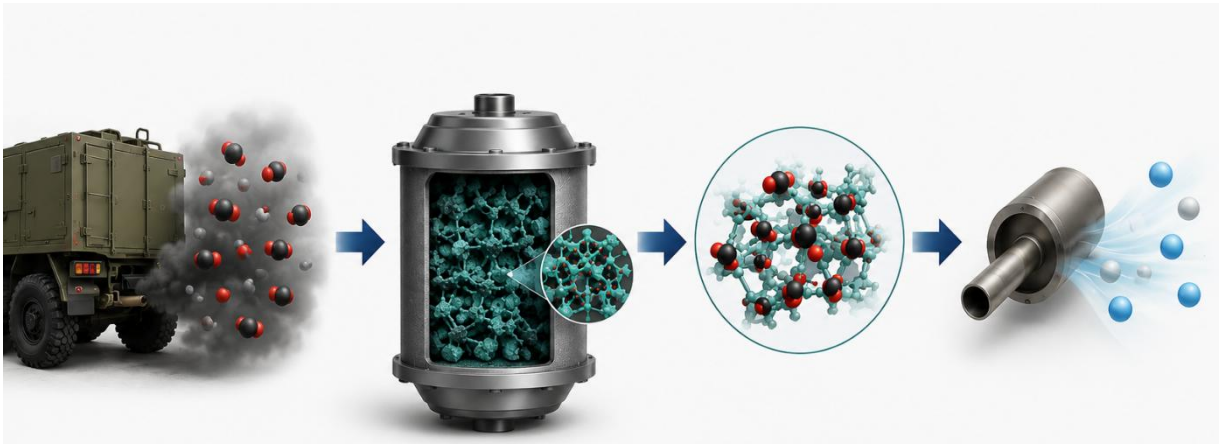


Figure 1. Conceptual graphical abstract showing the exhaust gas → MOF cartridge → CO_2 retention → reduced emission flow.

2. MATERIALS AND METHODS

The following methods were applied in this study, in that order:

2.1. Synthesis of MOF Structures

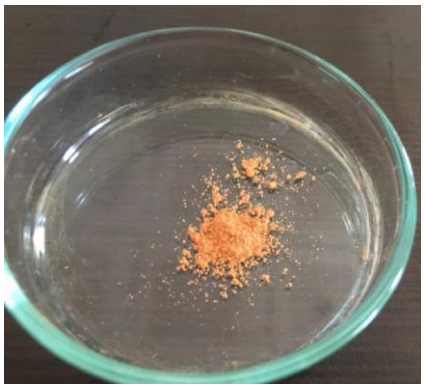
In this study, iron-based MOF-235(Fe), Nano MOF-235(Fe), NH_2-MOF-235(Fe), and Nano NH_2-MOF-235(Fe) structures were evaluated. MOF-235(Fe) was synthesized by the solvothermal method, while in the nanoscale

production approach, the solution was exposed to sound waves in an ultrasonic bath. The basic method used for MOF-235(Fe) synthesis is compatible with the approach reported in the literature for the synthesis of iron-based MOF-235 structures [5].

In the production of Nano MOF-235(Fe), a size-reduction approach was applied by keeping the initial solution in an ultrasonic bath. Ultrasonic-assisted MOF synthesis is considered one of the effective methods used in the literature since it can provide smaller particle size and rapid nucleation [6, 7].

In the synthesis of NH_2-MOF-235(Fe), 2-amino terephthalic acid was used to introduce amine functional groups into the structure. For the preparation of the amine-containing structure, synthesis and characterization approaches of similar iron-based amine-functionalized MOF structures were considered [8]. Synthesized MOF structures is presented in Figure 2.

(a)



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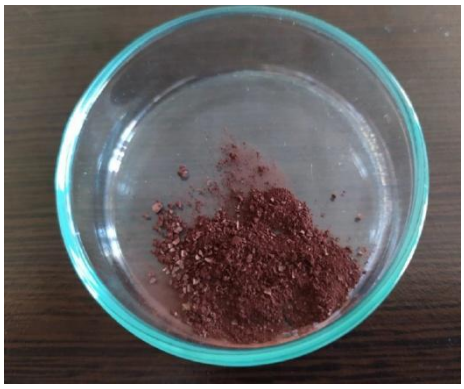


(c)

(d)

Figure 2. Images of the synthesized MOF-235(Fe) (a), Nano MOF-235(Fe) (b), NH_2-MOF-235(Fe) (c), and Nano NH_2-MOF-235(Fe) (d) samples.

2.2. Characterization Methods

SEM analysis was performed to determine the morphological properties of the synthesized MOF structures. The elemental composition of the samples was evaluated by EDX analysis, while particle size distributions were examined by DLS analysis. XRD analysis was applied to verify the crystalline structures, and FT-IR analysis was performed to determine the functional groups. TGA analysis was conducted to evaluate the thermal behavior of the materials.

BET surface area and porosity analyses were performed using N_2 gas. Gas adsorption isotherms and the BET method are among the fundamental approaches widely used for the characterization of porous solids [9]. CO_2 adsorption experiments were carried out at 0 °C and 25 °C, and the CO_2 retention capacities of different MOF structures were compared. Surface area, pore structure, pressure, and temperature directly affect the adsorption performance in CO_2 adsorption processes [10].

2.3. Conceptual Approach For The Modular Exhaust Cartridge

Based on the obtained material results, the use of Nano NH_2-MOF-235(Fe) in a modular cartridge system for tactical wheeled vehicle exhaust lines was proposed. In the conceptual approach, the MOF material is positioned inside a replaceable cartridge located in the final/cooled section of the exhaust line. The exhaust gas is intended to pass through the porous MOF filler structure inside the cartridge, allowing partial retention of CO_2 molecules on the MOF surface and within its pores. The proposed cartridge placement is schematically shown in Figure 3.

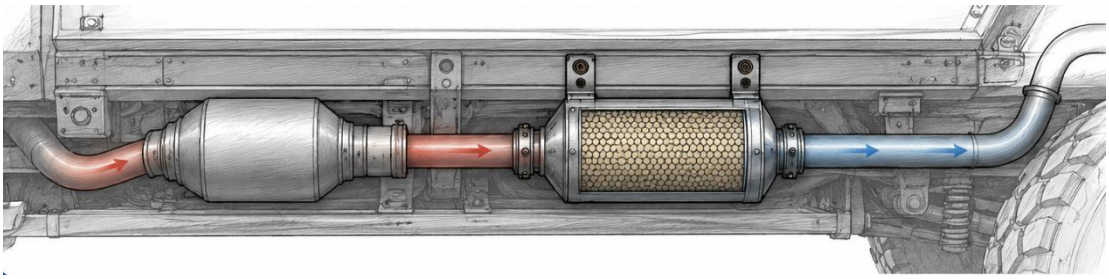


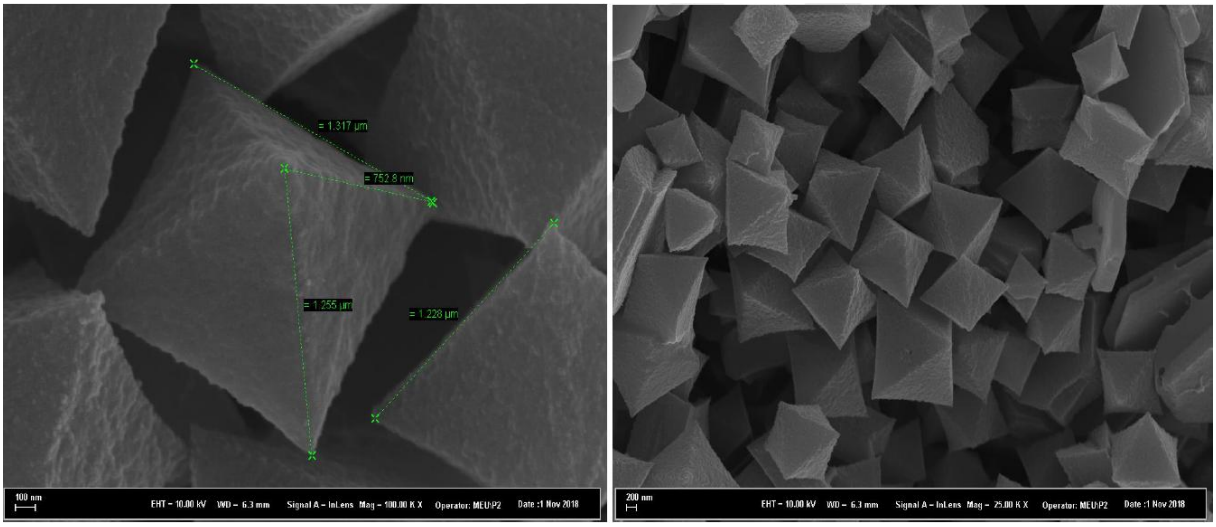
Figure 3. Technical sketch showing the tactical vehicle exhaust system and the proposed MOF cartridge placement.

This approach does not include direct experimental on-vehicle testing. Therefore, the study should not be considered as a final product validation or final system design, but rather as a conceptual preliminary feasibility evaluation for adapting a MOF-based carbon capture cartridge to a tactical vehicle exhaust system.

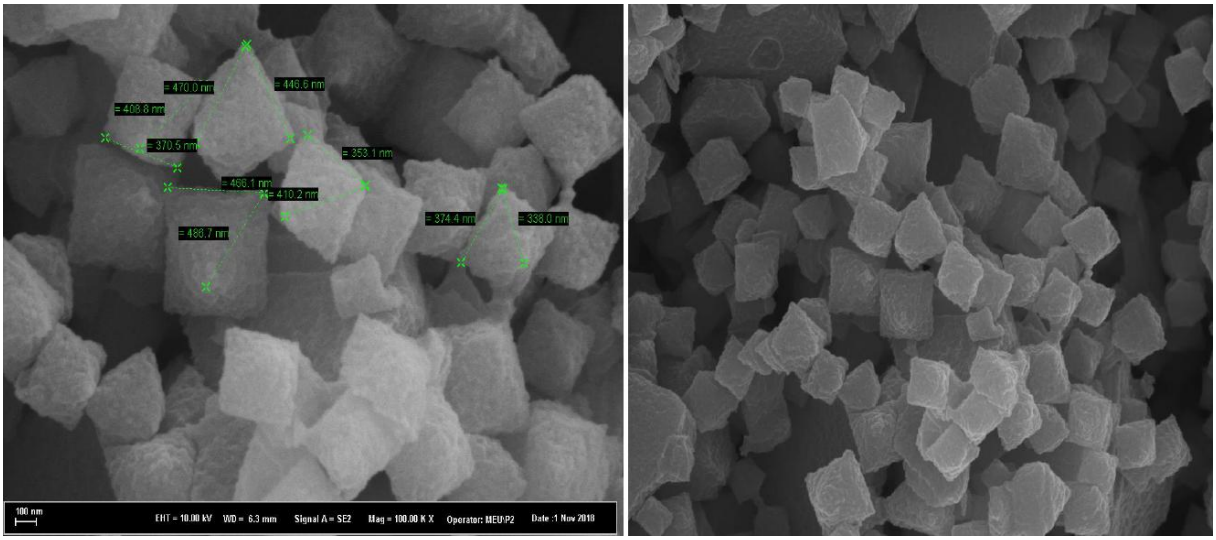
3. RESULTS AND DISCUSSIONS

3.1. SEM Analysis And Morphological Evaluation

SEM analyses revealed that the synthesized MOF structures exhibited different morphological features. While an octahedral crystal structure was observed in the MOF-235(Fe) sample, the NH_2-MOF-235(Fe) structure transformed into a hexagonal microspindle morphology after amine functionalization. Similar morphological properties for the MOF-235(Fe) structure have also been reported in the literature [11]. The comparative SEM images of the four different MOF structures obtained in this study are presented in Figure 4.



(a)



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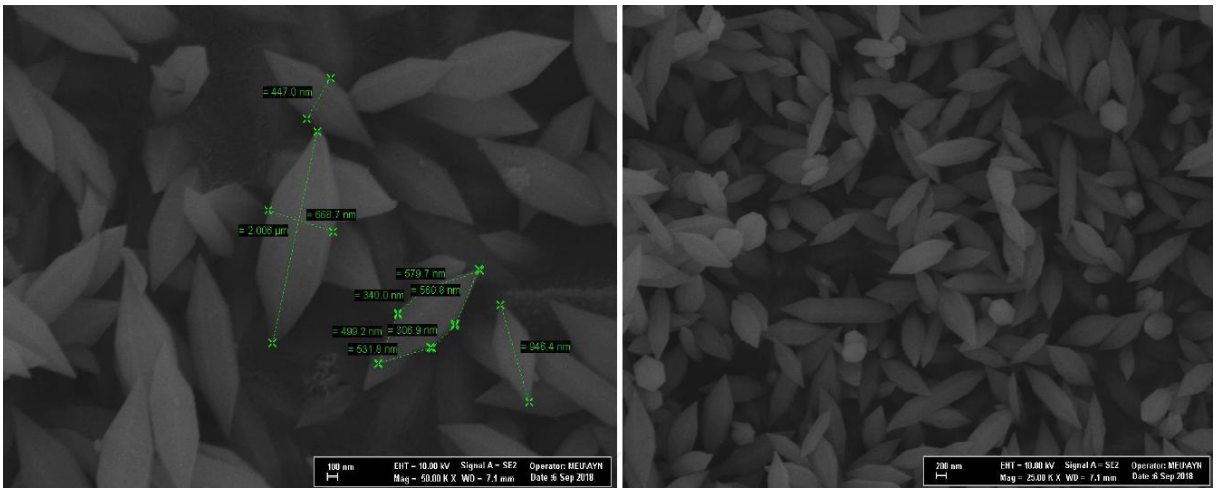
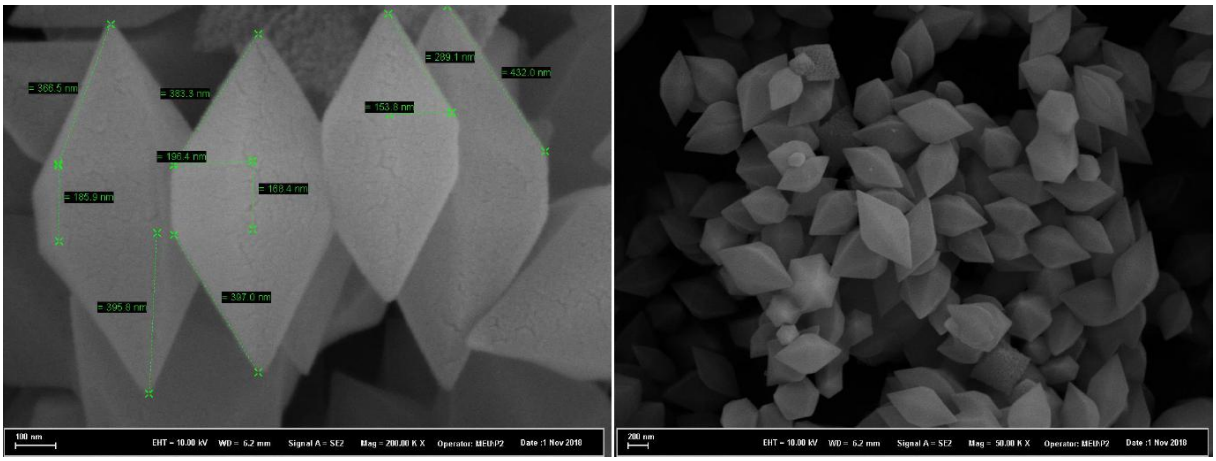


(c)



(d)

Figure 4. Comparative SEM images of the MOF-235(Fe) (a), Nano MOF-235(Fe) (b), NH_2-MOF-235(Fe) (c), and Nano NH_2-MOF-235(Fe) (d) samples.

In the Nano MOF-235(Fe) sample produced by the nano-synthesis approach, a reduction in particle size and an increase in surface roughness were observed. In the Nano NH_2-MOF-235(Fe) sample, a microspindle morphology similar to that of NH_2-MOF-235(Fe) was preserved, while the particle dimensions decreased. The

reduction in particle size is considered positive for CO_2 adsorption performance, since it can facilitate the access of gas molecules to the active surface and pores.

3.2. XRD Analysis

XRD analyses showed that the characteristic peaks of MOF-235(Fe) and Nano MOF-235(Fe) samples were compatible with the literature. The observation of characteristic crystalline peaks reported for MOF-235(Fe) in the synthesized samples supports the successful formation of the structure [12]. The XRD patterns of the four synthesized MOF structures are given in Figure 5.

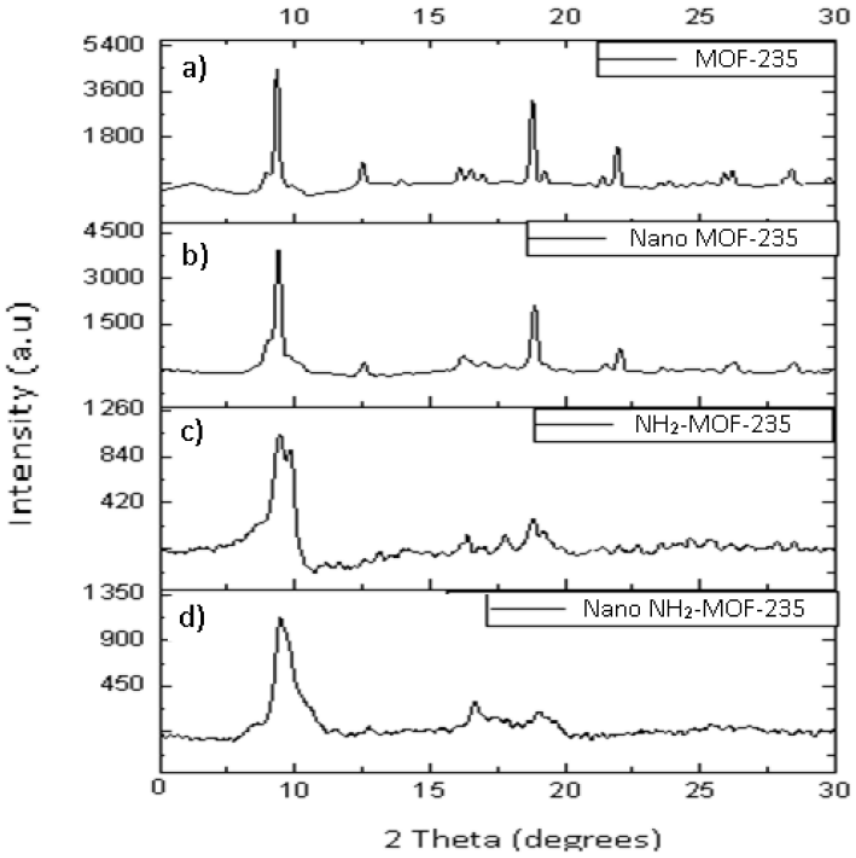


Figure 5. XRD patterns of MOF-235(Fe), Nano MOF-235(Fe), NH_2-MOF-235(Fe), and Nano NH_2-MOF-235(Fe).

In the NH_2-MOF-235(Fe) and Nano NH_2-MOF-235(Fe) structures, changes in peak positions and intensities were observed depending on amine functionalization. This can be associated with the incorporation of amine groups into the structure and the rearrangement of the crystalline structure after functionalization. Overall,

the XRD results indicate that the synthesized structures preserved their crystalline character and that structural modification occurred after the functionalization process.

3.3. FT-IR Analysis

FT-IR analyses were used to evaluate the bonding structures and functional groups of the synthesized MOF structures. Characteristic bond vibrations belonging to the terephthalic acid ligand were observed in the MOF-235(Fe) and Nano MOF-235(Fe) samples. In the NH_2-MOF-235(Fe) and Nano NH_2-MOF-235(Fe) samples, the detection of N-H vibrations belonging to the amino group supports the successful realization of amine functionalization [8]. The related FT-IR spectra are given in Figure 6.

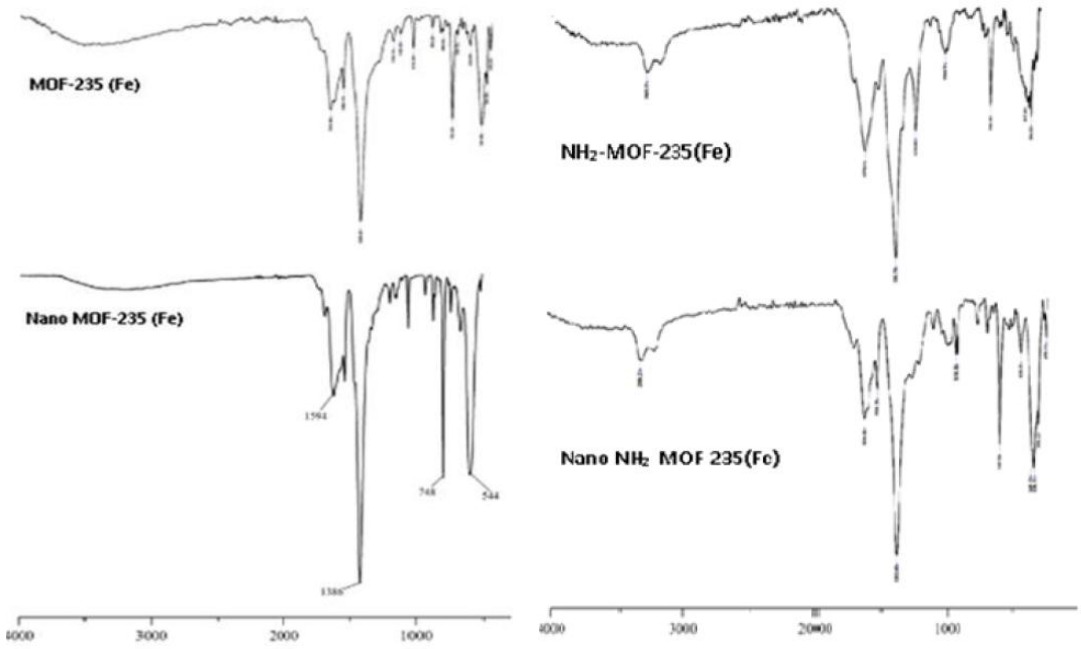


Figure 6. FT-IR spectra comparing MOF-235(Fe)/Nano MOF-235(Fe) and NH_2-MOF-235(Fe)/Nano NH_2-MOF-235(Fe).

Amine functionalization is important for CO_2 adsorption. Since CO_2 is an acidic molecule, it can interact more strongly with MOF surfaces that have been given a basic character [4]. Therefore, the FT-IR results are important not only for structural verification but also for explaining the increase in CO_2 adsorption performance.

3.4.1 BET Surface Area, Porosity and CO_2 Adsorption

According to BET analyses, the surface areas of MOF-235(Fe), Nano MOF-235(Fe), NH_2-MOF-235(Fe), and Nano NH_2-MOF-235(Fe) samples were determined as 1026, 1433, 478, and 712 m^2/g, respectively. The nano-

synthesis approach increased the surface area of MOF-235(Fe) from 1026 m²/g to 1433 m²/g. Similarly, in the amine-containing structure, the surface area of Nano NH_2-MOF-235(Fe) was higher than that of NH_2-MOF-235(Fe).

A decrease in surface area occurred as a result of amine functionalization. This can be explained by the partial occupation of pores by amine groups, which reduces the accessible surface area [13]. However, the CO_2 adsorption results showed that amine functionalization increased the CO_2 retention capacity despite the decrease in surface area. Similarly, it has been reported in the literature that the effect of functional groups can increase CO_2 adsorption capacity in different MOF structures [14]. This result indicates that not only physical surface area but also surface chemistry is decisive in CO_2 adsorption.

The surface area, average pore diameter, and CO_2 adsorption values of the synthesized MOF materials are given in Table 1.

Table 1. Surface area, average pore diameter, and CO_2 adsorption amounts of the synthesized MOF materials.

Sample name	BET Surface Area (m²/g)	Average Pore Diameter (Å)	CO_2 Adsorption at 25 °C (mmol/g)	CO_2 Adsorption at 0 °C (mmol/g)
MOF-235(Fe)	1026	9.02	3.76	4.82
Nano MOF-235(Fe)	1433	10.74	4.12	4.94
NH_2-MOF-235(Fe)	478	8.47	4.76	5.87
Nano NH_2-MOF-235(Fe)	712	8.86	5.03	6.43

As shown in Table 1, the highest CO_2 adsorption capacity was obtained from the Nano NH_2-MOF-235(Fe) sample. This sample exhibited a CO_2 adsorption capacity of 5.03 mmol/g at 25 °C and 6.43 mmol/g at 0 °C. It was observed that CO_2 adsorption increased as the adsorption temperature decreased. This can be explained by the generally exothermic character of gas adsorption and the more stable retention of adsorbed molecules on the surface at lower temperatures [15].

The graphical comparison of the CO_2 adsorption values at 0 °C and 25 °C given in Table 1 is presented. This graph clearly shows that the Nano NH_2-MOF-235(Fe) sample, in which nanoscale structuring and amine functionalization were applied together, exhibited higher performance than the other samples.

The adsorption isotherms of all synthesized MOF structures are given in Figure 7. The isotherm behavior indicates that the materials have a microporous character and a suitable pore structure for gas adsorption.

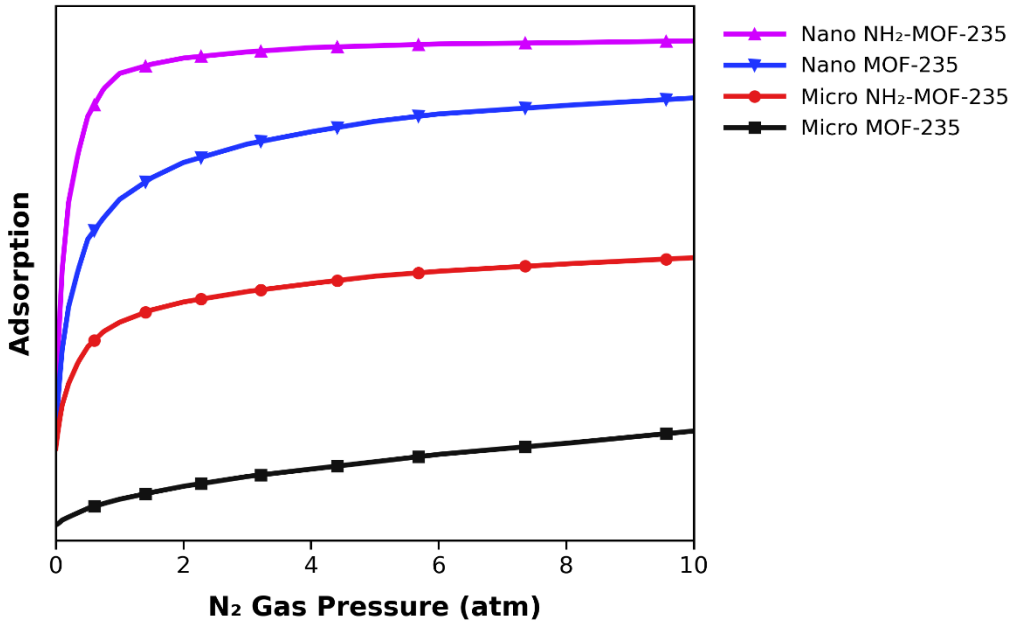


Figure 7. N_2 adsorption performance of the synthesized MOF samples under increasing gas pressure.

3.5. TGA Analysis and Thermal Stability

TGA analysis is critical for the proposed exhaust cartridge approach. This is because a MOF cartridge to be placed in the exhaust line must be stable against the operating temperature. TGA analyses performed for MOF-235(Fe) and NH_2-MOF-235(Fe) samples revealed that the materials exhibited thermal stability within certain temperature ranges. Monitoring mass losses depending on increasing temperature in the TGA method is a basic approach for evaluating the thermal behavior of materials [16].

It was determined that the MOF-235(Fe) sample maintained its thermal stability up to approximately 360 °C, while the NH_2-MOF-235(Fe) sample showed thermal stability up to approximately 400 °C. The first mass loss observed in the NH_2-MOF-235(Fe) sample was associated with the removal of free water and residual solvents in the sample. The mass loss observed at higher temperatures was attributed to the decomposition of organic ligands and the deterioration of the framework structure [17]. The TGA graph of the NH_2-MOF-235(Fe) sample is given in Figure 9.

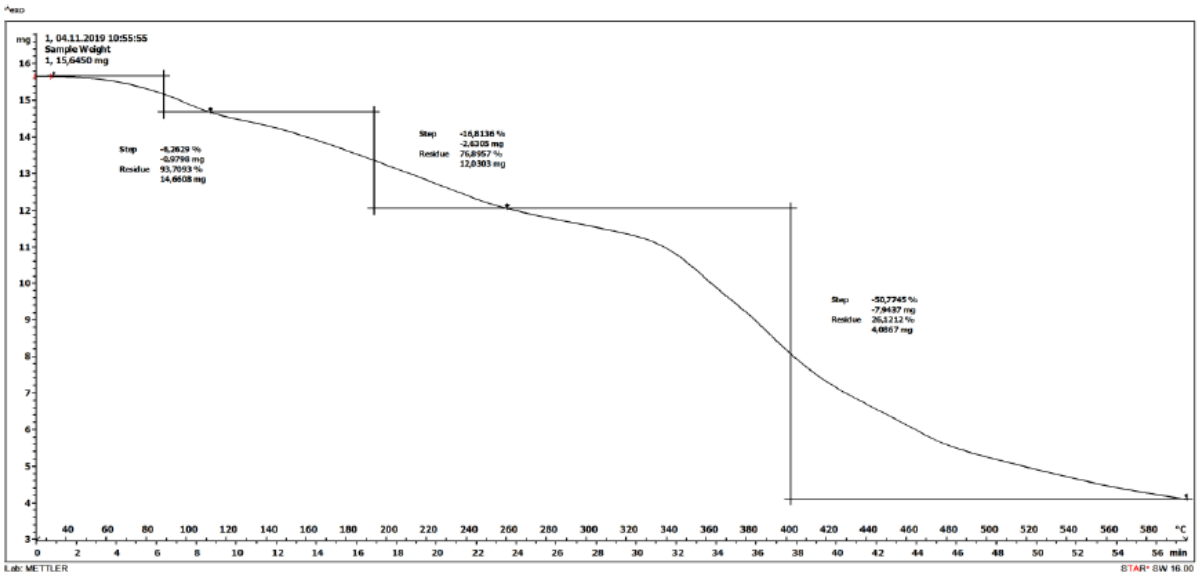


Figure 9. TGA graph of the NH_2-MOF-235(Fe) sample.

The TGA result shown in Figure 9 indicates that Nano NH_2-MOF-235(Fe) should not be positioned directly in the hottest exhaust region, but rather in the final/cooled section of the exhaust line. The temperature profile of the region where the cartridge will be positioned in the tactical vehicle exhaust line should also be evaluated during system design. Considering the assumption that the exhaust air and pipe-end temperature may reach approximately 270 °C under high-performance operating conditions, the TGA results indicate that the cartridge may provide an advantage in terms of material stability when positioned in a suitable region. However, the effects of humidity, gas mixture, vibration, and thermal cycling under real exhaust conditions should also be tested.

3.6. Evaluation of The Modular Exhaust Cartridge Application

Considering the adsorption results obtained, Nano NH_2-MOF-235(Fe) was evaluated as the most suitable candidate material for the modular exhaust cartridge application. Three main factors stand out in the selection of this material: high CO_2 adsorption capacity, increased surface interaction with CO_2 due to amine functionalization, and thermal stability within a certain temperature range according to TGA results.

The proposed cartridge system can be designed as a replaceable module positioned in the final/cooled section of the exhaust line. Exhaust gas passes through the porous MOF filler material inside the cartridge. In this process, CO_2 molecules are intended to be retained on the MOF surface and within its pores. Exhaust back pressure, gas flow rate, temperature distribution, humidity effect, vibration resistance, and service accessibility should be considered as key engineering parameters in the design of the cartridge structure.

The conceptual placement of the proposed exhaust cartridge approach on the vehicle is shown in Figure 9. This placement is based on the idea that the system can be adapted to the existing exhaust line with minimum structural modification and can be used with a replaceable cartridge logic under field conditions.

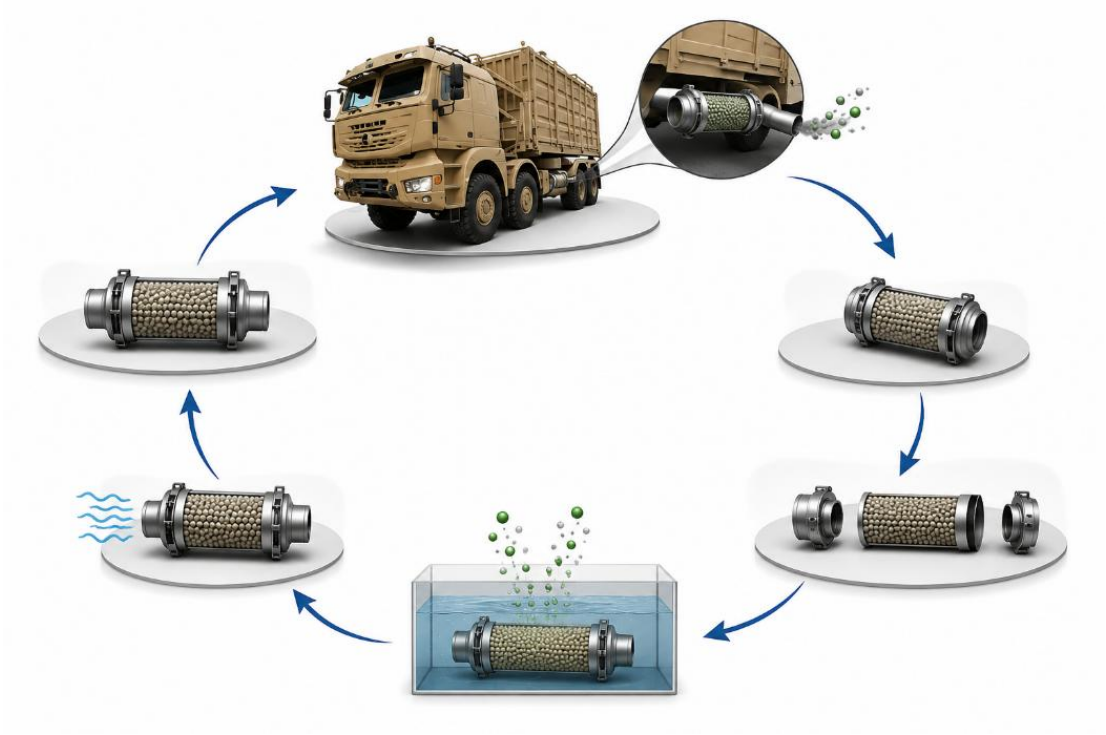


Figure 9. Technical schematic showing the integration of the MOF cartridge on the exhaust line.

The most important advantage of the system in on-vehicle application is the replaceability of the cartridge. Removing the saturated cartridge from the vehicle and replacing it with a new or regenerated cartridge may facilitate the field maintenance process. This approach may provide an advantage especially for tactical vehicles in terms of rapid maintenance and mission continuity.

3.7. Regeneration and Reusability Approach

The regeneration process is an important parameter for the applicability of the MOF-based cartridge system. In the conceptual approach, it is proposed that the saturated cartridge be removed from the vehicle and transferred to a controlled regeneration unit. The reusability potential of MOF structures is considered an important advantage in adsorption-based applications of these materials [18].

At this stage, the controlled removal of CO_2, low-temperature drying of the cartridge, and preparation for reuse are targeted. However, the regeneration approach evaluated in this study is not an experimentally verified on-vehicle process. Therefore, in future studies, the performance of Nano NH_2-MOF-235(Fe) in multiple adsorption-desorption cycles, capacity loss, drying temperature, regeneration time, and material stability should be investigated separately.

4. CONCLUSIONS

In this study, based on the CO_2 adsorption performances of iron-based MOF-235(Fe) structures, a MOF-based modular exhaust cartridge approach that can be used in tactical wheeled vehicles was conceptually evaluated. MOF-235(Fe), Nano MOF-235(Fe), NH_2-MOF-235(Fe), and Nano NH_2-MOF-235(Fe) structures were synthesized and examined by SEM, XRD, FT-IR, TGA, BET, and CO_2 adsorption analyses.

The nano-synthesis approach gave positive results in terms of reducing particle size and increasing surface area. Although amine functionalization caused a decrease in surface area, it increased the CO_2 adsorption capacity. The highest CO_2 adsorption performance was obtained from the Nano NH_2-MOF-235(Fe) sample. This sample showed a CO_2 adsorption capacity of 5.03 mmol/g at 25 °C and 6.43 mmol/g at 0 °C.

TGA results revealed that the NH_2-MOF-235(Fe) structure can show thermal stability up to approximately 400 °C. These data indicate that Nano NH_2-MOF-235(Fe) is a potential candidate for a modular cartridge structure that can be integrated into the final/cooled section of the exhaust line.

The proposed system is not a product directly tested on a vehicle. Therefore, future studies should evaluate prototype cartridge design, adsorption performance under real exhaust gas composition, pressure drop, humidity effect, vibration resistance, thermal cycling behavior, regeneration efficiency, and field tests in detail. This study presents a conceptual preliminary feasibility basis for the use of MOF-based adsorbents in post-exhaust carbon capture applications for tactical wheeled vehicles.

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FULL PAPER

S690QL Çeliği Üzerine MMA Yöntemi ile Uygulanılan Sert Dolgu Kaplamanın Mekanik Olarak Değerlendirilmesi

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ÖZET

Yüksek mukavemetli S690QL Steel çeliği üzerine, Örtülü Elektrod Ark Kaynağı (MMA – 111) yöntemi kullanılarak çok pasolu ve tek bindirmeli sert dolgu kaplama uygulamaları gerçekleştirilmiştir. Çalışmada dolgu metali olarak, yüksek krom (Cr) ve karbon (C) içeriğine sahip Fe-Cr-C sert dolgu elektrodu tercih edilmiştir.

Kaynak sonrası oluşan mikro yapısal ve mekanik değişimlerin incelenmesi amacıyla numuneler üzerinde makro yapısal incelemeler, SEM (Taramalı Elektron Mikroskobu) görüntü analizleri, XRD (X-Işını Difraksiyonu) analizleri ve sertlik testleri gerçekleştirilmiştir. Makro incelemelerde, çok pasolu bindirmeli kaynak yapısının esas malzeme ile yeterli metalürjik bağ oluşturduğu ve kaynak metalinin yüzey boyunca kesintisiz bir yapı sergilediği tespit edilmiştir. SEM görüntülerinde kaynak metalinde sert faz oluşumlarını destekleyen yapısal bölgeler gözlemlenirken, XRD analizlerinde yüksek sertlik oluşumuna katkı sağlayabilecek fazların varlığı tespit edilmiştir.

Sertlik testi sonuçları, kaplama bölgesinde esas malzemeye kıyasla belirgin bir sertlik artışı meydana geldiğini göstermiştir. Bununla birlikte, Fe-Cr-C esaslı sert dolgu kaplama metalinin yüksek karbon ve krom içeriği ile kaynak sırasında oluşan termal gerilmeler nedeniyle kaplama yüzeyinde yer yer enine çatlak oluşumları gözlemlenmiştir. Elde edilen bulgular doğrultusunda, Fe-Cr-C elektrodu ile gerçekleştirilen MMA sert dolgu kaplamalarının, yüksek mukavemetli çeliklerin aşınmaya maruz çalışma koşullarında yüzey performansını artırabilecek uygun bir yöntem olduğu değerlendirilmiştir. Özellikle beton pompası sistemlerinde kullanılan aşınma plakaları gibi aşındırıcı servis koşullarına maruz bileşenlerde uygulanabilir bir alternatif sunduğu sonucuna ulaşılmıştır.

Keywords: *S690QL çeliği, MMA, Sert dolgu kaplama, Fe-Cr-C alaşımı, çok pasolu kaynak, yüzey sertliği*

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1. INTRODUCTION

Yüzey kaplaman kaynağı, aşınma ve korozyon direncini artırmak amacıyla ana metal yüzeyine daha sert bir metalin kaplandığı bir yüzey iyileştirme işlemidir. Ayrıca, servis sırasında aşınmış bileşenlerin bakım ve onarımında yaygın olarak uygulanmakta olup, ekipmanların kullanım ömrünü etkin bir şekilde uzatmaktadır [1,2]. Bu yöntem sayesinde yalnızca çalışma koşullarına maruz kalan yüzeylerin özellikleri iyileştirilirken, esas malzemenin mekanik ve yapısal avantajları korunabilmektedir. Bu durum, özellikle yüksek maliyetli veya büyük boyutlu ekipmanların ekonomik bir şekilde kullanılmasına olanak sağlamaktadır [3].

Ağır hizmet şartlarında çalışan ekipmanlarda aşınma, servis ömrünü sınırlandıran en önemli hasar mekanizmalarından biridir. Madencilik, çimento, tarım, enerji ve beton pompası sistemleri gibi sektörlerde kullanılan parçalar abrazif aşınma, erozyon ve darbe etkilerine maruz kalmakta, bu durum bakım maliyetlerinin artmasına ve üretim kayıplarına yol açmaktadır. Bu nedenle aşınmaya karşı dayanıklı yüzeylerin oluşturulması endüstriyel uygulamalarda büyük önem taşımaktadır.

HSLA çelikler, yüksek mukavemet ve tokluk özellikleri ile birlikte mikroalaşım elementleri sayesinde tane inceltme ve çökelme sertleşmesi mekanizmalarıyla güçlendirilen çeliklerdir ve kaynak kabiliyetleri genellikle düşük karbonlu çeliklere benzemektedir [4]. Bu malzemeler arasında yer alan S690QL çeliği, yaklaşık 690 MPa akma dayanımına sahip olup yüksek yük taşıma kapasitesi gerektiren uygulamalarda tercih edilmektedir [5]. Ancak yüksek mukavemet özelliklerine rağmen, aşındırıcı servis koşullarında yüzey aşınmasına karşı ilave koruma gereksinimi ortaya çıkmaktadır.

Endüstriyel uygulamalarda sert dolgu kaplamalarının güvenilir şekilde kullanılabilmesi için kaynak prosedürlerinin belirli standartlara göre kalifiye edilmesi gerekmektedir. Bu kapsamda EN ISO 15614-7 standardı, yüzey kaplama kaynaklarının prosedür yeterlilik testlerinin gerçekleştirilmesi ve doğrulanması için esasları tanımlamaktadır [6]. Standart kapsamında gerçekleştirilen kaynak prosedür kalifikasyon çalışmaları, kaplama tabakasının metalürjik sürekliliğinin, mikro yapısal özelliklerinin ve mekanik performansının değerlendirilmesine olanak sağlamaktadır.

Bu çalışmada, EN ISO 15614-7 standardına uygun olarak hazırlanan kaynak prosedür kalifikasyon (PQR) çalışması kapsamında, 25 mm kalınlığındaki S690QL çeliği üzerine MMA (111) yöntemi kullanılarak Fe-Cr-C esaslı sert dolgu kaplama uygulanmıştır. Kaynak sonrası oluşan mikro yapısal ve mekanik değişimlerin belirlenmesi amacıyla makro yapı incelemeleri, Taramalı Elektron Mikroskobu (SEM) analizleri, X-Işını Difraksiyonu (XRD) analizleri ve sertlik ölçümleri gerçekleştirilmiştir. Elde edilen sonuçlar değerlendirilerek söz konusu kaplama sisteminin aşınmaya maruz servis koşullarındaki uygulanabilirliği incelenmiştir.

2. MATERYAL VE METOT

2.1. Esas Malzeme ve Kaynak Sarf Malzemesi

S690QL çeliği, ince taneli, yüksek mukavemetli ve su verme (quenching) ile temperleme (tempering) işlemleri uygulanarak üretilen bir yapı çeliğidir. Bu ısıl işlem sayesinde çelik yüksek akma dayanımı ve iyi tokluk özellikleri kazanmaktadır [7].

Suda soğutulmuş ve temperlenmiş yapı çelikleri, TS EN 10025-6 standardı kapsamında tanımlanmakta olup, belirli kimyasal ve mekanik kriterlere göre sınıflandırılmaktadır. Tablo 2'de standart değerler ile spektral analiz sonucunda elde edilen numuneye ait kimyasal kompozisyonlar karşılaştırmalı olarak sunulmuştur.S690QL çeliğinin kalite sınıflandırması, adındaki harf ve rakamların ifade ettiği teknik özelliklere göre aşağıda açıklanmıştır:

- S: Yapısal çelik (Structural steel)
- 690: Minimum akma dayanımı 690 MPa
- Q: Suda soğutulmuş ve temperlenmiş (Quenched and Tempered)

- L: Düşük sıcaklıkta çentik darbe tokluğu testi (Low temperature impact toughness test)

Bu sınıflandırma, çeliğin mekanik dayanımını, ısıl işlem ve düşük sıcaklıklarda süneklik davranışını tanımlamak amacıyla kullanılmaktadır [8].

Sert dolgu kaplama işlemlerinde sarf malzemesi olarak, yüksek krom (Cr) ve karbon (C) içeriğine sahip Fe–Cr–C esaslı Kobatek 578 örtülü elektrot kullanılmıştır. Bu tip elektrotlar, kaynak metali içerisinde krom karbür oluşumunu teşvik ederek yüksek sertlik ve aşınma direnci sağlamaktadır [9].

Şekil 1. Sert Dolgu kaynağı yapılmış aşınma plakası ve test numunesi.

2.2 Kaplama Yöntemi

Sert dolgu kaplama uygulamaları, EN ISO 15614-7 standardı esas alınarak kaynak prosedür kalifikasyon (PQR) çalışması kapsamında gerçekleştirilmiştir [6]. Kaplama işlemleri Örtülü Elektrot Ark Kaynağı (MMA–111) yöntemi ile uygulanmıştır.

Aşınma plakası üzerinde gerçekleştirilen kaplama işlemleri ile endüstriyel üretim koşullarına benzer uygulama şartları oluşturulmuş ve proses davranışı değerlendirilmiştir.

Kaynak işlemleri çok pasolu olarak gerçekleştirilmiş; tek, çift ve üç bindirmeli kaplama geometrileri uygulanmıştır. Her paso sonrası oluşan cüruf mekanik olarak temizlenmiş ve bir sonraki paso uygulanmıştır. Bu sayede kaplama tabakası boyunca süreklilik sağlanarak homojen bir sert dolgu yapısı elde edilmesi hedeflenmiştir.

Kaplama işlemlerinde 200 × 200 × 25 mm boyutlarındaki S690QL çelik plakaların tek yüzeyine, 4,0 mm çapında Fe–Cr–C esaslı Kobatek 578 örtülü elektrot kullanılarak MMA kaynağı uygulanmıştır.

Tüm deneylerde kaynak parametreleri birbirine yakın seçilmiş, uygulamalar aynı kaynak operatörü tarafından ve aynı çevresel koşullar altında gerçekleştirilmiştir.

Tablo 1. Kaynak kaplama parametreleri

Parametre	Tek Bindirme	Çoklu Bindirme	Aşınma Plakası
Esas Malzeme	S690QL	S690QL	S690QL

Boyut	25×200×250 mm	25×200×250 mm	25×320×570 mm
Akım	180–230 A	180–225 A	200–240 A
Gerilim	22–30 V	22–30 V	22–30 V
Sarf Malzeme	Kobatek 578	Kobatek 578	Kobatek 578
Elektrot	4.0 × 350 mm	4.0 × 350 mm	4.0 × 350 mm
Ön ısıtma	100 °C	100 °C	100 °C
Paso türü	Çoklu	Çoklu	Çoklu
Bindirme türü	Tekli	Çiftli	Üçlü
Paso arası sıcaklık	100–350 °C	100–375 °C	50–410 °C

3. BULGULAR VE TARTIŞMA

3.1 Spektral analiz

Kaplama işlemi öncesi kullanılan S690QL çeliğinin kimyasal bileşimi, optik emisyon spektrometresi ile belirlenmiştir. Yapılan analiz, malzemenin TS EN 10025-6 standardına uygunluğunu doğrulamak ve kaynak sonrası oluşabilecek difüzyon etkilerini değerlendirmek amacıyla gerçekleştirilmiştir. Ayrıca, kaplama işleminde kullanılan Kobatek 578 kaynak elektrotunun üretici firmalar tarafından belirtilen nominal alaşım bileşimleri, gerçekleştirilen spektral analiz sonuçları ile karşılaştırılmıştır.

Tablo 2. TS EN 10025-6 standardına göre S690QL çeliğinin maksimum alaşım element oranları ve spektral analiz sonuçları

Alaşım Elementleri	C %	Si %	Mn %	P %	S %	N %	B %	Cr %	Cu %	Mo %	Nb %	Ni %	Ti %	V %	Zr %
10025-6 Max. Oran	0,22	0,86	1,8	0,03	0,017	0,016	0,006	1,6	0,55	0,74	0,07	2,1	0,07	0,14	0,17
Numune Spektral Analizi	0,12	0,23	1,22	0,002	0,001	-	0,003	0,277	0,0156	0,03	0,031	0,008	0,02	0,007	0,014

Tablo 2'de, S690QL kalite çeliğe ait TS EN 10025-6 standardında belirtilen maksimum alaşım element oranları ile test numunesine ait spektral analiz sonuçları karşılaştırmalı olarak sunulmuştur [5].

Yapılan analiz sonucunda elde edilen kimyasal bileşim değerlerinin, tüm ana alaşım elementleri bakımından büyük ölçüde standarda uygun olduğu görülmektedir. Bu durum, kullanılan malzemenin kimyasal açıdan homojen bir yapıya sahip olduğunu ve kaplama işlemi için uygun nitelikte olduğunu ortaya koymaktadır.

Tablo 3. Kobatek 578 Ürün ve Üretici Spektral analizleri

Alaşım Elementleri	Fe %	C %	Si %	S %	P %	Cr %	B %
Kobatek 578 Kaynak Metali Üretici Firma Sertifika	52,9	5.1	0.8	0.008	0.009	41.2	0.4

Analizi							
Kobatek 578 Kaynak Metali Spektral Analizi	52.9	5.1	0.8	0.009	0.010	41.2	0.4
Kobatek 578 Kaynak Esas malzeme Arası geçiş bölge Spektral Analizi -1	84.2	1.84	0.583	0.0087	0.0099	12.1	0.0250
Kobatek 578 Kaynak Esas malzeme Arası geçiş bölge Spektral Analizi -2	81.5	2.12	0.679	0.0141	0.046	14.7	-
Kobatek 578 Kaynak Esas malzeme Arası geçiş bölge Spektral Analizi -3	69.5	3.65	0.882	0.0242	0.052	25.1	-

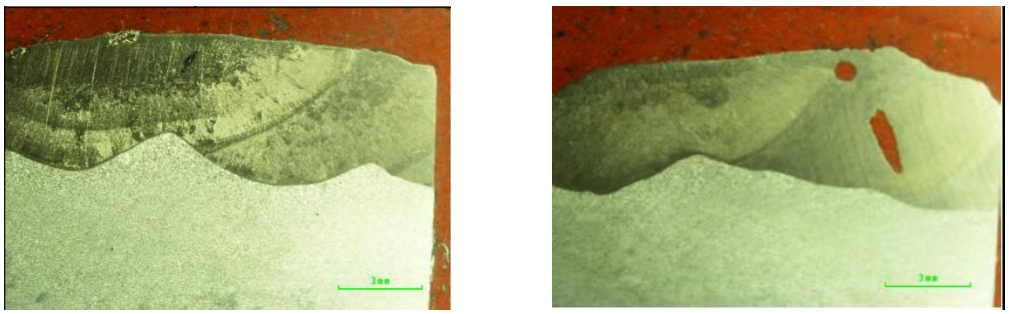
Tablo 3'te, Kobatek 578 elektroduna ait üretici katalog verileri, üretici sertifika analizi ve bu çalışma kapsamında gerçekleştirilen spektral analiz sonuçları karşılaştırmalı olarak sunulmuştur [9].

Yapılan spektral analiz sonuçlarının üretici firma tarafından verilen nominal kimyasal bileşim ve sertifika analiz değerleri ile büyük ölçüde uyumlu olduğu görülmüştür. Bu durum, kullanılan elektrodun kimyasal bileşim açısından üretim spesifikasyonlarını karşıladığını ve kaplama metalinin hedeflenen alaşım yapısına sahip olduğunu göstermektedir.

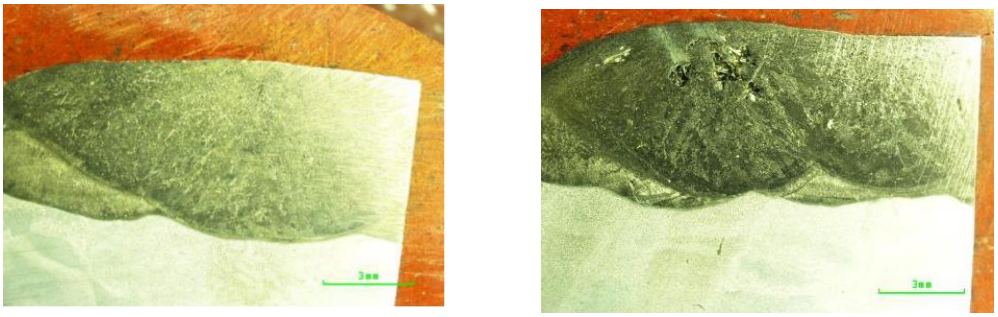
3.2 Makro Görüntü ve SEM Analizi

Kaplamaların makro yapısal analizi, optik mikroskop kullanılarak gerçekleştirilmiştir. Bu amaçla numuneler uygun boyutlarda kesilmiş, sırasıyla zımparalanmış, parlatılmış ve %2'lik Nital çözeltisi ile dağlanmıştır. Elde edilen makro görüntüler, kaplama kalınlığı, kaplama ile ana malzeme arasındaki bağlanma kalitesi ve oluşan ısıl etkilenmiş bölgenin (ITAB) morfolojisi açısından değerlendirilmiştir.

Tek bindirmeli kaynak kaplama makro görüntüleri şekil 2'de verilmiştir. İkili bindirmeli kaynak kaplama makro yapılar ise şekil 3'de gösterilmektedir.



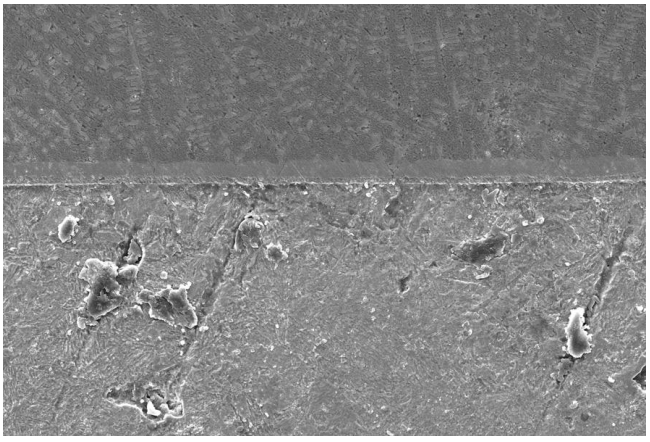
Şekil 2. Tek bindirmeli kaynak kaplama makro görüntüsü**.**



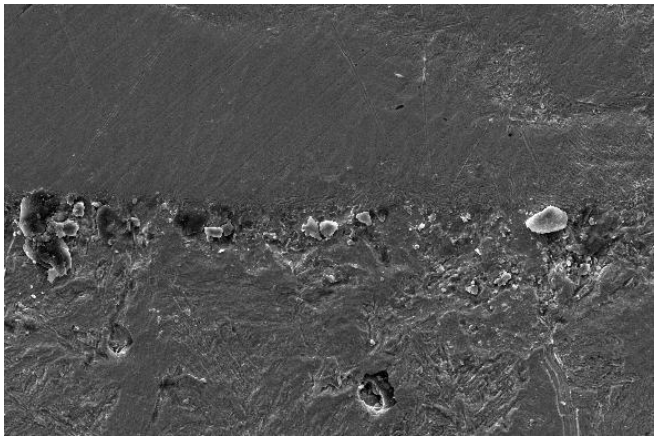
Şekil 3. İkili bindirmeli kaynak kaplama makro görüntüsü. SEM Analizi.

Her iki numuneye ait SEM görüntüleri 1000× büyütmede elde edilmiştir. Mikroyapısal incelemeler kaynak metali, füzyon çizgisi ve esas malzeme bölgelerinden alınan görüntüler üzerinden gerçekleştirilmiştir. Bu sayede kaplama işleminin farklı bölgelerde meydana getirdiği mikroyapısal değişimler değerlendirilmiştir.

Tek bindirmeli ve ikili bindirmeli kaplama numunelerine ait SEM görüntüleri sırasıyla Şekil 4 ve Şekil 5'te verilmiştir. SEM incelemelerinde kaynak metalinde sert faz oluşumları ile birlikte dendritik yapıların geliştiği, füzyon bölgesinde ise kaplama metali ile esas malzeme arasında süreklilik gösteren bir metalürjik bağın oluştuğu gözlemlenmiştir. Ayrıca, incelenen bölgelerde belirgin bir porozite veya süreksizlik tespit edilmemiştir.



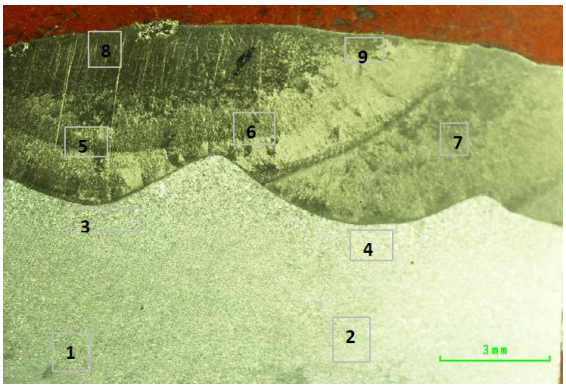
Şekil 4. Tek bindirmeli kaynak kaplama 1000× SEM görüntüsü.



Şekil 5. İkili bindirmeli kaynak kaplama 1000× SEM görüntüsü.

3.3. Sertlik Testi

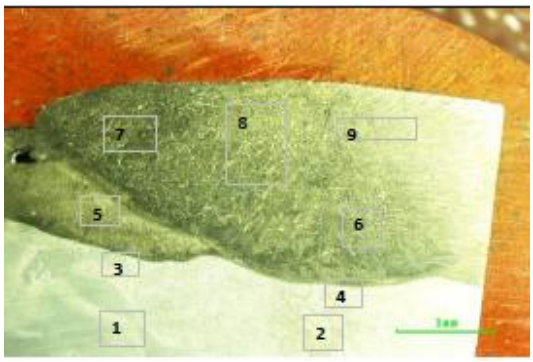
Vickers sertlik testi (HV10, 10 kg yük) ile kaplamaların sertlik değerleri ölçüldü. Her numune için 9 noktadan ölçüm alındı ve ortalama değerler hesaplandı. Kaplama, ısıl etkilenmiş bölge (ITAB) ve ana malzeme bölgelerinde sertlik dağılımı değerlendirildi.



Şekil 6. Tek bindirmeli kaynak numune üzerinde gerçekleştirilen sertlik testi noktalarının yerleşimi.

Tablo 4. Tek bindirmeli kaynak yöntemiyle yapılan numenin vickers sertlik testi sonuçları.

Test Bölgesi	Ölçüm Yeri	HV (HV10)
Esas Metal	1	261
Esas Metal	2	257
Isıdan Etkilenmiş Bölge	3	240
Isıdan Etkilenmiş Bölge	4	215
Kaynak Metali	5	735
Kaynak Metali	6	702
Kaynak Metali	7	726
Kaynak Metali	8	705
Kaynak Metali	9	768



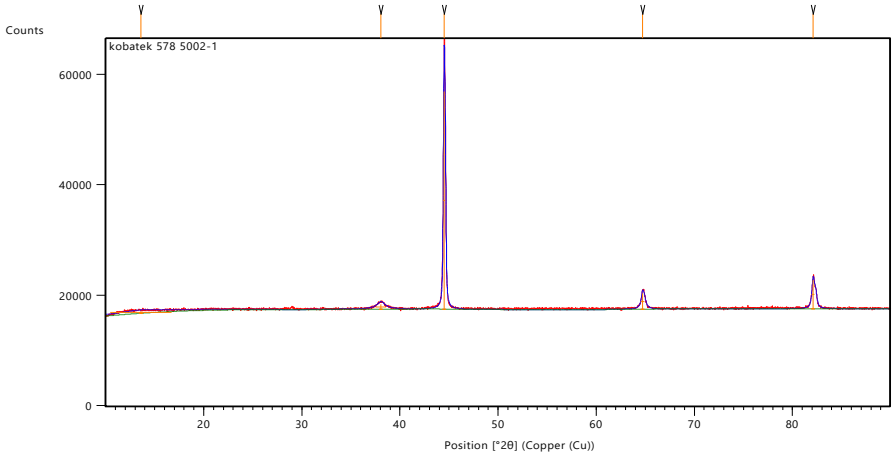
Şekil 7. İkili bindirmeli kaynak numune üzerinde gerçekleştirilen sertlik testi noktalarının yerleşimi.

Tablo 5. İkili bindirmeli kaynak yöntemiyle yapılan numenin vickers sertlik testi sonuçları.

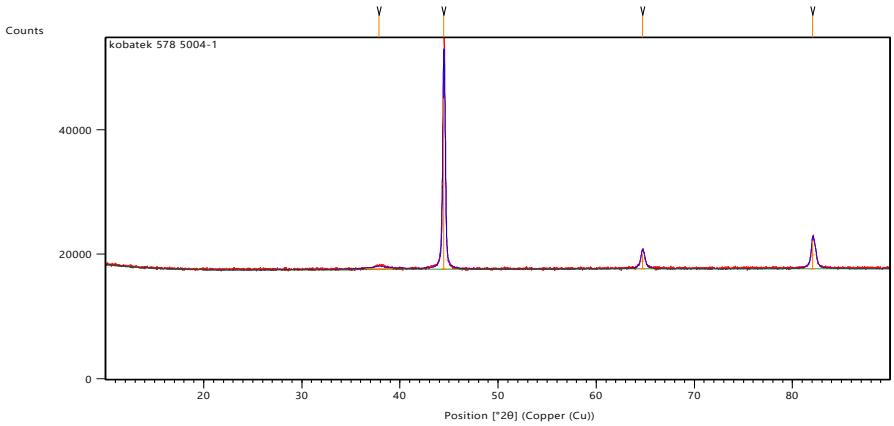
Test Bölgesi	Ölçüm Yeri	HV (HV10)
Esas Metal	1	249
Esas Metal	2	235
Isıdan Etkilenmiş Bölge	3	190
Isıdan Etkilenmiş Bölge	4	203
Kaynak Metali	5	797
Kaynak Metali	6	795
Kaynak Metali	7	799
Kaynak Metali	8	856
Kaynak Metali	9	856

3.4 XRD Analiz

Kaplama tabakasında oluşan fazların belirlenmesi amacıyla X-Işını Kırınımı (X-Ray Diffraction, XRD) analizi gerçekleştirilmiştir. XRD analizleri, kaplama yüzeyinden alınan numuneler üzerinde uygulanmış ve elde edilen kırınım desenleri kullanılarak kaynak metali içerisindeki kristal yapılar ve faz bileşenleri belirlenmiştir.



Şekil 8. Tek bindirmeli kaynak bölgesi



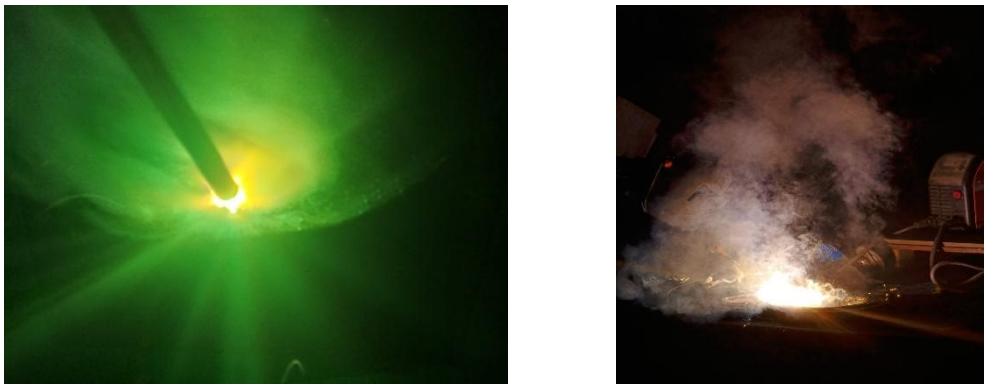
Şekil 9. Tek bindirmeli kaynak bölgesi

Elde edilen XRD desenleri incelendiğinde, her iki numunede de benzer pik konumlarının oluştuğu görülmüştür. Literatürde Fe–Cr–C esaslı sert dolgu kaplamalar üzerinde gerçekleştirilen çalışmalarla karşılaştırıldığında, tespit edilen piklerin α-Fe matrisi ile birlikte kromca zengin karbür fazlarına karşılık geldiği değerlendirilmiştir. Özellikle M_7C_3 ve $M_{23}C_6$ tipi krom karbürlerine ait karakteristik piklerin varlığı, kaplama tabakasında yüksek sertlik ve aşınma direnci sağlayan sert fazların oluştuğunu göstermektedir.

3.5 Prototip Ürün Süreçleri

PQR test çalışmalarının yanı sıra, kaynak sarf malzemesinin üretim koşullarındaki performansının değerlendirilmesi amacıyla prototip ürün çalışmaları da gerçekleştirilmiştir. Bu kapsamda elde edilen bulgular doğrultusunda üretim süreçleri teknik açıdan değerlendirilmiştir.

Çok pasolu kaynak uygulamaları ile üretilen prototip ürünlerde kaynak işlemi sırasında yoğun miktarda kaynak dumanı oluştuğu gözlemlenmiştir. Bununla birlikte, elektrodun ark başlatma ve yeniden tutuşturma özelliklerinin yeterli seviyede olduğu, kaynak süresince yanma kararlılığının korunduğu ve herhangi bir operasyonel problemle karşılaşılmadığı belirlenmiştir.



Şekil 10. Ark oluşumu ve prototip ürünün üretim aşamasına ait görüntü.

Kaynak işlemleri sonrasında esas malzemede belirgin düzeyde distorsiyon meydana geldiği tespit edilmiştir. Oluşan distorsiyonun, çok pasolu kaynak uygulamaları sırasında ortaya çıkan yüksek ısı girdisi

ve buna bağlı düzensiz büzülme gerilmelerinden kaynaklandığı değerlendirilmektedir. Distorsiyon etkilerinin azaltılması amacıyla kaynak öncesinde parçaya ters yönlü ön eğim (presetting) verilmesinin uygun bir yöntem olacağı öngörülmektedir [10]

MMA (111) kaynak yöntemi ile gerçekleştirilen sert dolgu kaplama uygulamalarında, çok pasolu kaynak gereksinimi ve tüketilen elektrodları eritip yenilme süreçlerinin sık aralıklarla yapılması nedeniyle işlem süresi önemli ölçüde artmıştır. Bu durum, kaplama işlemlerinin toplam üretim süresini uzatmış ve yöntemin yüksek biriktirme hızına sahip alternatif kaynak yöntemlerine göre üretkenliğini sınırlandırmıştır.

Kaplama sonrasında yüzey düzlemselliğinin sağlanabilmesi amacıyla numune CNC dik işleme tezgâhında işlenmek istenmiş, ancak kaplama tabakasının yüksek sertliği nedeniyle standart kesici takımlar ile yeterli talaş kaldırma işlemi gerçekleştirilememiştir. Bu durum, kaplama metalinde oluşan sert karbür fazlarının işlenebilirliği önemli ölçüde azalttığını göstermektedir.

Şekil 11. Sert dolgu kaplama uygulanmış prototip ürünün CNC dik işleme tezgâhındaki görüntüsü.

4. SONUÇ

Görsel muayene sonuçlarına göre kaplama yüzeyinde enine çatlak oluşumları tespit edilmiş olup, bunun dışında herhangi bir yüzey hatası, ayrılma veya süreksizlik gözlemlenmemiştir.

Spektral analiz sonuçları, S690QL esas malzemenin TS EN 10025-6 standardında belirtilen kimyasal kompozisyon aralıklarını sağladığını göstermiştir.

Kaynak metaline ait spektral analiz sonuçları, üretici firma tarafından sağlanan sertifika verileri ile uyumlu bulunmuştur.

Tam katılaşma çizgisi (fusion line) boyunca gerçekleştirilen spektral analizlerde, karbon (C) ve krom (Cr) oranlarında azalma, demir (Fe) oranında ise artış gözlemlenmiştir. Bu durum esas malzeme ile kaplama metali arasındaki seyreltme etkisi ile ilişkilendirilmiştir [12]

Makro yapı incelemelerinde, kaplama ile esas malzeme arasında yeterli metalürjik bağın oluştuğu ve nüfuziyet açısından herhangi bir sorun bulunmadığı belirlenmiştir. Bununla birlikte kaplama yüzeyinde gözlenen çatlakların uzun dönem servis ömrü üzerinde olumsuz etkiler oluşturabileceği değerlendirilmiştir.

Vickers sertlik ölçümlerinde kaplama bölgesinde yaklaşık 60–66 HRC seviyelerine karşılık gelen yüksek sertlik değerleri elde edilmiştir. Bu değerler kullanılan Fe–Cr–C esaslı sert dolgu elektrodu için beklenen sertlik aralığındadır.

Isıl etkilenmiş bölgede (ITAB) her iki numunede de belirgin sertlik düşüşleri gözlemlenmiştir. Bu durum kaynak ısısı nedeniyle meydana gelen mikroyapısal değişimler ve tane irileşmesi ile ilişkilendirilmiştir.

ITAB bölgesindeki sertlik kaybının azaltılması amacıyla ilerleyen çalışmalarda Ti, Nb ve V gibi mikroalaşım elementleri içeren dolgu metalleri kullanılarak tane büyümesinin sınırlandırılması değerlendirilebilir [4]

Üretilen prototip aşınma plakası CNC dik işleme tezgâhında işlenmeye çalışılmış ancak yüksek sertlik nedeniyle işleme kabiliyetinin oldukça düşük olduğu görülmüştür. İşleme sırasında kesici takım uçlarında kırılmalar meydana gelmiş ve uzun işlem süresine rağmen sınırlı miktarda talaş kaldırılabilmiştir. Bu nedenle, sert dolgu kaplama uygulanmış yüzeylerin işlenmesinde yüksek sertlikteki malzemelere uygun CBN (Cubic Boron Nitride) kesici takımların kullanılması önerilmektedir [11].

Üretici katalog verilerine göre kaplama yüzeyinin taşlama işlemi ile son ölçülerine getirilmesi önerilmektedir. Bununla birlikte ilk kullanım aşamalarında yüzey pürüzlülüğüne bağlı olarak akış direncinde artış veya basınç kayıpları oluşabileceği, servis sürecinde meydana gelecek aşınma ile yüzeyin daha uygun hale gelebileceği değerlendirilmektedir.[9]

MMA yöntemi ile başarılı sert dolgu kaplamaları elde edilmiş olmakla birlikte, seri üretim açısından değerlendirildiğinde üretim hızının MAG kaynak yöntemine göre daha düşük olduğu görülmektedir.

Buna karşın MMA yönteminin saha uygulamalarında önemli avantajlar sunduğu düşünülmektedir. Özellikle aşınan veya hasar gören bölgelerin yerinde tamir edilebilmesi sayesinde ekipman duruş sürelerinin azaltılması ve bakım maliyetlerinin düşürülmesi mümkün olabilecektir.

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