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October 13-19, 2026

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PLENARY SPEAKER

Id-2927

AI Cognitive Neural Networks Based on a Memristor's Array as Synapses

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Abstract: Currently, information technologies relating to artificial intelligence develop artificial neural networks using simple neurons and hardware for video signal processing. A biomorphic neuroprocessor provides the possibility to manage complex dynamic objects and make decisions not only on the basis of previously stored data, but also on the basis of new knowledge obtained during signal processing in the dynamically changing environment. Once such neuroprocessor is created, it can replace the present-day personal computers with new generation computers which can generate new knowledge. In addition to the task of obtaining new knowledge, which relates to creation of artificial intelligence systems, this hardware can solve such technical objectives, as increasing the performance and energy efficiency of calculations as compared to the existing computing devices (personal computers, servers, and supercomputers) due to the application of mixed analog and digital computations, including those using memristors integrated into nanoscale crossbars.

So, an alternative to the Neumann architecture is cognitive or neuromorphic computers, which operate on the principle of the organization and functioning of biological neural networks of a living organism, distributing processing and memory within a single system. For example, the human brain has a complex structure, consisting of more than a billion neurons and trillions of synapses. Neurons are composed of a cell body, an axon that generates a nerve pulse, and numerous dendrites that receive signals from other neurons. A synapse is a structure that allows a neuron to transmit an electrical signal to another neuron. Neuromorphic computing systems can be built on a similar principle and typically consist of neurons and synapses that mimic the system of the human brain. Each neuron represents a core that processes data, and the neurons themselves are connected in parallel via synapses for information transfer providing an ultra-fast and energy-efficient neuromorphic system capable of solving complex cognitive tasks, such as real-time image recognition.

The concept of neuromorphic devices, which are a combination of a CMOS logic and memristor array assumes that fabrication of memristors and memristor crossbars is compatible with the classical CMOS technology on silicon. The application of memristors as synaptic connections in the biomorphic neuron model can potentially increase the performance due to implementation of numerous resistive states in a memristor.

This presentation will describe the current status and future of memristor technology based on chalcogenide phase change materials. We consider that 2D phase changing materials will be the best candidate if we will solve the problem of its phase metastability.

During last three decades we were investigating physical effects of memory and switching at the interface of tellurium based chalcogenide thin films and designed the technological process to

manufacture the non-volatile and reprogrammable memory cells. We have developed also the physical model focusing on possible conversion of a normal isolator OFF state into a topological ON state by application of an external electric field that shifts different energies and induced a specific band inversion, which leads to a topological state.

We believe that artificial intelligence systems with novel memristor synapses for neuromorphic computing using the benefits of transition metal chalcogenide materials and two-dimensional heterostructures will be commercialized in the nearest future.

Keywords: Artificial intelligence, Neuromorphic computing, Memristor synapses, Transition metal chalcogenides

PLENARY SPEAKER

Id-2934

Reconfigurable Nanooptics and Smart Chromogenic Sensors Enabled by Multi-Stimuli-Responsive Shape Memory Polymers

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Abstract: Shape memory polymers (SMPs) are stimuli-responsive materials that can change their shapes upon application of an external stimulus (e.g., heat and light). They have been extensively exploited for a wide spectrum of technological applications ranging from smart biomedical devices to aerospace morphing structures. Unfortunately, most of the currently available SMPs are thermoresponsive and they suffer from heat-demanding shape memory programming and recovery processes. Additionally, the intriguing nanoscopic shape memory effects, which could significantly enhance the response speed and greatly expand the application scopes of SMPs, are largely unexplored. In this presentation, I will discuss unconventional nanoscopic shape memory effects exhibited by a new series of multi-stimuli-responsive SMPs. When combined with a unique macroporous photonic crystal structure templated from self-assembled colloidal crystals, these smart SMPs enable nontraditional “cold” programming and instantaneous shape recovery at ambient conditions triggered by multiple nontraditional stimuli, such as static pressure, lateral shear stress, a large variety of liquids and vapors, ultrasonic waves, and laser illumination. Additionally, striking chromogenic responses associated with a full all-room-temperature shape memory cycle could render a new and sensitive optical technology for investigating the intriguing nanoscopic deformation and recovery of SMPs. Moreover, the stepwise recovery of collapsed macropores leads to easily perceived color changes that can be correlated with concentrations of various analytes in gas, liquid, and solid phases, promising for developing novel chromogenic sensors. These smart polymers provide vast opportunities for a plethora of applications ranging from reconfigurable nanooptical devices to chromogenic pressure and chemical sensors to novel biometric and anti-counterfeiting materials.

Keywords: Photonic crystals, Shape memory polymers, Self-assembly, Structural colors, Sensors, Stimuli-responsive

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PLENARY SPEAKER

Id-2938

Neuromorphic Edge Computing for Low-Power Intelligent Sensing

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Abstract: Neuromorphic computing is emerging as a promising paradigm for energy-efficient artificial intelligence in sensing and monitoring systems that must operate under strict power, memory, thermal, and communication constraints. Inspired by the structure and dynamics of biological nervous systems, neuromorphic approaches exploit event-driven operation, sparse activity, temporal coding, local adaptation, and the close coupling of memory and computation. These principles are particularly relevant for edge devices, where data are generated close to physical processes and where conventional cloud-centric AI can be limited by latency, bandwidth, reliability, privacy, and energy costs. As sensing infrastructures become more pervasive, the ability to process information locally and efficiently is becoming essential for sustainable digital systems.

This talk presents sustainable neuromorphic edge computing as an interdisciplinary research direction at the intersection of nanoelectronics and information technology, microelectromechanical systems (MEMS), environmental physics, and computer science. From the device and materials perspective, emerging neuromorphic technologies based on memristive effects, phase-change materials, spintronic devices, photonic components, ferroelectric materials, and other non-von-Neumann substrates offer new opportunities for low-power computation, adaptive signal processing, and in-memory learning. These developments create a natural bridge between physical device principles and intelligent information processing, especially when computation must be embedded directly into compact, resource-constrained sensing platforms.

The talk will also discuss how neuromorphic principles can be integrated with MEMS-based and embedded sensing systems for autonomous monitoring, distributed decision-making, and resilient operation in real-world environments. MEMS sensors already provide compact and energy-efficient interfaces to physical phenomena such as motion, pressure, vibration, flow, and environmental change. When combined with event-driven neuromorphic processing, they can support sensing architectures that react primarily to meaningful changes rather than continuously transmitting redundant data. This is important for environmental and safety-critical monitoring scenarios, where sensors and edge devices must operate for long periods in remote, harsh, or resource-constrained conditions.

Examples include infrastructure monitoring, early warning systems, adaptive environmental sensing, and monitoring of critical assets affected by climate-induced hazards. In such applications, efficient local intelligence can reduce data transmission, improve responsiveness, support operation under intermittent connectivity, and extend device lifetime. At the same time, environmental physics provides the context for understanding the monitored processes, the dynamics of physical signals, and the constraints imposed by deployment environments.

By linking underlying physics and materials with edge-level AI system design, neuromorphic computing can contribute to a new generation of intelligent sensing systems that are faster, more autonomous, and more energy-aware. The central argument of the talk is that progress in this area requires a full-stack perspective, spanning materials, devices, MEMS-enabled sensing, algorithms, embedded platforms, and distributed edge--cloud infrastructures. Such a perspective can help translate advances in applied physics and materials science into practical AI-enabled systems for sustainable and resilient monitoring.

Keywords: Nanoelectronics and information technology, Microelectromechanical systems, Environmental physics, Neuromorphic computing, Edge AI.

PLENARY SPEAKER

Id-2945

Waste-Derived Zeolite for Pollution Remediation: An Example of the Circular Economy

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Abstract: Zeolites are natural and synthetic minerals characterized by open structures composed of TO4 tetrahedra (T = Si, Al), which provide a high surface area and porosity. Zeolite synthesis primarily relies on pure chemical sources, which are generally expensive and often have a negative environmental impact. Therefore, approaches based on sustainable processes compatible with environmental protection and circular economy are highly attractive. In recent years, attention has shifted toward industrial and agricultural waste, which serves not only as an alternative to disposal but also as a valuable source of silicon and aluminum essential for zeolite synthesis.

Rice husk is an agricultural by-product of rice production, accounting for 22% of paddy rice by weight. Global paddy rice production in 2019 reached 782 million tons, yielding 172 million tons of rice husk and 43 million tons of rice husk ash after combustion. Generating such large volumes of waste leads to growing disposal challenges. However, its chemical composition reveals a high silica content (15–28% by weight), which reaches 85–98% by weight after combustion. Steel slag is the most abundant metallurgical waste discharged by the steel industry. According to the 2020 Iron and Steel Statistical Yearbook, global crude steel production reached 1.875 billion tons in 2019; consequently, the volume of generated waste is substantial, causing issues such as landfill land use and environmental pollution. Nonetheless, steel slag is characterized by high concentrations of acid oxides (SiO_2) and other oxides (mainly FeO). Fly ash is the product of coal combustion in thermal power plants, with approximately 800 Mt produced annually worldwide. This indicates that a significant amount of coal fly ash is currently disposed of in landfills. However, fly ash is composed of 34–80% amorphous material. Finally, red mud is a waste material generated during alumina production when bauxite ore undergoes caustic leaching. The risks associated with this waste mainly stem from the cumulative contamination of soil and surrounding areas. Red mud is composed of iron oxyhydroxides and aluminum hydroxides.

Based on their composition, these waste materials can be used as cost-effective sources of silicon, aluminum, or both, for zeolite synthesis. These zeolites can also exhibit magnetic properties, achieved simply by exploiting the chemical-mineralogical composition of the precursor waste. Furthermore, due to their unique structural characteristics, these zeolites can be applied to mitigate environmental pollution. Water pollution is a growing global concern, and the increasing presence of heavy metals and pharmaceuticals in aquatic ecosystems represents a critical issue. Antibiotics pose the most serious threat. The use of waste-derived magnetic zeolites has been successfully tested for the adsorption and recovery of heavy metals and fluoroquinolone antibiotics from aqueous solutions. These studies highlight, on the one hand, the significant adsorption capacity of these synthetic materials, along with

their effortless removal from decontaminated solutions via an external magnetic field. On the other hand, they underscore the desorption capabilities of these synthetic products, validating innovative approaches such as magnetic hyperthermia, which can be applied precisely due to the unique magnetic properties of these materials.

Keywords: Waste, Zeolite, Water pollution, Heavy metals/antibiotic, Circular economy.

PLENARY SPEAKER

Id-2970

FFLUX: Machine Learnt Potentials Based on Quantum Topological Atoms

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Abstract: We pioneered the use of Gaussian Process Regression in atomic potentials. Contrary to other research groups we started with the machine learning (ML) of electrostatics. We covered all 20 amino acids because FFLUX targets protein simulation. Electrostatics manifests itself at long-range and, in order to reach the exact limit, one must work with multipole moments. Next followed accurate ML predictions of the atomic energies using quantum topological atoms, such that a single partitioning method provides all atomic properties. This uniformity guarantee accuracy for the right reasons and hence future-proof work. Sustained in-house software development delivered the training program[5] FEREBUS supported by the pipeline ICHOR and the MD program DL_FFLUX. ML methods such as grey-wolf optimisation are used for the first time with superior performance. The parallellisation of DL_FFLUX enables the simulation of condensed matter, whether molecular crystals or liquid water, all with polarisable electrostatics. We also reached a proof-of-concept replacing Lennard-Jones potentials for both repulsion and dispersion. FFLUX simulations show unprecedented robustness with competitive CPU timings.

Keywords: FFLUX simulations.

PLENARY SPEAKER

Id-3001

Experimenting with Individual Atoms and Molecules – From Nano-Snowflakes to Single-Molecule Switches

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Abstract: In the novel “The Wrench” from 1978, a chemist explains how he and his colleagues dream of building molecules, how they fantasize about tweezers with which they pick up individual parts of a molecule, hold them and place them exactly where they are needed in a molecule. If such tweezers existed, we would be able to produce wonderful things such as only God was able to produce until now, the chemist ends his description. With the invention of the scanning tunneling microscope (STM) in the 1980s, such 'tweezers', which allow individual atoms and molecules to be observed and changed, were actually realized. Such physical and chemical systems are the subject of current basic research, on the one hand, and, on the other hand, they form the basis for future technologies in information technology. We employ this technique in order to understand the properties of nanostructures and chemistry on the nanoscale. Here, I will present the fascination of experimenting with individual atoms and molecules on three examples. First, the formation of nano-snowflakes is monitored from single water molecules to fractal islands. Then, the advantage of a laser-induced over a thermally induced on-surface reaction is demonstrated. Finally, an individual molecule is manipulated that might serve as a molecular switch in future nano-electronics.

Keywords: Scanning Tunneling Microscope (STM), Molecular manipulation, Nano-electronics

PLENARY SPEAKER

Id-3005

Nanomaterial Engineering for Advanced Functional Devices

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Abstract: Nanomaterials such as carbon nanotubes (CNTs), graphene quantum dots (GQDs), and semiconductor nanowires (NWs) exhibit exceptional physical and chemical properties that open new pathways for advanced device architectures. Their integration into device fabrication enables multifunctional platforms that address diverse technological challenges, including unconventional computation, efficient solar-driven water splitting, and high-performance energy storage.

This paper introduces the concept of multifunctional nanomaterial-enabled devices, highlighting simple and scalable fabrication processes that allow a single device to perform multiple functions. Likewise, we will discuss how the introduction of nanostructured materials can enhance devices' performance, e.g. supercapacitor energy storage. Two case studies are presented to demonstrate these principles.

The first case study focuses on the controlled growth and processing of ZnO nanowires (NWs) for application as photoanodes in water-splitting systems. ZnO NWs, with their wide bandgap (~3.37 eV) and high exciton binding energy (~60 meV), are particularly attractive for photoelectrochemical applications. We demonstrate that low-cost chemical bath deposition can yield single-phase wurtzite ZnO NWs, whose optical properties can be tuned via doping. Furthermore, conformal coating with a metal–organic framework enhances charge separation and surface reactivity, offering a promising route toward high-efficiency photoanodes.

The second case study explores the role of edge-engineered graphene quantum dots in electrochemical energy storage. Nitrogen-doped zigzag-edge GQDs (ZZ N-GQDs) are synthesised hydrothermally, with size controlled by reaction time and bandgap tunability achieved through electrolyte pH modulation. Compared with armchair-edge GQDs, ZZ N-GQDs exhibit enhanced quantum capacitance and density of states owing to dispersionless edge states, thereby yielding superior energy storage performance. When integrated with tungsten disulfide (WS_2), a layered transition metal dichalcogenide with high theoretical capacity but limited cycling stability, the ZZ N-GQDs significantly improve electrochemical kinetics and structural integrity, leading to stable WS_2-based supercapacitor electrodes that have not been achieved to date. This hybrid architecture enhances the specific capacitance from 64.8 F g^{-1} to 118.6 F g^{-1} in 1 M KOH electrolyte, demonstrating its potential for next-generation high-energy supercapacitors.

Together, these studies illustrate how nanomaterial design and interface engineering can enable multifunctional devices with enhanced performance across energy, catalytic, and sensing applications.

Keywords: Nanomaterials, Devices, Energy, sensing

PLENARY SPEAKER

Id-3040

Tunable Photonic Liquid Crystal Metasurfaces for Spectral-Polarimetric Imaging, Biosensing, aand Energy Management Applications

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Abstract: Photonic metasurfaces hold tremendous potential for a wide range of applications, particularly when endowed with tunability, enabling next-generation optical systems requiring higher speeds, enhanced contrast ratios, cost-effectiveness, and miniaturization. Such systems are highly desirable for spectral and polarimetric imaging, smart windows, tunable lasers, adaptive lenses, medical diagnostics, and augmented/virtual reality (AR/VR) technologies.

Recent advances in nanotechnology, computational methods, artificial intelligence, and nanophotonics have created new opportunities for engineering reconfigurable photonic platforms. Liquid crystals (LCs) are particularly attractive active materials due to their large electro-optic and thermo-optic responses, low power consumption, and ability to infiltrate nanoscale structures. Leveraging these properties, we have developed unique LC-based devices, including smart windows, high-speed light modulators, tunable optical switches, a spectral camera, and a fast spectral-polarimetric imager.

Fast spectral modulators offer transformative opportunities for real-time monitoring of environmental pollutants and hazardous materials, either through infrared spectroscopy or surface-enhanced Raman scattering (SERS). However, realizing the full potential of LC-integrated metasurfaces remains challenging due to difficulties in controlling LC alignment inside nanoapertures and maximizing interaction with confined optical fields.

One approach involves integrating nanostructures with submicron-thick LC layers, enabling tunable devices with achromatic operation, improved bandwidth, and enhanced field of view. Alternatively, exploiting resonant nanostructures and evanescent-field interactions provides enhanced tunability and faster switching, although the thick LC layer still limits response speed. By introducing LC directly into nanoapertures, the overlap with localized optical fields can be dramatically increased, resulting in stronger light–matter interaction, wider tuning ranges, and switching speeds improved by an order of magnitude.This research will explore advanced strategies for controlling LC alignment within nanoapertures and engineering the local optical environment to maximize LC–field interaction, enabling fast, highly tunable photonic metasurfaces for imaging, sensing, energy management, and adaptive optical systems.

Ibrahim Abdulhalim studied Physics at the Technion, where he received his D.Sc. in 1988. He has been a Professor in the Department of Electro-Optics and Photonics Engineering at Ben-Gurion University since October 2005 and served as Head of the Department from 2007 to 2015. Before this position, he held research and professional roles in both academia and industry, including at the Optical Computing

Systems Center at the University of Colorado Boulder, the Optoelectronics Research Centre (ORC) at the University of Southampton, the Thin Films Centre at the University of the West of Scotland, as well as companies such as KLA-Tencor, Nova Measuring Instruments, and GWS Photonics. His current research focuses on liquid crystal (LC) devices for photonic applications, energy-saving optoelectronic devices, nanophotonics and plasmonics for biosensing, and biomedical optical imaging techniques. Prof. Abdulhalim has published over 300 scientific articles, co-authored two books and 12 book chapters, and holds more than 25 granted patents. He is a Fellow of the Institute of Physics (IoP) and SPIE, and a Senior Member of OPTICA. He has served as Associate Editor for the “SPIE Journal of Nanophotonics” and the “Journal of Imaging”, and currently serves as Topical Editor for “Applied Optics” and Associate Editor for the journals “Biosensors” and “Sensors”. He has also founded two startup companies: Photonicsys, specializing in miniature photonic sensing instruments, and Photoliqsys, focusing on liquid crystal devices and their integration into systems.

Keywords: Liquid crystal devices, Tunable metamaterials, Spectral-polarimetry, Energy saving

PLENARY SPEAKER

Id-3042

New Frontiers in Topological Quantum Matter

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Abstract: Topology plays a key role in describing quantum matter, which has been greatly explored in recent decades [for an introduction: M. Z. Hasan & C. L. Kane, Rev. of Mod. Phys. (RMP) 82, 3045 (2010)]. I present how tuning a topological insulator featuring a Dirac fermion can be used as a platform to realize emergent Weyl fermion and “fractional” Fermi surfaces; and can also lead to correlated magnetic, Chern, or many-body topological states. The kagome lattice, which features Dirac fermions, flat bands, and van Hove singularities, can serve as the 2D platform to explore topology, strong correlation, exotic superconductivity and many-body density-wave and topological phenomena as shown in a series of most recent works. I will also discuss our recent successful observation of quantized photocurrents in gapless topological matter establishing an all-optical analogue for the quantum Hall effect with potential applications in topological optoelectronics. These novel topological quantum matter in 2D and 3D harbor properties that provide platforms for the development of next-generation quantum devices and novel technologies.

Keywords: Topological Quantum Matter, Topological Insulators, Weyl semimetals.

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PLENARY SPEAKER

Id-3066

Higher-Order Interactions as a Route to Tunable Phase Behavior in Two-Dimensional XY Systems

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The properties of functional materials are often determined by subtle details of the interactions between their microscopic degrees of freedom. In magnetic and orientational systems, these interactions need not be restricted to the conventional bilinear coupling and may contain significant higher-order contributions. We investigate how such interactions can be used to modify and control the collective behavior of two-dimensional systems with continuous rotational degrees of freedom.

Using generalized XY models with systematically introduced higher-order angular interactions, we demonstrate that these terms provide a powerful mechanism for tailoring the effective interaction potential and, consequently, the macroscopic phase behavior. Depending on their order, strength, and mutual competition, higher-order interactions can substantially modify the stability of the ordered state, alter the character of the thermal transition, and generate intermediate phases that are absent in the conventional XY model. In particular, competing interactions can stabilize non-collinear and canted configurations, while appropriately designed sequences of higher-order terms can produce multiple successive ordering transitions upon cooling.

We further show that the number and nature of the observed transitions can be controlled by systematically varying the number and relative strength of the higher-order contributions. For sufficiently strong and rapidly increasing higher-order interactions, a single transition of the conventional model can split into a sequence of transitions between states with progressively different orientational symmetries. Conversely, a suitable combination of higher-order terms can drive the system toward a strongly discontinuous transition.

These results demonstrate that higher-order interactions should be regarded not merely as small corrections to conventional exchange coupling, but as an important design parameter for controlling emergent collective states. The generalized XY framework provides a simple model platform for exploring how microscopic interaction engineering may lead to tunable magnetic, orientational, and non-collinear structures in low-dimensional materials and complex systems.

Keywords: Generalized XY model; Higher-order interactions; Phase transitions; Emergent magnetic phases; Interaction engineering

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PLENARY SPEAKER

Id-3068

Artificial Intelligence-Driven Materials Characterization via Synchrotron-Based Spectroscopy and Scattering: A Review and Examples

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Abstract: As an indispensable tool in energy science, molecular biology, and materials research, synchrotron radiation relies on ultra-high-resolution data capture. Synchrotron facilities deliver unique insights into atomic and electronic material structures via high-brightness X-rays, but the resulting "data deluge" now exceeds the capabilities of traditional analysis. The convergence of synchrotron methods with modern AI and machine learning has opened new avenues for high-throughput, efficient experimentation. This review highlights how Artificial Intelligence (AI) and Machine Learning (ML) are reshaping synchrotron-based materials characterization. I will focus on AI applications in X-ray Absorption Spectroscopy (XAS) for electronic structure analysis and Small-Angle X-ray Scattering/X-ray Diffraction (SAXS/XRD) for structural profiling. Traditionally, analyzing synchrotron data such as X-ray diffraction (XRD), absorption spectroscopy (XAS), or small-angle scattering (SAXS) has depended on manual curve-fitting or computationally heavy first-principles methods like Density Functional Theory (DFT). These traditional approaches are labor-intensive, require specialized expertise, and fail to provide the real-time feedback essential for dynamic experimental tuning. To address these limits, the field is undergoing a fundamental shift toward data-driven paradigms. Artificial Intelligence (AI) and Machine Learning (ML) overcome these bottlenecks by learning complex non-linear relationships across large datasets, resolving the inverse problem mapping scattering spectra back to core material properties in milliseconds. Beyond simple property prediction, modern "Agentic AI" architectures now deploy autonomous agents capable of managing entire experimental cycles, from generating hypotheses to executing direct beamline control. Specific examples from our research on Hf-based ferroelectric materials and LaSrCoO-based solid oxide fuel cell materials that could benefit from these new developments will be presented.

Keywords: X-ray Absorption Spectroscopy (XAS), Artificial Intelligence (AI), Machine Learning (ML).

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INVITED SPEAKER

Id-2941

Recent Advances in Development of Amorphous Microwires for Sensor Applications

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Abstract. Amorphous magnetic wires have attracted great attention owing to their excellent soft magnetic, mechanical and corrosion properties. Rather unusual magnetic properties such as magnetic bistability or Giant Magnetoimpedance (GMI) effect are suitable for various sensor applications [1]. Recent tendency in devices miniaturization stimulated development of thin (few μm diameters) microwires. Generally, better magnetic softness and higher GMI effect have been observed in Co-rich amorphous microwires, while Fe-rich amorphous microwires present spontaneous magnetic bistability related to remagnetization process through fast domain wall propagation. Less expensive Fe-rich microwires are preferable for the applications, but exhibit rather high magnetostriction coefficient, λ_s, and quite low GMI effect. We designed the post- processing allowing remarkable improvement of magnetic softness of Fe- and Fe-Co based glass-coated microwires. Stress annealing of Fe-rich microwires allows considerable magnetic softening, GMI effect enhancement and remarkable improvement of domain wall (DW) dynamics. In Co-rich microwires stress-annealing allows better magnetic softness, GMI effect improvement due to induction of transverse magnetic anisotropy at high enough annealing temperature. On the other hand, conventional annealing allows to obtain Co-rich microwires with magnetic bistability and rather fast DW dynamics. Observed versatile properties of properly processed glass-coated amorphous microwires with enhanced and tunable soft magnetic properties make them suitable for various sensor applications.

Keywords: Magnetic wire; Amorphous materials; Soft Magnetic materials; GMI effect; hysteresis loop.

INVITED SPEAKER

Id-2944

Multilayer Non-Volatile Memory Elements

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Abstract: Analysis of the current state of research in the field of memristor structures shows that classical resistive switching mechanisms based on the electroforming of conductive regions or phase transitions between amorphous and crystalline states have reached the limits of their technological capabilities in terms of energy consumption, scaling and stability of characteristics. In this regard, an urgent scientific and technical task is to find alternative switching mechanisms that could provide record write/erase times, low threshold voltages and long data storage times. One of these promising areas is the study of the processes of polar electromigration of components at the interfaces of complex chalcogenide compounds, leading to the formation of metastable phases with a fundamentally different type of conductivity. The purpose of this work is to simulate and study physical processes at the interface in thin-film structures based on two- and three-component chalcogenides that determine the mechanisms of phase transitions and memory. For the first time, an alternative concept of resistive threshold switching at the interfaces of two- and three-component chalcogenide semiconductor materials with the formation of metastable dichalcogenide compounds and the development of methods for their structural stabilization are proposed.

Keywords: Thin films, chalcogenide alloys, switching and memory effects, transition metal dichalcogenides.

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INVITED SPEAKER

Id-2973

Key Elements on Data Digitalization Methodology for Radiological Characterization of a Cyclotron U-120- Type Particle Accelerator Under Decommissioning

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Abstract: The present paper describes key elements on data digitalization methodology developed for radiological characterization of Cyclotron U-120-1 type particle accelerator under decommissioning, from IFIN-HH, Romania. Digitalization of radiological data conduct to an efficient planning of decommissioning work performed in order to reduce decommissioning costs and period, to assess the dose and radiological risks for different working scenarios. Also, ensures an efficient management by retrieval and use critical decommissioning information, promotes transparency, accuracy and facilitates informed decision-making. Data digitalization methodology is defining, establishing and implementing the appropriate objectives, methods and procedures for identifying, quantifying, mapping, data digitizing on radioactive contaminants from Cyclotron structures, systems, components, and spaces. It is an efficient method with high confidence level and low uncertainties for in situ measurement, large volumes of radioactive waste, radioactive waste packages with complex configurations. The methodology was developed, tested and implemented using DigiWASTE Platform for easily identification of radioactive sources and waste tracking from the earliest phase of D&D cycle. Radionuclide identification, dose rate monitoring and read/write UHF RFID tagging of materials is done with RADHAND 600 PRO innovative instrument equipped with high-efficiency 2"x2" NaI detector and advanced digital pulse processing (DPP) algorithms. Radiological data from D&D activities are loaded, collected and processed into RadBASE. Methodology was developed in line with Holistic Strategy to eliminate legacy system limitations, ensures data security and regulatory compliance. Data accuracy and accessibility are increased by routine tasks automation, sensor networks integration and advanced data analytics. Personnel is trained with skills needed to operate new technologies and adapt to digital workflows.

Keywords: Data digitalization, Methodology, Radiological Characterization, Decommissioning.

Acknowledgement: The paper is performed under the Research Project "Developing and Implementing of a Digitalization System to Streamline the Nuclear/Radiological Facilities Radiological Characterization under Decommissioning" IAEA Research Agreement No: 28780, developed under IAEA Coordinated Research Project ‘T24010’ "Deployment of Innovative Digital Technologies for Efficient Decommissioning of Nuclear Facilities (DEDICATE)".

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INVITED SPEAKER

Id-3007

Modern Electric Power System Power Surges

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Abstract: Modern electric power systems are experiencing increased number of blackouts. This fact seems to be true in different countries and on different continents. Renewables could support such events in different ways. Electric power system stability has been assured however, blackouts are still occurring. Explanation could be offered in form of simulations conducted with various software tools.

Keywords: Electric power system, Photovoltaics, Power surges, Blackouts

INVITED SPEAKER

Id-3009

Molecular Self-Assembly to Advanced Microelectronics: Tailoring Nanostructures and Phase Interactions

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Abstract. Self-organization processes are driven by the spontaneous arrangement of molecular units into ordered supramolecular architectures via non-covalent interactions. Operating through weak molecular forces, such as van der Waals interactions and hydrogen bonding, these localized phenomena enable autonomous nanostructure formation. Consequently, self-assembly methods represent a vital "bottom-up" approach to nanofabrication, holding significant promise for next-generation microelectronics.

This work examines the fabrication of mesoporous films and composites utilizing template-assisted molecular self-assembly, focusing on silica-based organic-inorganic hybrids, mesoporous oxides, and related composite materials. Porous structures obtained via template synthesis exhibit a direct correlation with the supramolecular assemblies formed by surfactant templates. This relationship allows for precise tailoring of material properties by tuning the synthesis parameters, offering viable solutions to the critical challenges of modern semiconductor manufacturing. However, the precise synthesis mechanisms of these materials require further elucidation.

As a primary application, low-k dielectrics are evaluated. Current porous organosilicate glasses with low dielectric constants deposited via PECVD fail to meet further scaling requirements due to an inherent trade-off between porosity, hydrophobicity, and mechanical rigidity. In contrast, periodic mesoporous organosilicates provide enhanced control over porosity and stiffness through surfactant modulation, while demonstrating excellent gap-fill capability between metal lines. Nevertheless, their formation mechanisms and intrinsic properties remain partially understood. This report focuses on optimizing the key parameters critical for successful integration into Back-End-of-Line (BEOL) processes.

Furthermore, molecular self-assembly methodologies are extended to the fabrication of diverse oxide materials, with particular emphasis on controlling the pore structures and properties of various porous systems, including perovskites. A novel approach is presented involving the synthesis of a composite thin film composed of a crystalline framework with an embedded atomic layer deposition (ALD) layer. We demonstrate that the synergistic interaction between the two phases enables the design of materials with novel physical properties.

Keywords: Mesoporous film, Self-assimbly, Composite, Low-k, BEOL.

Acknowledgment: This work was supported by the Russian Science Foundation, grant № 23-79-30016.

16th International Advances in Applied Physics & Materials Science Congress & Exhibition

INVITED SPEAKER

Id-3022

Vertical Control in Magnonics: Layered Architectures for Tunable Spin-Wave Interactions and Band Engineering

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Abstract. The possibility of manipulating spin-wave propagation without relying on charge transport has made magnonics a promising platform for low-power information processing. Beyond the engineering of in-plane magnonic crystals, an increasingly attractive strategy is the exploitation of vertical heterostructures, where different magnetic or multifunctional layers interact to generate new dynamic functionalities that are inaccessible in isolated systems. This talk will provide a brief overview of the physical mechanisms governing spin-wave propagation, mode hybridization, and band-structure engineering in such layered architectures, highlighting how interlayer coupling can be exploited as a versatile degree of freedom for controlling magnon transport.

The first part of the presentation will focus on coupled artificial spin ice (ASI)/continuous-film heterostructures. Combining micromagnetic simulations with experimental evidence, we demonstrate that the interaction between propagating spin waves in the film and the localized eigenmodes of the ASI gives rise to highly frequency-selective magnon–magnon coupling. Depending on the magnetic properties of the constituent materials, and in particular on their saturation magnetizations, the hybridization can be tailored to involve either edge-localized or bulk ASI modes, providing an effective route toward selective mode conversion and tunable dynamic coupling between distinct magnonic excitations.

In the second part, the discussion will move to a different realization of vertical control, where a continuous magnetic film experiences a periodically modulated magnetization produced by an equally periodic magnetic field. Such a field may originate from a meandering current conductor or, more intriguingly, from strain-mediated magnetoelectric coupling in multiferroic heterostructures, where a ferroelectric layer with alternating polarization directions induces a spatially modulated magnetic anisotropy through inverse magnetostriction. The resulting reconfigurable magnonic crystal exhibits a tunable band structure, whose band gaps and dispersion characteristics can be continuously engineered by varying either the magnetic-field profile or the electrically controlled anisotropy.

Within this framework, we discuss a transition from a gapless ('metallic') to a gapped ('insulating') magnonic band structure, moving from a Dirac-like magnon dispersion to an electrically controllable band gap. This transition provides a powerful mechanism for dynamically tailoring spin-wave transport

and offers new opportunities for reconfigurable magnonic devices, including directional couplers and programmable wave-based logic architectures.

Overall, the examples presented illustrate how vertical integration of magnetic and multifunctional materials enables unprecedented control over magnon spectra, interactions, and transport, opening new perspectives for scalable, low-dissipation magnonic technologies.

Keywords: Magnonics, Magnon-magnon coupling, Spin Waves, Brillouin light scattering, Magnetoelectric Coupling.

Acknowledgment: Authors acknowledge support by the Department of Physics and Earth Sciences-University of Ferrara Grant Bando FIRD 2024, as well as the CINECA award under the ISCRA initiative, or the availability of high performance computing resources and support.

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INVITED SPEAKER

Id-3029

Crystal Growth, Transport Phenomena, and Superconducting Properties of K and Cs-based Ferroselenides

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Abstract: Alkali-metal ferroselenides $A_xFe_{2-y}Se_2$ belonging to the 122-Se family show a set of unique properties which are not typical for other iron-based superconductors. Ferroselenides are natural composites of antiferromagnetic (AFM) dielectric phase (which occupies about 85% of the bulk) with $A_{0.8}Fe_{1.6}Se_2$ structure and superconducting (SC) phase with $A_{0.3}Fe_2Se_2$ structure occupying only 15% of the bulk of the crystal. Due to the presence of alkali metal, such compounds rapidly degrade in open air, and therefore remain understudied to date.

We have grown large (up to 8 mm in length) crystals of K-based ferrosenides with isovalent substitutions $K_{0.8}Fe_{1.7}(Se_{0.73}S_{0.27})_2$ (KFSS), $(K_{0.8}Na_{0.2})_{0.9}Fe_{1.7}Se_2$ (KNFS) and $(Na,K,Rb)_{0.8}Fe_{1.7}Se_2$ (NKRFS), as well Cs-based compound $Cs_{0.8}Fe_{1.7}Se_2$ (CFS) with critical temperatures $T_c \approx 23–33$ K. The AC magnetic susceptibility $\chi'(T)$ and resistance R(T) characteristics were measured within the wide range of temperatures. The R(T) dependences reproducible show features originated from multiple-phase composition of the studied crystals, and an absence of structural or magnetic transitions up to 300 K in accordance with the doping phase diagram of the iron-based superconductors.

In order to study the SC properties, we used two complementary tunneling spectroscopy techniques realized by a planar mechanically controlled break-junction technique. The fundamental characteristics of the SC phase — the SC order parameter $|\Delta(0)|$, its temperature dependence $|\Delta(T)|$, and the characteristic ratio $2|\Delta(0)|/k_BT_c$ — were directly measured using incoherent multiple Andreev reflection effect (IMARE) spectroscopy of ballistic SnS-junctions (S — superconductor, n — thin normal metal). The temperature dependence of the self-field critical current proportional to the Cooper pair concentration $I_c(T) \propto \rho_S(T)$ were determined using spectroscopy of phase-coherent ScS-junctions (c — constriction or Sc-circuit). The self-consistency of the two techniques was unambiguously demonstrated. Using the tunneling spectroscopy data obtained with KNFS, KFSS, NKFRS, and CFS, we determined a strong coupling of the electrons in the Cooper pair and discuss the SC properties evolution with critical temperature T_c for the ferroselenides.

Keywords: High-temperature superconductivity, Fe-based superconductors, Superconducting order parameter, Tunneling spectroscopy, Nematicity.

Acknowledgements: This research was funded by the Russian Science Foundation project number 22-72-10082-P.

INVITED SPEAKER

Id-3039

Design and Engineering of Multifunctional and Antifouling Biomaterials

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Abstract: Biomaterial-associated fouling – occurring mainly in the shape of thrombogenic fouling, resulting from blood protein and platelet adhesion or biofilm formation caused by bacterial adhesion and accumulation – poses significant challenges in the healthcare system. These challenges can greatly impact the performance of medical devices and implants, extend hospital stays and can lead to life-threatening events such as systemic infections and embolisms. Moreover, standard preventive measures such as anticoagulants and antibiotics can lead to additional problems such as severe bleeding and the emergence of antimicrobial-resistant bacteria, a crisis that poses a worldwide public health threat. Given these challenges, there is an urgent need to develop new biomaterials and surface coatings with superior antifouling properties that also maintain verified biocompatibility under realistic biological conditions. Factors such as surface chemical, physical, and bulk mechanical properties of the material, combined with the stability of the surface coating and the entire synthetic system, need to be thoroughly investigated and optimized during the design, fabrication, and testing processes. The surface properties and spatial structure of the substrate (e.g., roughness, micro-nano structures, wettability) play a crucial role in influencing their effectiveness in preventing/enhancing biointeractions. Moreover, studies have shown these properties highly affect bacterial behaviour and their resistance toward antibacterial treatment. In this talk, I will share insights from our research, highlighting our work in developing novel combinations of synthetic and natural biomaterials, fabrication methods, and surface coating and modification techniques with the aim to design the next generation of multifunctional biointerfaces that prevent non-specific adhesion and biofouling, promote desired biointeractions, and ultimately guarantee the reliability and performance of the biomedical system.

Keywords: Biointerface, Biomaterials, Antifouling surfaces, Multifunctional surface coatings, Multifunctional biomaterials

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INVITED SPEAKER

Id-3048

Rare and Lesser-Known Minerals as Prospective Sources for Advanced Functional Materials

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Abstract. The modern needs of humanity for in technology and new materials are rapidly evolving, and, consequently, the field of materials science is undergoing dynamic development. The objectives and goals of materials science are extensive, encompassing the full spectrum of current advancements both within individual scientific disciplines and in the form of interdisciplinary research. One such example is the investigation of the properties of natural objects, which subsequently become relevant prototypes for the creation of synthetic materials with unique luminescent, biochemical, electrical conductivity, sorption, catalytic, surface, and many other properties. Minerals represent research subjects capable of combining two or more of these properties. For this reason, newly discovered minerals of terrestrial and meteoritic origin, rare minerals, or samples with poorly studied properties serve as a unique foundation for the development of synthetic analogues and novel functional materials. At present, there are numerous examples of the application of minerals with the crystalline structures of clays and zeolites in the fields of radiochemistry, catalysis, gas separation, and pervaporation. In this work, we present examples of rare minerals from the Khibiny Massif: the lintisite group, polezhaevaite-Ce, natisite, armbrusterite, sitinakite, and eveslogite (Kola Peninsula, Russia), and their synthetic analogues, which served as the basis for the development of new catalysts for the synthesis of environmentally friendly solvents (1-methoxy-2-propanol), the synthesis of propylene carbonate from propylene oxide and CO_2, the synthesis of precursors for pharmaceutical compounds (1,5-benzodiazepine), matrices for radionuclides ^{137}Cs and ^{90}Sr, and fillers for polymer membranes.

Keywords: Mineral, Synthetic analog, Sorption, Membrane, Catalysis, Radioisotope, Matrix

Acknowledgment: This work was supported by the Russian Scientific Foundation, grant № 24-63-00006.

INVITED SPEAKER

Id-3062

Interface-Mediated Control of Structural and Electrical Properties in Active Dielectric Thin-Film Heterostructures

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Abstract. Heterostructures based on thin films of active dielectrics, including layered, porous, and composite structures, are key components in various devices for information receiving, storage, and processing. Interfaces, such as electrode-film, intercrystallite, and interphase boundaries, play a critical role in controlling the electrical parameters of these heterostructures. This report discusses examples of such electrical property control in various functional dielectric structures.

We discuss the mechanisms by which the interfaces between morphotropic PZT films and metallic (Pt) or oxide (RuO_2, $LaNiO_3$) electrodes influence the structural and primary electrical properties of the films. Mechanical stresses induced by Ru oxidation are shown to trigger the formation of a structure with an anomalously high dielectric permittivity. Conversely, film growth on an isostructural lanthanum nickelate electrode slows down switching kinetics and reduces the dielectric response due to the pinning of mobile domains.

Furthermore, we discuss the role of crystallization kinetics in PZT thin film formation. Rapid thermal annealing (RTA) increases the rate of heterogeneous nucleation, leading to highly textured films that maintain their polarization properties while exhibiting slightly enhanced dielectric permittivity. However, RTA also accelerates diffusion processes along the grain boundaries of the Pt electrode. This results in higher conductivity compared to isothermal annealing, driven by carrier transport dominated by grain boundary diffusion. This factor must be considered during the integration of ferroelectric elements to achieve an optimal trade-off between minimizing the thermal budget and maximizing electrical performance.

Prior work proposed a method for fabricating Pt/PZT:TiO_x/Pt composite structures, which consist of a mesoporous PZT film with nanoscale channels filled with conductive titanium oxide (TiO_x). Electrical characterization of these structures revealed a memristive effect, characterized by reversible resistive switching upon reversing the bias voltage polarity. Finally, we discuss the switching mechanisms and evaluate the impact of the porous structure on the stability of filament formation.

Keywords: Active dielectrics, Interface, Structure, Memristor, Polarization.

Acknowledgment: This work was supported by the Russian Science Foundation, grant № 23-79-30016.

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INVITED SPEAKER

Id-3064

Machine Learning Assisted Discovery of a Novel High-Entropy Oxide Catalysts for Selective Reduction of CO_2 to Ethanol

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Abstract: High-entropy oxides (HEOs) have emerged as promising electrocatalysts for the electrochemical reduction of carbon dioxide (CO2RR) because their multicomponent compositions provide extensive opportunities for tuning surface and electronic properties.[1] However, identifying catalyst compositions and operating conditions that simultaneously promote high activity, stability, and selectivity remains challenging.[2] Here, we combine machine learning (ML), experimental synthesis, electrochemical characterization, and density functional theory (DFT) calculations to establish a data-driven strategy for the design of HEO electrocatalysts for CO2RR. A database comprising experimental results from 100 publications reported between 2018 and 2025 was constructed to correlate catalyst composition, physicochemical properties, and reaction conditions with CO2RR performance. Because the dataset size was limited, noise addition, SMOTE, SMOGN, and Gaussian mixture model (GMM) augmentation methods were evaluated in combination with Elastic Net, Extra Trees, Random Forest, CatBoost, and Gaussian Process Regression (GPR) models. Five-fold cross-validation was employed, with augmentation performed exclusively within each training fold to prevent information leakage. Model performance was assessed using mean absolute error (MAE), weighted absolute percentage error (WAPE), and R^2. The optimal modeling strategy depended on the target property: Extra Trees provided the most accurate predictions of Faradaic efficiency and stability, whereas GPR performed best for current density. Accumulated Local Effects analysis revealed that increasing Pauling electronegativity, oxygen-vacancy concentration, and surface area can continuously enhance both current density and operational stability, while optimized ranges were identified for other catalyst and reaction parameters. Guided by these ML-derived design criteria, a novel ZnCuNiCoSbSnFeO HEO nanoparticle was synthesized through a facile co-precipitation route. Structural and morphological characterization confirmed the formation of a single-phase HEO with a $ZnSb_2O_6$-type prototype structure, an average particle size of approximately 11 nm, and homogeneous elemental distribution. The optimized HEO exhibited high CO2RR activity and sustained operation, maintaining a high steady-state current density over 10 h of continuous electrolysis. Gas chromatography revealed exceptional selectivity toward C^{2+} products, including an ethanol Faradaic efficiency of approximately 80%, indicating efficient C–C coupling. Experimental observations combined with DFT calculations suggest that synergistic interactions among the multiple constituent elements modify surface adsorption energetics and thermodynamically favor carbon–carbon bond formation. These results demonstrate the potential of

integrating ML with experimental and computational approaches for the rational discovery and optimization of multicomponent HEO electrocatalysts for selective CO_2 conversion.

Keywords: Machine learning, High-entropy oxide, CO2RR, DFT

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INVITED SPEAKER

Id-3067

Strong Interaction of a Signal Transverse-Electric and Transverse-Magnetic Waves with a Periodically Modulated Wave of a Magnetodielectric Plate, Placed in a Waveguide

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Abstract. The paper provides an overview of the author's scientific papers related to the theoretical study of the interaction of transverse electric (TE) and transverse magnetic (TM) signal waves with a magnetodielectric plate periodically modulated in space in a waveguide [1, 2]. It is assumed that the waveguide has an arbitrary cross-section, the axis of the waveguide coincides with the axis oz of some rectangular coordinate system and modulation indexes are much less than one. Using boundary conditions at the boundaries of the modulated plate, analytical expressions for the reflection and transmission coefficients for TE and TM waves are obtained, which make it possible to calculate the power reflection and transmission coefficients in the frequency region of the strong interaction between the signal wave and the plate modulation wave (the first-order Wolfe-Bragg condition takes place) [3]. The theoretical studies carried out lead to the following results: 1. Generalized Fresnel formulas for TE and TM waves in the region of strong interaction are obtained. 2. Using Fresnel formulas, the power reflection and transmission coefficients in the frequency region of strong interaction are found. 3. It is shown that the expressions for the reflection and transmission coefficients in the region of strong interaction are simplified in the special case of equality of the relative dielectric and magnetic permittivity outside the plate in the waveguide and in the magnetodielectric plate in the absence of modulation. 4. It turns out that the power reflection and transmission coefficients in the case indicated in point three are expressed by the hyperbolic functions sine and cosine. 5. It is shown that in the case specified in point four, the sum of the power reflection and transmission coefficients is equal to one. This is because there is no power dissipation in the periodic medium under consideration. 6. It is shown that if a modulated dielectric plate is considered in the waveguide instead of a modulated magnetodielectric plate, the results obtained in this work are equivalent to those of [4] and [5].

Keywords: Waveguide of arbitrary cross section; Periodically modulated magnetodielectric plate; Frequency region of strong interaction; Small indexes of modulation; Power reflection and transmission coefficients.

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ORAL PRESENTATION

Id-2940

Evaluation of the Associated Yld2000-2d and Non-Associated Hill48 Models for the Description of Planar Anisotropy in a 1180 MPa Grade High-Strength Steel Sheet

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Abstract: The associated flow rule (AFR) is one of the fundamental assumptions in continuum plasticity theory. In this approach, both yielding and plastic flow behavior of the material are described using a single function, namely the yield function. However, representing the behavior of materials exhibiting strong anisotropy using the same function for both yielding and plastic flow may be insufficient. Therefore, the non-associated flow rule (non-AFR) approach has been introduced to overcome this limitation. In the non-AFR framework, yield stress anisotropy and plastic flow anisotropy are described separately by using two different functions: the yield function and the plastic potential function.

In this study, the non-quadratic AFR Yld2000-2d and the quadratic non-AFR Hill48 functions are selected and evaluated for the description of the in-plane anisotropic behavior of a 1180 MPa-grade advanced high-strength steel. Uniaxial tensile tests are performed in seven different orientations, and the directional yield stresses and plastic strain ratios of the material are determined experimentally. Then, the yield stress and plastic flow anisotropy of the material under uniaxial stress state are analytically predicted using these approaches and compared with the experimental data. The comparisons show that the analytical predictions of both models are identical under uniaxial stress state. However, some differences are observed between the predicted yield loci, especially in the region associated with plane strain loading.

Keywords: Planar anisotropy, Advanced high-strength steel, Flow rule, Yld2000-2d, non-AFR Hill48.

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ORAL PRESENTATION

Id-2954

Exploring the Therapeutic Potential of Cannabis Sativa: Phytochemical Profiling, Antioxidant, and Antimicrobial Activities of Two Distinct Strains

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Abstract: Cannabis sativa L. is increasingly recognized for its therapeutic potential beyond its psychoactive properties and use in fiber production. Recent research highlights its efficacy in treating pain, anxiety, inflammation, and as an antioxidant. These benefits are attributed to a variety of bioactive compounds, including cannabinoids, terpenes, and flavonoids, which have sparked interest in their medicinal applications. This study investigated the phytochemical composition and biological activities of two C. sativa strains, with a particular focus on identifying functional groups using FTIR. Crude extracts from C. sativa buds were prepared using solvents of varying polarities. Phytochemical contents were quantified using standard techniques. Antioxidant activity was measured via TLC, DPPH, and FRAP assays, while antimicrobial activity was assessed using the agar well diffusion method. FTIR analysis was used to detect functional groups in the extracts. Phytochemical analysis showed TPC values ranging from 11.77 to 93.51 mg GAE/g and TFC values from 25.61 to 45.95 mg QE/g. The ethyl acetate extract (high THC) exhibited the highest TPC (93.5 mg GAE/g) and a DPPH IC50 of 0.0065 µg/L, indicating strong antioxidant activity. Cheese 2 extracts (ethanolic and n-hexane) showed higher TFC values (45.95 & 45.59 mg QE/g). TLC confirmed antioxidant activity. The DPPH assay confirmed strong radical-scavenging activity, while FRAP showed notable activity in neutralizing free radicals. Both strains displayed notable antimicrobial activity against E. coli, S. aureus, B. cereus, and S. typhi. FTIR analysis identified key functional groups related to cannabinoids, terpenes, and fatty acids. These findings highlight C. sativa as a promising source of bioactive compounds with antioxidant and antimicrobial properties. However, further research is needed to assess its antioxidant potential fully.

Keywords: Cannabinoids, Antioxidants, Phytochemicals, C. Sativa

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ORAL PRESENTATION

Id-2989

The Possibility of Using of Recycled PVB in The Mixture with PVC and Fillers

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Abstract. The manufacture of safety glass and its subsequent end-of-life processing generates a substantial amount of waste in the form of PVB film, for which new routes of utilization are currently being explored. One potential approach is the preparation of blends with PVC, as both materials are polymeric, can be plasticized, and exhibit similar mechanical properties. This study investigated the feasibility of blending PVC with recycled PVB, the suitable blending ratios, and the influence of kaolin and microprecipitated carbon dioxide, fillers commonly used in PVC formulations, on the resulting material properties. The results showed that these blends can be prepared over a wide range of composition ratios and that key properties—such as tensile strength, hardness, and rebound resilience—do not differ significantly from those of neat PVC. These findings indicate that such blends have potential applicability, for example, as inner layers in flooring or hydroisolating systems.

Keywords: Recycled PVB, PVC and PVB blends, filled polymer blends.

Acknowledgment: The department of Processing Engineering

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ORAL PRESENTATION

Id-2993

Synthesis and Characterization of Electroless Ni–B Composite Coatings with Varying Dispersed Boron Phase Content

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Abstract: This study presents the synthesis and characterization of electroless Ni–B composite coatings containing varying contents of a dispersed boron phase. The coatings were deposited on different substrate types in order to evaluate the influence of substrate material on coating formation and properties. Comprehensive characterization included the analysis of surface morphology and topography, coating thickness, roughness, adhesion to the substrate, and tribological performance.

The results indicate that the type of substrate significantly affects the morphology, topography, and thickness of the deposited coatings. The incorporation of a dispersed boron phase into the Ni–B matrix leads to an increased surface development, reflected in higher roughness and more complex surface features. Furthermore, the concentration of the dispersed boron phase in the plating bath plays a crucial role in determining the mechanical and tribological properties of the coatings.

The findings demonstrate that controlled modification of the dispersed phase content enables tailoring of coating performance, making Ni–B/B composite coatings promising candidates for applications requiring enhanced wear resistance and surface functionality.

Keywords: Ni-B matrix, boron dispersed phase, electroless deposition, composite coatings

Acknowledgements: The project „New electroless Ni-B/B and Ni-B/MoS_2 composite coatings with improved mechanical properties” benefits from grant from Norway. The aim of the Small Grant Scheme (SGS) call is to support applied research projects led by female scientists in technical sciences.

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ORAL PRESENTATION

Id-2995

Assessment of Low-Energy X-Ray Beam Quality through Dose Distribution Measurements in the Focal Spot Projection Area Using Thermoluminescent Dosimetry

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Abstract: The quality of low-energy X-ray beams is an important parameter in diagnostic radiology, influencing both image quality and radiation dose delivery. In the present study, the quality of a low-energy X-ray beam was evaluated in the focal spot projection area on a tissue-equivalent PMMA phantom by means of absorbed dose measurements using LiF:Cu,Mg,P (GR200A) thermoluminescent detectors and analysis of the spatial dose distribution across the experimental surface.

Metallic filters of various materials and thicknesses were employed to modify the beam quality and evaluate their influence on dose distribution and dosimeter response.

Beam quality assessment was performed on a tissue-equivalent PMMA phantom positioned in the projection area of the X-ray focal spot. Dose measurements were carried out using thermoluminescent detectors, and the spatial uniformity of the absorbed dose was evaluated by analyzing dose variations across different points of the experimental surface. Low-energy X-rays are widely used in diagnostic radiology, where dose uniformity is essential for obtaining high-quality radiographic images and enhancing the visualization of clinically relevant anatomical details.

The experimental irradiation were conducted using the X-Strahl X-ray generator available at the Secondary Standard Dosimetry Laboratory (LMRI), within the Horia Hulubei National Institute for R&D in Physics and Nuclear Engineering (IFIN-HH). Groups of five dosimeters, each containing three LiF:Cu,Mg,P detectors, were exposed to doses ranging from 0.1 to 100 mSv on a PMMA phantom (30 mm × 30 mm × 15 mm) and positioned within the projection of a 16 cm diameter focal spot. Irradiation were performed at tube voltages of 30 kV and 80 kV. In the first stage, a 2.4 mm Al filter was used, while in the second stage beam qualities N30 and N80 were achieved using filtration combinations of 4 mm Al and 4 mm Al + 2 mm Cu, respectively. The X-Strahl generator incorporates an inherent filtration of 1 mm Be.

The recorded thermoluminescent signals were processed in the personal and environmental dosimetry laboratory. Detectors were mounted in dosimetric holders featuring different materials (aluminium, plastic, and open-window configurations). Dose evaluation considered both batch homogeneity and energy-dependent detector response through the application of two dose-to-signal conversion factors established at the laboratory using calibration conditions corresponding to the conventional true dose equivalent at N60 and 75 kV.

The proposed methodology provides a practical framework for investigating low-energy X-ray beam characteristics and supports the optimization of dosimetric procedures and radiation protection practices in diagnostic radiology.

Keywords: Low-Energy X-Rays, Beam quality, Dose distribution, Thermoluminescent dosimetry, Radiation protection.

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ORAL PRESENTATION

Id-2996

Synthesis of Magnetite (Fe_3O_4) Nanoparticles Functionalised with Cyclodextrin via Polydopamine Coating for the Remediation of Tetracycline and Ciprofloxacin from Aqueous Solution

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Abstract: Advancements in nanotechnology and increments in the knowledge of synthesis and characterization of varieties of nanoparticles birthed the development of hybrid nano adsorbents. Magnetic nanoparticles exhibit high surface area, tunable surface properties, and unique magnetic properties, while polysaccharide materials have exceptional structure and unique properties. To explore this potential, a magnetic nanocomposite was synthesized by coating magnetite with silica (SiO_2) using the modified Stober route. The synthesized Fe_3O_4-SiO_2 was polymerized with dopamine in a basic solution to obtain Fe_3O_4-SiO_2-PDA, followed by functionalization with β-cyclodextrin. The successful synthesis of Fe_3O_4-SiO_2-PDA-CD nanocomposite was confirmed through scanning electron microscopy (SEM), transmission electron microscopy (TEM), Fourier transform infrared (FTIR), X-ray diffraction (XRD), and X-ray photoelectron spectroscopy (XPS). Batch adsorption studies were conducted to investigate whether the synthesized nanocomposite could adsorb tetracycline (TC) and ciprofloxacin (CIP) from aqueous solution. Functionalization of magnetite with polydopamine and cyclodextrin led to improvement in surface characteristics and incorporation of relevant functional groups. XRD results showed that magnetite retained its magnetic properties after incorporation of PDA and CD. Morphological and structural analysis showed the presence of iron, carbon, oxygen, and nitrogen with spherically shaped nanoparticles with an average particle size of 12.02 nm. Maximum adsorption was achieved at pH 7, and equilibrium time was reached before 30 min for initial concentrations ranging from 50 to 300 mg/dm^3. The adsorption kinetics suited the pseudo-second order model, and the equilibrium data fitted the Langmuir isotherm with TC and CIP adsorption capacity of 286.13 and 446.56 mg/g, respectively. These findings highlight the strong potential of Fe_3O_4-SiO_2-PDA-CD nanocomposite as an effective adsorbent for TC and CIP remediation in contaminated wastewater.

Keywords: Cyclodextrin; Kinetics; Magnetic nanocomposites; Water remediation; adsorption

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ORAL PRESENTATION

Id-3026

Analysis of the Influence of Steel Fibres on the Mechanical Properties of Vibropressed Products

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Abstract: This study investigates the effect of dispersed steel fibre reinforcement on the physical and mechanical properties of vibropressed concrete intended for the mass production of small-sized prefabricated elements such as paving blocks and kerbs. Four concrete series were designed and manufactured under industrial-laboratory conditions on an automated vibropressing line: a reference mixture without fibres and three mixtures modified with straight, cold-drawn steel fibres dosed at 5%, 10% and 15% of the cement mass, introduced by the substitution method. All mixtures were based on Portland cement CEM I 42.5R (440 kg/m³ in the reference series), washed natural aggregate composed of three fractions (0/2, 2/8 and 8/16 mm; 1880 kg/m³ in total), tap water (140 kg/m³) and two chemical admixtures (a superplasticizer and an air-entraining agent), with a constant, low water–cement ratio of approximately 0.32, typical of the semi-dry mixtures used in vibropressing technology. After 28 days of water curing, fourteen laboratory tests were performed, covering bulk density, linear shrinkage, dimensional tolerance, total porosity, water absorption, coefficient of friction, abrasion resistance, surface hardness, freeze–thaw resistance, water permeability, impact resistance, compressive strength, flexural strength and modulus of elasticity.

The results demonstrate a systematic, dosage-dependent improvement of nearly all examined parameters. Compressive strength increased from 69.74 MPa (reference) to 84.93 MPa at 15% fibre content (+21.8%), while flexural strength rose from 6.35 MPa to 8.92 MPa (+40.4%), accompanied by a change of the failure mode from brittle to ductile owing to the crack-stitching effect of the fibres. Impact resistance showed the most pronounced growth, from 23.03 Nm to 38.43 Nm (+66.9%). The modulus of elasticity increased by 17.8% (from 33.17 to 39.06 GPa) and surface hardness by 18.9%. Durability-related properties also improved: abrasion loss on the Böhme disc decreased by 28.1% (from 18.50 to 13.31 mm/50 cm²), water absorption dropped from 2.81% to 2.19%, water permeability from 0.30 to 0.22 mm/h, total porosity from 6.70% to 5.68%, linear shrinkage was reduced by 25.1%, and the mass loss after cyclic freezing and thawing fell from 2.32% to 1.62%. Bulk density decreased slightly (by 4.23%) because the spatial fibre skeleton hinders full compaction, while the dimensional accuracy of the products improved by 18.1%.

Considering both technical performance and production economics, the mixture containing 10% steel fibres (compressive strength 81.59 MPa, flexural strength 8.60 MPa) was identified as the optimal composition for large-scale industrial implementation, since raising the dosage to 15% yields diminishing property gains at a disproportionate material cost. The findings confirm that straight steel fibres are an

effective structural modifier of semi-dry vibropressed concretes, extending the service life of infrastructure elements.

Keywords: Steel fibre reinforced concrete, Vibropressed concrete, Dispersed reinforcement; mechanical properties, Durability.

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ORAL PRESENTATION

Id-3065

Tailoring Magnetic Coupling in Co/Cu/Co Synthetic Antiferromagnets through Pt Interface Engineering

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Abstract: Synthetic antiferromagnets (SAFs) provide a versatile structure for controlling magnetic configurations through exchange coupling between ferromagnetic layers separated by a non-magnetic spacer. Their magnetic response, however, is strongly influenced not only by the spacer layer but also by the interfaces surrounding the magnetic structure. Understanding the interplay between interlayer exchange coupling (IEC) and interface-induced spin–orbit effects is therefore essential for the rational design of multilayer magnetic systems. This study investigates Co/Cu/Co-based SAF structures grown on Pt surfaces to comparatively evaluate how distinct interfacial environments modify their static and dynamic magnetic properties. The Co/Cu/Co multilayer is employed as a common magnetic architecture, with the Cu spacer thickness serving as the primary parameter for controlling the IEC between the Co layers. Following optimization of the multilayer growth by magnetron sputtering, structurally comparable Co/Cu/Co-based heterostructures are prepared on Pt surfaces. Pt represents a conventional heavy-metal interface with strong spin–orbit coupling. Maintaining the magnetic multilayer architecture while varying the underlying interface provides a controlled strategy for distinguishing interface-dependent contributions to the magnetic response. Film thickness, density, and interfacial roughness are evaluated by X-ray reflectivity, while X-ray photoelectron spectroscopy and complementary electron microscopy are employed to examine chemical integrity and elemental composition. Static magnetic properties are investigated by magneto-optical Kerr effect and vibrating sample magnetometry, focusing on IEC behavior, magnetic anisotropy, coercivity, and hysteresis evolution. Ferromagnetic resonance measurements are further employed to probe magnetization dynamics and damping behavior. Selected structures are subsequently patterned for magnetotransport and spin-torque measurements to examine how the interface-dependent magnetic characteristics translate into functional response. The comparative Pt/Co/Cu/Co structures enable the effects of conventional heavy-metal and topological interfaces to be investigated within the same IEC-controlled magnetic architecture. Establishing correlations among interfacial properties, exchange coupling, magnetic anisotropy, magnetization dynamics, and transport response is expected to clarify the role of

interface engineering in controlling SAF behavior and provide design principles for low-power spintronic heterostructures.

Keywords: Synthetic antiferromagnet, Interlayer exchange coupling, Interface engineering, Spin–orbit interaction, Magnetic multilayers, Spintronics.

Acknowledgment: This study was supported by Gebze Technical University through Scientific Research Project No. 2026-A-105-08. The work was also supported by a Short-Term Scientific Mission (STSM) grant awarded within COST Action CA23136 (CHIROMAG).

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ORAL PRESENTATION

Id-3070

Sol–Gel Derived $Hf_6Ta_2O_{17}$ Thin Films for Optical Waveguide Applications

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Abstract: $Hf_6Ta_2O_{17}$-based thin films are promising high-refractive-index materials for integrated optical applications owing to the favorable optical properties of Hf- and Ta-based oxide systems. In this study, $Hf_6Ta_2O_{17}$ thin films were prepared by a sol–gel method and investigated with particular emphasis on their potential application as optical waveguides. The structural, morphological, chemical, and optical characteristics of the films were systematically evaluated using X-ray diffraction (XRD), scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), UV–Vis spectroscopy, and prism coupling measurements. XRD analysis was used to determine the structural characteristics and phase formation of the prepared films, while SEM observations provided information on surface morphology and film uniformity. XPS analysis confirmed the chemical states and surface composition associated with Hf, Ta, and O species. UV–Vis measurements revealed the optical transmission and absorption behavior of the films in the investigated wavelength range. Furthermore, prism coupling measurements were performed to determine the refractive index and evaluate the light-guiding characteristics of the $Hf_6Ta_2O_{17}$ films. The combined structural and optical characterization demonstrates the relationship between the material characteristics and waveguiding behavior of the sol–gel-derived films. These findings indicate the potential of $Hf_6Ta_2O_{17}$ thin films as high-index dielectric layers for optical waveguide and integrated photonic applications.

Keywords: $Hf_6Ta_2O_{17}$. Sol–gel, Thin films, Optical waveguide, Prism coupling, Refractive index.

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POSTER PRESENTATION

Id-2926

Influence of Hydrothermal Carbonisation Temperature on Porous Carbon Spheres Preparation

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Abstract: Porous carbon spheres have attracted significant attention due to their unique combination of high surface area, tunable porosity, and good electrical conductivity. These properties make them promising materials for a wide range of applications, including adsorption, catalysis, and energy storage and conversion systems. In particular, their well-defined morphology and surface functionality are highly advantageous for use in electrochemical devices such as fuel cells, where efficient charge transfer and mass transport are essential.

Hydrothermal carbonisation (HTC) is a simple, environmentally friendly, and versatile method for producing carbonaceous materials under relatively mild conditions. The process involves a series of complex reactions, including dehydration, polymerisation, and aromatisation, which lead to the formation of carbon-rich solid products with controllable structural properties. Among the various process parameters, temperature plays a key role in determining the physicochemical characteristics of the resulting materials.

In this study, the influence of HTC temperature on the formation and properties of porous carbon spheres is investigated. A series of HTC syntheses from monosaccharides was carried out in the temperature range of 200–300 °C, followed by thermal stabilization and thermochemical activation using NaOH. The effects of HTC temperature and thermal stabilization on the specific surface area of the activated spherical carbon materials were examined. It was demonstrated that spherical carbon particles with a high surface area (above 1800 $m^2\ g^{-1}$) can be obtained while preserving their morphology after thermochemical activation. These findings highlight the potential of HTC-derived porous carbon spheres for application as electrode materials in fuel cells and other energy-related technologies.

Keywords: Porous carbon spheres, Hydrothermal carbonization, Monosaccharides

Acknowledgements: The research was funded by ERAF project 1.1.1.9/LZP/1/24/007 "Hydrothermal processing as a platform for valorization of value added solid and liquid biomass based products (HTCelect)".

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POSTER PRESENTATION

Id-2928

Ultrafast Subwavelength CVD-Graphene Nanoheater for the Generation of Broadband Photoacoustic Waves

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Abstract: Efficient operation of light-to-pressure transducers and flexible fabrication on demand are key factors for the use of photoacoustic devices in various biomedical disciplines. Graphene layers can be grown at wafer scale and transferred to any surface geometry, providing a versatile approach for the development of photoacoustic emitters with a large and nearly uniform thermal interface. Here we report the picosecond excitation of a photoacoustic emitter consisting of a large-area, 10-layer graphene grown by chemical vapour deposition and encapsulated with a polydimethylsiloxane. The theoretical and experimental studies address the generation of broadband ultrasounds upon excitation with nanosecond and picosecond laser pulses, showing how the multilayer graphene can serve as an ultrafast nanoheater to drive efficient expansion of the adjacent polymer layer in the picosecond regime. The picosecond excitation results in a sharper acoustic waveform, and the pressure evolution time is twice as short with a 30 ps excitation as with a 6 ns pulse, thus satisfying the thermal and stress confinement conditions, while energy loss occurs with nanosecond excitation. We experimentally observed that the 10-layer graphene/polydimethylsiloxane generates a high-frequency photoacoustic wave with a bandwidth of about 110 MHz at −6 dB, increasing to 250 MHz at −20 dB, due to stress confinement, increased thermal interface, and ultrafast dynamics. The peak pressure of 0.85 MPa in 3.4 nm thick graphene multilayers (~20 % absorption of 40 mJ cm–2) is remarkably high, demonstrating its potential as a photoacoustic material and the advantages of combining picosecond excitation with large-area graphene in wave transmission technologies. Our results provide a comprehensive understanding of picosecond PA generation in large-area GR interfacing a viscoelastic polymer. This highlights a new, versatile, and biocompatible PA material and the potential benefits of combining picosecond excitation with CVD-GR-based PA emitters for PA imaging, targeted therapies, neuromodulation, and cell permeabilisation.

Keywords: CVD graphene, photoacoustic emitter, picosecond excitation. PDMS, polymer.

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POSTER PRESENTATION

Id-2933

Co-Au Core Shell Nano Particles: Microwave Absorption and Bio-ReRAM

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Abstract: Here we report on the first observation of the Low Field Microwave Absorption (LFMA) in Co-Au core shell nano particles. The LFMA signal was very strong and persists into the low temperature regime. The phase comparison of the LFMA with the ESR signal of the same sample shows that the absorption is a maximum at zero field and decreases with field rapidly, showing a great tunability of absorption with small applied magnetic fields. This feature is very good for the design of 'field tunable microwave absorbers' using Co-Au core shell nano particles. Further, as reported earlier by our group, these Co-Au Core shell nano particles when incorporated into Chitosan, showed a remarkable Resistive switching 'O' type memory behaviour Resistive Random Access Memory (ReRAM) is a type of non-volatile memory for computers. Here, we integrate and review the results from ref.[1], with our latest results on the observation of LFMA in Co-Au core shell nano particles and demonstrate that these Co-Au core shell nano particles and their Biomaterial composites have potential for advanced Bio-ReRAM devices that can be integrated with the 'Green Computing' as well as field tunable microwave absorbers.

Keywords: Low Field Microwave Absorption, Bio-ReRAM, Green Computing.

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POSTER PRESENTATION

Id-2942

Grading of Magnetic Anisotropy and Engineering of Domain Wall Dynamics in Fe-Rich Microwires by Stress- Annealing

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Abstract. Magnetic wires present outstanding magnetic properties such as the giant magnetoimpedance (GMI) as well as the magnetic bistability and related single domain wall (DW) propagation. These make them quite attractive for a number of technological applications. The Taylor-Ulitovky method allows the preparation of the thinnest amorphous magnetic microwires (with typical metallic nucleus diameters of 0.1-100 μm) coated by thin glass-coating. The origin of the magnetic bistability is related to the peculiar domain structure of magnetic wires consisting of a single inner axially magnetized domain and the outer domain shell with either radial or circular magnetization orientation. As observed elsewhere, the magnetization switching in magnetic microwires consists of the single DW propagation, which starts from the ends, where closure domains appear due to the demagnetizing field effect. We have studied the magnetic properties and domain wall dynamics in Fe-rich microwires subjected to stress-annealing. The hysteresis loops of Fe-rich microwires was considerably affected by stress-annealing. We obtained drastic decrease in coercivity and change in the character of hysteresis loops from rectangular to linear in stress-annealed Fe-rich microwires. For the wires after stress-annealing at variable temperatures we obtained a graded magnetic behavior with local hysteresis loops shapes and features (coercivity, remanent magnetization) changing along the sample length. The obtained graded magnetic anisotropy allows one to manipulation of the domain wall dynamics by controllable domain wall injection into a samples region with lower coercivity or domain wall braking and trapping in magnetically harder regions.

Keywords: Magnetic wire, Amorphous alloys, Domain wall propagation, Magnetic bistability, Hysteresis loop.

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POSTER PRESENTATION

Id-2943

Microstructure and Tip Shape of Crystals in Al-Si Alloys

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Abstract: This study investigates the microstructure and dendrite tip morphology of Al-Si alloys obtained at various melt cooling rates. Experimental analysis reveals distinct layered structures in melt-spun foils, contrasting with conventional dendritic solidification in bulk samples. A homogeneous layer of foil adjacent to the crystallizer is formed by chemically partitionless crystallization during the movement of an initially flat front, which then transforms into a cellular-dendritic form. The layer at the freely solidifying side crystallizes according to the mechanism of formation of primary dendrites and a eutectic mixture in the interdendritic spacing, however, the size of the dendrites is of the order of magnitude smaller than at equilibrium crystallization. Primary and secondary dendrite arm spacings are measured for different alloy compositions and cooling rates. In addition, we confirm that the shape of Al-Si dendrites is in agreement with recently developed Geomentrically Morphological Theory.

Keywords: Dendritic growth, Crystallization, Microstructure, Properties, Solidification, Crystal growth

Acknowledgements: this study was financially supported by the Russian Science Foundation (project no. 24-19-00566).

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POSTER PRESENTATION

Id-2950

Overview of Research on Silicon Carbonitride Films Fabricated by Hot-wire Chemical Vapor Deposition

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Abstract: In this presentation, we will provide a comprehensive overview of our longstanding research focused on the deposition of silicon carbonitride (SiCN) films utilizing the Hot-wire Chemical Vapor Deposition (HWCVD) technique. This innovative method employs a low-temperature deposition process that relies on radicals generated through the thermal catalytic decomposition of precursor gases. Notably, the deposition can occur even at room temperature, offering significant advantages for various applications.

The precursor gas used in our studies consists of hexamethyldisilazane, diluted with hydrogen or ammonia to achieve optimal deposition conditions. The resultant SiCN films exhibit exceptional chemical resistance, particularly against acidic environments, and demonstrate remarkable hardness. These properties render them not only suitable for use as protective coatings for integrated circuits but also open avenues for their application in general industrial metal coatings.

In this presentation, we will summarize our key findings and discuss the implications of this technology, contemplating its future prospects and potential advancements that may arise from continued exploration in this field.

Keywords: SiCN, HWCVD, Coating.

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POSTER PRESENTATION

Id-2956

AI Earthquake Detection Using MEMS Sensors for Smart Alarm Systems

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Abstract. Earthquakes entail a significant threat worldwide, often causing catastrophic losses within seconds. Existing Earthquake Early Warning Systems (EEWS) either suffer from low sensitivity to localised events, or produce excessive false alarms due to limited data integration. We propose a novel smart earthquake detection and response system that integrates local IoT-based sensor modules, centralised seismic data, and AI-based event classification. In this study, raw acceleration signals are pre-processed using a cascaded non-linear adaptive time-varying IIR filter to eliminate ambient sensor noise and any undesired frequency content, leveraging a tunable parameter optimized at zero to preserve high-frequency P-wave onset without transient delay. This is followed by a micro-calibrated Nakazawa Kalman filter to estimate high-frequency seismic jerk features. Time-frequency spectrogram textures derived from these jerk signatures are then classified via an optimised deep convolutional neural network. Tested on both regional Istituto Nazionale di Geofisica e Vulcanologia (INGV) seismic records and the global STanford EArthquake Dataset (STEAD) dataset, the proposed framework achieved an outstanding overall classification accuracy of 97% with near-zero false alarm rates. The system triggers automated safety actions, such as cutting off gas or electricity in smart homes, and provides real-time seismic excitation data to evaluate building integrity. By merging stochastic and deterministic filtering with AI-based classification, local sensors, and cloud-based storage, the developed system successfully enhances detection accuracy, shortens response time, and provides an infrastructure for long-term seismic risk modelling.

Keywords: Earthquake Detection, MEMS Sensors, Deep Learning, Deterministic and Stochastic Filtering, IoT.

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POSTER PRESENTATION

Id-2967

Design and Implementation of an OSDP-Native Electronic Handle Lock for Access Control Systems

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Abstract: Access control systems are commonly built using separate card readers, control panels and locking devices connected through different interfaces. While the Open Supervised Device Protocol (OSDP) is widely used for secure communication between access control panels and peripheral devices, its direct implementation within electronic handle locks is not common. In this study, an electronic handle lock operating as an OSDP Peripheral Device (PD) was designed and developed. The lock combines RFID authentication, lock control, visual and audible indications, handle monitoring and status reporting within a single device. The aim of the work is to evaluate the feasibility of integrating OSDP functionality directly into an electronic handle lock while preserving secure communication and compatibility with existing access control infrastructure. The developed system communicates over an RS-485 network and supports OSDP Secure Channel for encrypted and authenticated communication. A prototype was manufactured and tested under different operating conditions. Communication reliability, authentication performance, event reporting functions and interoperability with OSDP-compliant systems were evaluated experimentally. Test results showed reliable OSDP communication, successful authentication and stable operation with centralized access control systems. The developed lock was able to exchange standard OSDP messages, report device status and operate as part of an OSDP-based access control architecture. The study shows that OSDP functionality can be directly integrated into an electronic handle lock while maintaining secure communication and centralized management capabilities. To the best of the authors' knowledge, published studies focusing on electronic handle locks with embedded OSDP functionality are limited. The developed system may serve as a reference for future intelligent locking solutions based on open access control standards.

Keywords: OSDP, Electronic Handle Lock, Access Control Systems, RFID Authentication, RS-485 Communication, Embedded Systems, Physical Security, Smart Lock.

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POSTER PRESENTATION

Id-2968

Biochar as a Biomaterial for Reducing the Soil Acidity: A Long-term Field Study

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Abstract: Biochar has emerged as a promising amendment for sustainable soil management, particularly in temperate regions with acidic Luvisols. This long-term field study (2014–2022) evaluated the effects of biochar application and reapplication, combined with varying nitrogen (N) fertilization levels, on soil pH. The experiment was conducted on Haplic Luvisol in southwestern Slovakia using a randomized block design with three biochar rates (0, 10, 20 t/ha), a reapplication after four years, and three nitrogen levels (N0, N1, N2). In the present study, the biochar used for both application and reapplication had a pH of 8.8 and contained 0.77 g/kg Na^{+}, 15 g/kg K^{+}, 57 g/kg Ca^{2+}, and 3.9 g/kg Mg^{2+}. These chemical properties contributed to a statistically significant increase in soil pH during the initial years following incorporation into acidic soil. N fertilization alone at both N1 and N2 levels exerted a clear acidifying effect on the soil, with the higher rate (N2) causing a more pronounced decline, which aligns with established knowledge regarding the acidifying nature of mineral nitrogen fertilizers. Soil pH declined linearly and significantly each year in treatments B20N1, B0N2, B10N2, and B20N2, with annual reductions of 0.07, 0.09, 0.09, and 0.09 pH units, respectively. This corresponds to a cumulative pH decrease of approximately 12–15% compared to initial values over the 9 years.

The combined application and reapplication of biochar with both N levels mitigated soil acidification, with statistically significant effects observed only under the higher nitrogen rate (N2). Compared to the B0N2 treatment, soil pH increased by 11, 15, 16, and 19% in treatments B10N2A, B20N2A, B10N2B, and B20N2B, respectively. These findings indicate that higher application rates and reapplication of biochar are more effective in counteracting acidification induced by elevated nitrogen inputs, whereas biochar applied without nitrogen fertilization had no significant long-term effect on soil pH. The results of this study underscore that the effectiveness of biochar is most evident in acidic soils (initial pH of the Luvisol was 5.76) and under higher N fertilization regimes (N2). In particular, biochar reapplication emerges as a promising strategy for sustaining or optimizing soil pH in acidic soils, especially in systems reliant on intensive N fertilization to achieve target yields. These findings contribute significantly to our understanding of the long-term behavior of biochar under field conditions.

Keywords: Soil, Biochar, Nitrogen, Soil Ph

Acknowledgements: The research was partially supported by the Slovak Research and Development Agency under the contract No. APVV-21–0089, and the Slovak Grant Agency (VEGA) project no. 1/0024/25, no. 1/0313/26 and KEGA 047SPU-4/2025.

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POSTER PRESENTATION

Id-2975

Underfilm Corrosion and Stress Corrosion Cracking of Metals and Inhibition of These Dangerous Types of Metal Destruction by Surface Organosilicon Micro- and Nanolayers

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Abstract: The process of metal dissolution beneath a disbonded insulating polymer coating (under-film dissolution) was investigated. An experimental setup was used to simulate corrosion of underground metal structures in the presence of through-coating defects and/or extended areas of coating disbondment from the metal (loss of adhesion), forming under-film cavities partially or completely filled with electrolyte.

In particular, the distribution of protective current beneath the disbonded polymer coating was studied. A sharp decrease in protective current was observed at a distance of 1-3 cm from the defect edge when the gap between the metal and the coating was 1-6 mm. The localized nature of metal corrosion beneath the disbonded polymer coating was demonstrated: the areas affected by accelerated corrosion may account for only about 1/100 of the total metal surface. Zones of anodic metal dissolution were found to exist even under cathodic polarization of the entire specimen with a disbonded coating.

Carbon dioxide and hydrogen sulfide were shown to activate corrosion and anodic dissolution of steel beneath the coating. In the presence of carbon dioxide and hydrogen sulfide, the dissolution current generated by anodic surface sites may increase by approximately an order of magnitude. A synergistic effect of these compounds on localized under-film corrosion of steel was identified. A mechanism was developed for the formation of localized corrosion damage in steel beneath a disbonded polymer coating; such damage may act as initiation sites for corrosion cracks once a certain level of mechanical stress is reached, i.e. for stress corrosion cracking (SCC) of carbon steel. The initiation and propagation of SCC in pipeline steel in a corrosive chloride-containing electrolyte were also investigated separately. In addition, SCC of X70 pipeline steel was studied using corrosion-mechanical tests that simulated underground pipeline operating conditions under cyclic four-point bending, with stresses close to the yield strength, in electrolytes differing in hydrogen-charging ability. The model media were NS4 solution and citrate buffer (pH 5.5). Hydrogen charging was controlled by adding thiourea and by varying the potential. Microcracks were shown to nucleate in corrosion defects (pits), then emerge at the surface and develop into narrow cracks. The incubation period depends on the environment: under corrosive conditions, it is approximately half as long as in air. The size and nature of stress concentrators play a significant role: natural pits hundreds of micrometers in size lead to crack formation within 24-28 days, whereas artificial holes 0.6-1 mm in diameter lead to cracking within 5-7 days. The effect of hydrogen

was established: moderate hydrogen charging produces only minor acceleration, whereas high hydrogen charging sharply shortens the incubation period. Critical hydrogen concentrations at which its effect becomes substantial were determined.

Possible methods for inhibiting under-film dissolution and stress corrosion cracking of metals were considered. A method was proposed for pretreating the surface with organosilane solutions in order to form self-assembled polymeric siloxane nanolayers on the surface; these nanolayers inhibit under-film corrosion and SCC of steel. The most effective treatment was a vinylsilane + benzotriazole composition: the time to crack initiation increased from 5 to 36 days, and the crack growth rate decreasedю

Keywords: Polymeric coating, Underfilm corrosion, Corrosion-mechanical testing, Stress corrosion cracking; Organosilanes,

Acknowledgement: This work was carried out with the financial support of the Russian Science Foundation, grant No. 25-29-01051

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POSTER PRESENTATION

Id-2977

Clay-Based Materials for Immobilization of Halide-Containing Radioactive Waste

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Abstract: Nowadays, many countries that operate nuclear power plants share an ambitious goal: closing the nuclear fuel cycle. One of the major tasks is spent nuclear fuel (SNF) management. Due to the continuous development of Generation-IV nuclear reactor technologies, there are some significant issues. For example, the processing of mixed nitride uranium-plutonium SNF from fast-neutron reactors (FNR) suggests the use of a chloride electrolyte in pyrochemical or combined technology. In addition, fluoride eutectic mixtures are of interest for possible use as a medium in molten-salt reactors (MSR). Thus, the forms of generated radioactive waste (which are high-level waste, HLW) are becoming increasingly complex and pose a key challenge requiring urgent solutions, because industrial technologies cannot be fully implemented until immobilization methods for the resulting radioactive waste have been developed.

Studies with glass composite materials show that for reliable fixation of a significant amount of alkali chlorides, they must be preliminarily converted into the form of phosphates or oxides, i.e., conventional technological forms. Na-Al- and Fe-phosphate glasses have demonstrated the possibility of immobilizing alkaline-earth and rare-earth fluorides. Ceramic or glass-ceramic matrices are more robust alternatives to vitrified matrices. To reduce the release of radionuclides from the matrix into the biosphere, the matrix material should be as close as possible to the surrounding host rocks in its chemical and phase composition. Therefore, we propose using clays as a material for manufacturing matrices for the immobilization of specific halide-containing HLW generated during MSR operation or the pyrochemical processing of SNF from FNR. These finely dispersed materials, consisting of more than 70% of layered minerals (such as montmorillonite or kaolinite) and having large specific surface area, become very durable after sintering, and are able to retain alkali metal ions due to their layered structure.

Specific compositions and temperature–time regimes were chosen in our earlier works empirically for immobilization of the spent LiCl–KCl electrolyte with addition of fission products. As a result, strong ceramic samples based on bentonite clay with an electrolyte content of up to 30 wt. % were synthesized. Furthermore, three new clay samples with contrasting mineralogical and chemical profiles were analyzed for their ability to immobilize fluoride wastes from MSR and chloride wastes from FNR processing. The studied characteristics include mechanical strength, thermal and freeze–thaw stability, phase composition, morphological structure, resistance to leaching, and radiation stability. A set of modern analytical and physicochemical methods was employed to support the results: X-ray powder diffraction, ICP-OES and ICP-MS, mercury porosimetry, X-ray fluorescence analysis, etc. Thus, the fundamental possibility of using clays as a material for immobilizing the spent chloride and fluoride

electrolytes from pyro-processing of SNF and MSR is demonstrated. Moreover, comparative data on the correlation between the characteristics of the obtained matrices and the type of clay used are presented.

Keywords: Radioactive waste, Spent chloride eutectics, FLiNaK, Ceramic matrices, Bentonite clay.

Acknowledgment: This work was supported by the Russian Science Foundation (grant № 25-23-00886).

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POSTER PRESENTATION

Id-2978

Electronic and Magnetic Anisotropy in $Ba_{1-x}K_xFe_2As_2$ Single Crystals: An Angular- Dependent NRMA and DFT Study.

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Abstract: $Ba_{1-x}K_xFe_2As_2$ is an important iron-based superconductor exhibiting pronounced anisotropic electronic and magnetic properties. In this work, angular-dependent Non-Resonant Microwave Absorption (NRMA) measurements were performed on $Ba_{1-x}K_xFe_2As_2$ single crystals to investigate the influence of crystal orientation on the microwave absorption response. Changes in microwave absorption intensity with magnetic field and crystal orientation were analysed to probe anisotropic magnetic behaviour and superconducting characteristics. To support the experimental findings, Density Functional Theory (DFT) calculations were conducted to examine the electronic structure and magnetic anisotropy of the material. The combined experimental and theoretical results provide insight into the relationship between crystal orientation, electronic structure, and magnetic response in $Ba_{1-x}K_xFe_2As_2$. This study demonstrates the effectiveness of integrating angular-dependent NRMA measurements with first-principles calculations for investigating anisotropic phenomena in iron-based superconductors.

Keywords: $Ba_{1-x}K_xFe_2As_2$, NRMA, DFT, Magnetic anisotropy, Electronic structure, Superconductivity.

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POSTER PRESENTATION

Id-2979

Energy Consumption Analysis of Hybrid and Electric Vehicles in Real Driving Cycles

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Abstract. The European Union's transport policy assumes a gradual increase in the share of low-emission and zero-emission vehicle technologies in order to achieve climate neutrality by 2050. Road transport remains one of the most energy-intensive sectors, particularly in urban areas characterized by high traffic density and frequent changes in driving conditions. Consequently, the development of hybrid and electric powertrains has become a key direction in the evolution of modern passenger vehicles. The aim of this study is to assess the energy consumption of passenger cars equipped with different propulsion systems under real driving conditions. The research included vehicles powered by conventional internal combustion engines, hybrid powertrains, and a battery electric vehicle. Comparative analyses were conducted under various traffic conditions, with particular emphasis on urban operation and the complete RDE (Real Driving Emissions) driving cycle. The obtained results were used to evaluate the influence of powertrain technology on vehicle energy demand. The battery electric vehicle exhibited the lowest total energy consumption in real-world operation. The plug-in hybrid vehicle demonstrated approximately 10% higher energy consumption, whereas the conventional internal combustion vehicle required approximately 30% more energy compared to the electric vehicle. The results provide a basis for assessing the energy efficiency of contemporary vehicle technologies and identifying the benefits associated with the implementation of advanced hybrid and electric propulsion systems.

Keywords: Transport, Hybrid and electric vehicle, Energy consumption.

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POSTER PRESENTATION

Id-2980

Non-Intrusive Assessment of Efficiency of Fuel Cell in FCHEV in Real Driving Conditions

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Abstract. Modern powertrains are increasingly combining proton exchange membrane fuel cells (PEMFCs) with electric motors and batteries to meet the challenges of decarbonising transport. Modern powertrains are increasingly utilising fuel cell technology in parallel with electric motors. This study presents an assessment of fuel cell efficiency under real road conditions, carried out without any physical modifications to the vehicle's powertrain system, using a production fuel cell hybrid electric vehicle (FCHEV) with a power output of 128 kW, operated under representative urban, suburban and motorway conditions. The aim of the research was to determine the efficiency of the fuel cell efficiency under real driving environment and to compare these results with laboratory values stated in the literature. The tests were conducted in accordance with Real Driving Emissions (RDE) procedures, and diagnostic data was collected from the vehicle's controllers and hydrogen storage sensors. Key measured signals included fuel cell current and voltage, battery voltage and current, vehicle speed, and pressure and temperature in the hydrogen tank; hydrogen mass flow was calculated analytically based on tank thermodynamics and compressibility corrections, rather than by installing an in-line flow meter. Taking into account the compressibility of hydrogen, was determined. The test vehicle was a Toyota Mirai II, and data was recorded using the manufacturer's diagnostic interface (TechStream), which enabled a non-invasive assessment of the fuel cell system under realistic load cycles. As part of the work, the propulsion efficiency was determined for each driving phase. The following fuel cell efficiency values were obtained in the urban, suburban and highway phases were 51, 56 and 66% respectively. The values obtained are very close to the direct tests, while completely eliminating the need to modify the powertrain in order to determine the fuel cell efficiency.

Keywords: Hydrogen fuel cell, Real driving conditions, Fuel cell efficiency.

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POSTER PRESENTATION

Id-2981

Research on a Hybrid Rail Vehicle in Terms of Energy Consumption and Ecology

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Abstract: Rail vehicles are playing an increasingly important role in the transport sector due to the European Union's long-term environmental policy. This indicates that intra-EU air travel, particularly within countries, will be limited to reduce the carbon footprint and meet sustainable development policies. Rail vehicles are characterized by significant energy efficiency, mainly due to the ability to transport larger masses of goods compared to other means of transport. Consequently, modern alternatives are being implemented in rail vehicles – hybrid and battery designs. Therefore, research on various rail propulsion technologies, their optimization, and their environmental impact is crucial for the sustainable development of rail transport. This paper presents an innovative method for assessing the energy consumption of a hybrid rail vehicle, which considers both electric traction and combustion engine operation. Energy consumption measurements were performed under real-world operating conditions on a test track, using mobile measurement equipment. The determined energy consumption and emission indicator values were determined for the entire test, as well as for the acceleration process. This is supplemented by comparing the value of electricity consumed to emissions generated in conventional coal-fired power plants. The energy mix on the measurement day was also considered, taking into account the share of non-renewable energy sources in the traction network. Research shows that combustion engines meeting the latest emission standards contribute less to global air pollution than vehicles powered by electricity derived from fossil fuels. Therefore, research on the energy consumption of electric/hybrid rail vehicles is necessary to accurately assess their actual environmental impact.

Keywords: Energy consumption, Exhaust emission, Hybrid powertrain, Rail transportation, Real operating conditions.

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POSTER PRESENTATION

Id-2984

Stability and Magnetic Ordering Near the Antiphase Boundary In Ni_2MnGa

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Abstract. Ni-Mn-Ga alloy is the most promising candidate as material for magnetic shape memory applications. In addition to austenite, it is also found in variety of martensite phases. Antiphase boundaries (APBs) are planar defects that play a critical role in strengthening Ni-based alloys, and their sensitivity to alloy composition offers a flexible tuning parameter for alloy design. We combine experimental and theoretical methods to analyze the stability and magnetic order in the vicinity of an antiphase boundary in Ni2MnGa possessing L21 order. Ab initio electronic structure calculations based on density functional theory are used to investigate the magnetic order in structure simulating APBs in cubic austenite. Based on ab-initio calculations we suggest that one APB curve with dark & light contrast consists of a pair of APB interfaces with narrow, only one-layer thick, core with structural partial B2 order in contrast to full L21 order of bulk. Our simulations indicate that at the interface, the ferromagnetic arrangement changes its orientation in the opposite direction. This sudden change in magnetization is observed using a magnetic force microscope. Calculated magnetic contrast using magnetostatic continuum simulations agrees well with magnetic force microscopy observation.

Keywords: Ab-initio methods, Magnetic ordering, Crystallographic defects, Alloys, Magnetic force microscopy

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POSTER PRESENTATION

Id-2988

pH-Responsive Poly(ethylene terephthalate) Track-Etched Membranes for Water-Organic Emulsion Separation

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Abstract. The development of adaptive membranes capable of changing their surface properties in response to external stimuli is an effective strategy for reducing fouling during water-organic emulsion (WOE) separation. In this work, pH-responsive poly(ethylene terephthalate) track-etched membranes (PET TeMs) were fabricated by grafting polystyrene (PS) followed by UV-initiated RAFT polymerization of poly(methacrylic acid) (PMAA). The modified membranes exhibited pronounced pH-responsive wettability, with the water contact angle changing from 90º at pH 2 to 65º at pH 9. Increasing grafting time, monomer concentration, and UV irradiation intensity promoted PMAA grafting and enhanced surface hydrophilicity. Successful membrane modification was confirmed by FTIR-ATR, thermogravimetric analysis, and microscopic characterization. The separation performance was evaluated using model water-in-oil and oil-in-water emulsions. The membranes demonstrated high separation efficiency ranging from 80 to 98% and a maximum flux of 800 $Lm^{-2}h^{-1}$ for water-in-chloroform emulsions. Owing to pH-induced wettability switching, the membranes showed significantly improved antifouling properties, achieving flux recovery values up to 96% after repeated filtration cycles. Compared with previously developed hydrophobic PET TeMs, the pH-responsive membranes exhibited enhanced operational stability, reduced irreversible fouling, and improved long-term filtration performance. These results demonstrate the potential of PET TeMs-g-PS-g-PMAA as adaptive membrane materials for efficient emulsion separation and water treatment applications.

Keywords: PET track-etched membranes, pH-responsive membranes, Water-organic emulsion separation, Antifouling

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POSTER PRESENTATION

Id-3006

Electrochemical Deposition Of Nickel - Boron Composite Coatings: The Influence Of Bath Composition With Organic Additives On Surface Morphology And Tribological Properties

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Abstract: Nickel matrix composite coatings can be used especially in the automotive, aerospace, space and electrical industry industries due to their very good mechanical properties.

The paper presents the results of the studies of nickel-boron composite coatings deposited by the electrochemical reduction method. A bath with low concentration of nickel ions, boron as dispersed particles and organic compounds were used for deposition of the composite coatings nickel-boron. Composite coatings were deposited using the dispersion phase of boron powder with the size of the particles about 200 nm.The results of investigations of coatings deposited from the electrolyte containing 2, 5 and 10 g/dm^3 boron and surface-active compounds were shown.

The contents of particles in coatings was determined gravimetrically. The roughness of the layers was measured by TR 100 profilograph. The microhardness of the coatings was measured using the Vickers' method at a load of 0.01 kg. The Amsler testing machine with system: block – ring was used for tribological tests with lubrication Lux oil. The obtained results suggest that the content of incorporated boron particles increases with an increasing amount of boron in plating bath. The coatings nickel-boron produced during investigation were distinguished by much better tribological properties than nickel coating.

Keywords: Nickel, Boron, Electrodeposition, Composite coatings.

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POSTER PRESENTATION

Id-3008

Sensitivity of Laser Diffraction Sizing to Optical Parameters: A Comparative Study of Mie and Fraunhofer Scattering Models in Heterogeneous Media

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Abstract: Laser diffractometry has emerged as a premier optical method for rapid, high-resolution particle size distribution (PSD) analysis, relying on the predictable scattering of electromagnetic waves by particulate matter. In modern laser particle sizing, calculating the precise dimensions of particles from spatial light intensity patterns requires the application of robust optical scattering theories. The two predominant algorithms utilized are the Fraunhofer diffraction approximation and the rigorous Mie scattering theory. While the Fraunhofer model assumes opaque particles and relies strictly on edge diffraction without requiring the material's optical properties, Mie theory provides an analytical solution to Maxwell's equations for spherical particles, accounting for diffraction, refraction, transmission, and absorption. Consequently, Mie theory requires accurate inputs for both the refractive index and the absorption index of the dispersed medium, which are often unknown for highly heterogeneous mixtures. This study investigates the sensitivity of laser diffraction analytical outcomes to the variation of these optical parameters, aiming to evaluate the optical artifacts introduced by mismatched indices in heterogeneous particulates. Using a laser particle sizer operating in the 0.08 to 2000 µm range, particulate samples (heterogeneous environmental soils) were analyzed under various computational scenarios. The measured spatial light scattering data were processed through the Fraunhofer model and compared against different Mie theory setups. The complex optical parameters tested included refractive indices ranging from 1.3 to 1.8 and absorption indices ranging from 0.001 to 0.2. The results demonstrate that the calculated particle size distributions are highly sensitive to the chosen optical indices, particularly in the sub-micron regime. Utilizing a low refractive index (1.3) within the Mie model artificially inflated the estimation of the finest particle fractions by up to 58% compared to the Fraunhofer approximation. Conversely, employing a very low absorption index (≤ 0.008) combined with a high refractive index (≥ 1.5) fundamentally altered the continuous course of the size distribution curve, creating optical artifacts characterized by isolated, multi-peak size fractions. The closest alignment between the two theories was observed when applying a refractive index of 1.5 paired with higher absorption indices (0.1–0.2), which effectively neutralized the transmission anomalies in the Mie calculation. These findings underscore the critical importance of optical parameter optimization in laser diffraction applications. For complex, multi-component media where precise optical properties are indeterminate, inappropriate selection of Mie parameters can distort the physical reality of the scattering data. Understanding the boundary conditions between the Fraunhofer and Mie calculations remains

essential for advancing the reliability of laser physics applications in metrology and material characterization.

Keywords: Laser diffractometry, Soil, Particle size distribution

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POSTER PRESENTATION

Id-3015

Antifibrotic Effects of Polyphenolic Extracts in an Experimental Model of Pulmonary Fibrosis

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Abstract: Objective; pulmonary fibrosis is a progressive disease characterized by excessive extracellular matrix deposition, chronic inflammation, and irreversible remodeling of lung tissue. Current therapeutic options remain limited, prompting the search for novel antifibrotic agents. The aim of this study was to evaluate the antifibrotic potential of concentrated polyphenolic extracts from bilberry (*Vaccinium uliginosum*), cranberry (*Vaccinium oxycoccos*), and lingonberry (*Vaccinium vitis-idaea*) using a bleomycin-induced rat model of pulmonary fibrosis.

Methods; pulmonary fibrosis was induced in Wistar rats by a single intratracheal administration of bleomycin (5 mg/kg). Beginning one week after fibrosis induction, animals received daily intragastric administration of berry polyphenol extracts for 14 days. Histological assessment included hematoxylin-eosin, Masson's trichrome, Gomori silver impregnation, and orcein staining. Morphometric analysis evaluated inflammatory cell infiltration, edema, collagen deposition, fibrosis severity and stage, and elastic fiber integrity. Blood viscosity was also measured to assess hemorheological changes associated with pulmonary fibrosis.

Results; bleomycin administration induced severe diffuse pulmonary fibrosis accompanied by extensive inflammatory infiltration, edema, predominance of mature type I collagen, disruption of elastic fibers, and increased blood viscosity. Treatment with all three berry polyphenol extracts significantly reduced the severity of fibrotic remodeling and inflammatory changes. Lung lesions in treated animals were predominantly focal rather than diffuse and demonstrated a shift toward immature type III collagen (reticulin), indicating attenuation of collagen maturation. The extracts also reduced inflammatory cell infiltration, eliminated multinucleated giant cells, preserved alveolar elastic fibers, and increased the presence of macrophages with phagocytic morphology. *Vaccinium oxycoccos* and *Vaccinium vitis-idaea* exhibited the most pronounced antifibrotic and anti-inflammatory effects. In addition, polyphenol treatment decreased blood viscosity, suggesting improvement of pulmonary fibrosis-associated hemorheological disturbances.

Conclusions; polyphenolic extracts from northern berries demonstrated significant antifibrotic activity in experimental pulmonary fibrosis by limiting inflammatory injury, reducing collagen maturation, preserving lung histoarchitecture, and improving blood rheology. Cranberry (*Vaccinium oxycoccos*) and lingonberry (*Vaccinium vitis-idaea*) exhibited the greatest therapeutic potential. These findings provide histological evidence supporting berry-derived polyphenols as promising multi-target antifibrotic agents and highlight their potential for the development of novel adjunctive strategies aimed at preventing or

slowing the progression of pulmonary fibrosis. The ability of these extracts to modulate both tissue remodeling and hemorheological disturbances suggests a broader therapeutic relevance that warrants further translational studies.

Keywords: Pulmonary Fibrosis; Bleomycin; Blood Hyperviscosity; Polyphenols; Antifibrotic Effect

Acknowledgment: This research is funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP23489474).

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POSTER PRESENTATION

Id-3016

Grape Polyphenol Concentrate Improves Oxidative Stress Markers in Coal Miners with Occupational Lung Disease Predictors

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Abstract: Objective; occupational pulmonary fibrosis in coal miners represents a severe and irreversible stage in the progression of chronic dust-induced bronchitis, chronic obstructive pulmonary disease, and pneumoconiosis, characterized by replacement of normal lung tissue with fibrotic connective tissue. However, at earlier stages, before clinically evident pneumoconiosis develops, interventions targeting key pathogenic mechanisms may help slow disease progression. Since chronic oxidative stress plays an important role in the initiation and progression of fibrotic processes, circulating markers of oxidative and antioxidant status may serve as relevant preventive targets. This study aimed to evaluate the potential effect of grape polyphenol concentrate on oxidative stress parameters in coal miners with predictors of dust-induced occupational lung diseases.

Methods; oxidative stress markers were assessed over a six-month observation period in 90 coal miners with more than eight years of underground work experience and a diagnosis of chronic dust-induced bronchitis. Pro-oxidant status was evaluated using the d-ROMs test, reflecting the production of reactive oxygen and nitrogen species, while antioxidant/reductive status was assessed using the PAT test. These parameters allowed identification of redox imbalance associated with increased oxidant burden, reduced antioxidant capacity, or both. The intervention group received grape polyphenol concentrate orally at a dose of 30 mL once daily for one month, corresponding to 600 mg of total polyphenols per day. The placebo group included 37 participants who received 30 mL of grape juice daily.

Results; at baseline, the mean d-ROMs value was 307.28 ± 144.63 U.CARR, indicating a moderate increase in oxidative stress compared with the optimal range. The mean PAT value was 623.80 ± 365.53 µmol Trolox equivalents/L, reflecting markedly reduced antioxidant protection. After one month of grape polyphenol concentrate intake, d-ROMs levels decreased by 37%, while PAT values increased by 76% in the intervention group. In contrast, no meaningful changes in d-ROMs or PAT values were observed in the placebo group. At the six-month follow-up, d-ROMs and PAT values in the placebo group remained largely unchanged compared with baseline. In the intervention group, PAT values slightly decreased compared with the one-month assessment but remained 29% higher than baseline. The d-ROMs index showed an additional 6.8% decrease at six months.

Conclusions; grape polyphenol concentrate intake was associated with improved oxidative stress and antioxidant status markers in coal miners with predictors of dust-related occupational lung diseases. These findings suggest that grape polyphenol concentrate may have preventive potential by reducing oxidative stress, a key mechanism involved in the progression of dust-induced bronchopulmonary

pathology and fibrotic remodeling. Further controlled studies with clinical, functional, and imaging endpoints are needed to confirm its potential role in preventing fibrotic progression.

Keywords: occupational lung disease; coal miners; dust-induced bronchitis; oxidative stress; grape polyphenols; antioxidant status; pulmonary fibrosis prevention

Acknowledgment: This research was funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan under IRN BR27199517, “Comprehensive Approach to Medical Prevention and Rehabilitation of Occupational Bronchopulmonary Diseases of Dust Etiology.”

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POSTER PRESENTATION

Id-3017

Biomarker Panels Reflect the Development of Pulmonary Fibrotic Processes in Coal Miners

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Abstract: Objective; pulmonary fibrosis is a typical consequence of prolonged occupational exposure of the bronchoalveolar system to coal dust in miners. Identification of predictors of fibrosis risk using a panel of objective biomarkers may provide a basis for monitoring early pathological changes and implementing preventive measures. The aim of this study was to evaluate early biomarkers associated with the risk of pulmonary fibrotic remodeling in coal miners.

Methods; venous blood samples, including serum and plasma, were collected from three groups: 1) coal miners without clinical signs of occupational lung disease, with 8–10 years of underground work experience in coal mines (50 men aged 32–47 years); 2) coal miners with diagnosed occupational lung diseases, including chronic dust-induced bronchitis and chronic obstructive pulmonary disease (COPD) (40 men aged 38–52 years); and 3) mine workers without occupational exposure to coal dust, who served as the control group (22 men aged 25–50 years). Concentrations of interleukin-6 (IL-6), interleukin-10 (IL-10), matrix metalloproteinase-7 (MMP-7), and surfactant protein D (SP-D) were measured using commercially available quantitative sandwich ELISA kits.

Results; in the group of coal miners without clinical signs of lung disease, IL-6 levels were higher than those in the control group and corresponded to a background level of systemic inflammation. IL-10 demonstrated considerable interindividual variability. Moderately expressed signs of extracellular matrix remodeling were reflected by increased MMP-7 concentrations, while early subclinical impairment of the surfactant system was indicated by a slight increase in SP-D levels, reaching up to 16.8%. In the group of coal miners with occupational lung diseases, relatively high levels of IL-6, IL-10, MMP-7, and SP-D were observed, as expected.

Conclusions; a biomarker panel comprising IL-6, IL-10, MMP-7, and SP-D may have prognostic value for monitoring the development of occupational lung pathology in coal miners. Moderate extracellular matrix remodeling, reflected by MMP-7, subclinical impairment of the surfactant system, reflected by SP-D, the intensity of the anti-inflammatory response, reflected by IL-10, and systemic inflammation, reflected by IL-6, may indicate an increased risk of pulmonary fibrotic processes in coal miners.

Keywords: Pulmonary fibrosis; coal miners; oxidative stress; matrix metalloproteinase-7; IL-6; IL-10

Acknowledgment: This research was funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan under IRN BR27199517, “Comprehensive Approach to Medical Prevention and Rehabilitation of Occupational Bronchopulmonary Diseases of Dust Etiology.”

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POSTER PRESENTATION

Id-3018

Plant-Derived Exosome-Like Nanoparticles from Polyphenol-Rich Berries as Natural Nanocarriers for Quercetin Delivery

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Abstract: Objective; plant-derived exosome-like nanoparticles (PDENs) are emerging as biocompatible nanoscale carriers capable of transporting bioactive compounds and modulating cellular responses. Berries rich in polyphenols, including grape, blueberry, and strawberry, represent promising sources of natural nanovesicles with antioxidant and anti-inflammatory potential. The aim of this study was to isolate and characterize PDENs from polyphenol-rich berries and to evaluate their potential as natural nanocarriers for quercetin delivery.

Methods; exosome-like nanoparticles were isolated from grape, blueberry, and strawberry using isoelectric precipitation, size-exclusion chromatography, and total exosome isolation approaches. Size-exclusion chromatography was selected as the preferred method for obtaining a purified nanoparticle fraction. Quercetin loading into grape-derived PDENs was performed using incubation for 2 and 18 hours, as well as a freeze–thaw method involving three freeze–thaw cycles over 18 hours. Association and dissociation of quercetin were evaluated using a dialysis system with 100 nm pores at 37°C and 4°C. Anti-inflammatory activity of berry-derived PDENs was assessed in LPS-stimulated RAW264.7 macrophages by evaluating the expression of inflammatory markers iNOS and COX-2 using qRT-PCR. Antioxidant activity was assessed using DPPH and ABTS assays, while cytoprotective and antiproliferative properties were evaluated using the MTT assay in human fibroblast cell culture.

Results; berry-derived PDENs demonstrated anti-inflammatory activity in vitro, reflected by reduced expression of iNOS and COX-2 mRNA in LPS-stimulated macrophages. The strongest inhibitory effect was observed for blueberry-derived PDENs, with relative iNOS expression decreasing to 0.62 ± 0.04 at 1:100 dilution and 0.30 ± 0.15 at 1:10 dilution, while COX-2 expression decreased to 0.47 ± 0.11 and 0.28 ± 0.06, respectively. Grape-derived PDENs also reduced iNOS expression to 0.89 ± 0.17 and 0.35 ± 0.02, and COX-2 expression to 0.87 ± 0.23 and 0.31 ± 0.07 at 1:100 and 1:10 dilutions, respectively. Strawberry-derived PDENs showed a moderate inhibitory effect, with iNOS values of 0.81 ± 0.12 and 0.49 ± 0.18, and COX-2 values of 0.95 ± 0.36 and 0.60 ± 0.07. Quercetin loading increased with prolonged incubation and freeze–thaw processing: 2-hour incubation resulted in a loading value of 11.6 ± 0.08, 18-hour incubation increased this value to 24.9 ± 1.86, while the freeze–thaw method achieved 31.4 ± 2.07. Dialysis experiments demonstrated temperature-dependent quercetin dissociation from grape-derived PDENs. At 37°C, quercetin release progressed substantially over 24 hours, whereas at 4°C, dissociation was minimal, indicating better stability under low-temperature conditions.

Conclusions; plant-derived exosome-like nanoparticles isolated from polyphenol-rich berries demonstrate anti-inflammatory activity and can serve as natural nanocarriers for quercetin. Among the

tested samples, blueberry-derived PDENs showed the most pronounced suppression of inflammatory gene expression, while grape-derived PDENs demonstrated efficient quercetin loading and temperature-dependent release behavior. These findings support the potential application of berry-derived PDENs as biocompatible delivery systems for polyphenols in biomedical, nutraceutical, and preventive health applications.

Keywords: Plant-Derived Exosome-Like Nanoparticles; Pdens; Quercetin; Grape; Blueberry; Strawberry; Nanocarriers; Polyphenols; Anti-Inflammatory Activity; Antioxidant Activity.

Acknowledgment: This research is funded by the Science Committee of the Ministry of Science and Higher Education of the Republic of Kazakhstan (Grant No. AP23490945).

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POSTER PRESENTATION

Id-3034

Fabrication of Maize Cob/CuS-PVA Nanocomposites for the Removal of Iron (III) Ions from Wastewater

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Abstract: The rapid increase of heavy metals in the surface and groundwater may be due to the untreated industrial sewages. The discharge of these heavy metal from wastewater systems can be escalated to the soil and causes risk to the environment. In this project, CuS nanoparticles capped with PVA were synthesized and incorporated with activated maize cob to fabricate maize cob nanocomposites. The nanocomposites were used to remove Fe(III) ions from wastewater solution through adsorption process. The optical properties of the synthesized nanoparticles showed two absorption peaks on the spectra of the uncapped CuS and PVA capped CuS nanoparticles that was red shifting when the capping molecule was introduced. TEM images of the nanoparticles showed spherical particles. The sizes decreased when the stabilizer (PVA) was introduced onto the surface of the copper sulfide nanoparticles from 3.57±0.30 nm to 1.85±0.511 nm, respectively. The XRD pattern of all the nanoparticles projected hexagonal phase structures. SEM micrograms of the activated maize cob showed an improve surface with many sites for bonding compared to the inactivated maize cob. PVA-CuS-MC nanocomposites also shows the distribution of nanoparticles onto the surface of an activated maize cob. Adsorption of Fe(III) ions onto maize cob and PVA-CuS-MC nanocomposites was investigated using ICP. An optimum pH of 4 was achieved and the equilibrium reached it maximum peak in 60 minutes. The discovered results showed that PVA-CuS-MC nanocomposite can be used as an alternative adsorbent as it displayed the highest adsorption capacity of 88.74 mg/g. Kinetics study showed that sorption of Fe(III) ions was achieved through more than one process. The equilibrium data fitness was also tested using Langmuir, Freundlich, and Sips isotherm models. Adsorption kinetics and isotherm accurately fitted the pseudo-second-order kinetic model and Sips isotherm model, respectively. Thermodynamic studies also confirmed that the adsorption was a spontaneous endothermic system. The obtained results proved that PVA-CuS-MC nanocomposite can be employed as an effective and inexpensive adsorbent for the removal of heavy metal ions such as Fe(III) ions from aqueous solutions compared to the conventional adsorbents.

Keywords: Copper sulfide, PVA, maize cob, nanocomposites, Fe(III) ions, Adsorption, Isotherm

Acknowledgment: The authors would like to acknowledge the Vaal University of Technology and National Research Foundation (TTK13071722088: “Thuthuka Grant Holder”) for funding this project.

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POSTER PRESENTATION

Id-3047

Fabrication of antibacterial copper thin films on fibrous substrates via DC magnetron sputtering

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Abstract: The development of fibrous materials endowed with antimicrobial action has become increasingly significant across healthcare, industrial filtration, and protective apparel sectors. Conventional textile finishing practices frequently employ chemical crosslinking systems capable of generating hazardous volatile compounds—formaldehyde being particularly concerning—thereby raising occupational exposure risks and environmental contamination issues. These limitations have motivated substantial investigation into alternative, environmentally responsible approaches for imparting durable biocidal functionality to both cellulosic and synthetic fiber assemblies. Application of copper as thin surface layers onto textile structures presents an efficient strategy for creating functional interfaces suitable for demanding applications including clinical textiles and specialized performance garments. Magnetron sputtering represents a clean, precisely controllable vacuum-based fabrication approach capable of producing uniform, nanoscale copper coatings directly onto thermally sensitive fibrous substrates while preserving the inherent mechanical properties of the underlying fiber structure. This investigation aims to fabricate copper-functionalized textile materials utilizing DC magnetron sputtering performed on the EPOS-PVD-440 automated vacuum coating system. The process was carried out in a stainless steel (AISI 304) vacuum chamber with dimensions of 750×850 mm. High-vacuum conditions were established using a dual-stage pumping system consisting of an Actan vacscroll-60 dry scroll pump and a Cryo-Plex 8/8LP cryogenic pump, reaching an initial base pressure of 1.7×10^{-5} mbar. Sputtering was executed in an argon atmosphere at a working pressure of 1.38×10^{-3} mbar. The process was maintained at a constant discharge power of 0.5 kW for a total duration of 40 minutes. During the stable deposition phase, operating voltages ranged between 338 V and 347 V with discharge currents around 1 A (1.03 A–1.29 A initial, concluding at 0.86 A). Substrate rotation was facilitated by a planetary carousel system at speeds of 1-10 rpm to ensure coating uniformity across target samples. These established parameters provide a standardized baseline for controlled copper thin film synthesis using industrial-scale PVD equipment. Our result provides a scalable, eco-friendly framework for manufacturing high-performance, antibacterial materials suitable for demanding applications in healthcare and industrial protective apparel.

Keywords: magnetron sputtering, copper thin films, PVD deposition, process parameters, medical textiles, antimicrobial coatings.

Acknowledgement: This research was funded by Ministry of Science and Higher Education of the Republic of Kazakhstan, grant number AP25794661.

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POSTER PRESENTATION

Id-3049

Synthesis and Properties of Castor Oil-based Non-isocyanate Polyurethane Films

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Abstract: In this study, Castor oil was epoxidized using epichlorohydrin and subsequently carbonated through a reaction with CO_2. The resulting carbonated castor oil was then reacted with amines to synthesize castor oil-based non-isocyanate polyurethanes (NIPUs). The structure of the epoxidized and carbonated castor oils, as well as the synthesized NIPUs, were analyzed using FT-IR and ^{1}H-NMR, depending on the amount of epichlorohydrin used during the epoxidation. Tensile strength and thermal stability were evaluated using a universal testing machine (UTM) and thermogravimetric analysis (TGA), respectively. As the epichlorohydrin content increased, the tensile strength of the synthesized NIPU films improved. All NIPU films exhibited high thermal stability with initial decomposition temperatures above 320℃, and self-healing capability was also confirmed.

Keywords: Non-isocyanate polyurethane, Castor oil, Epichlorohydrin, Bio-based polyurethane

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POSTER PRESENTATION

Id-3050

Improvement of Hydrometallurgical Methods for Processing High-Silica Bauxite Raw Materials

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Abstract: Low-grade, high-silica bauxites cause substantial alumina and alkali losses in the Bayer process because silica reacts with aluminate solutions. This study comparatively evaluates alternative routes for separate treatment of the fine high-silica fraction of gibbsite-kaolinite bauxite after gravity beneficiation. Three routes were investigated: thermochemical transformation followed by chemical beneficiation and Bayer leaching; a combined Bayer-hydrochemical process; and one-stage hydrochemical leaching after preliminary activation with an active calcium additive. The combined route gave the highest overall Al2O3 recovery (92.06%), while the one-stage hydrochemical route achieved 89.5% with fewer technological operations.

Keywords: High-Silica Bauxite, Gravity Beneficiation, Hydrochemical Processing, Bayer Process, Active Calcium Additive, Alumina.

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POSTER PRESENTATION

Id-3051

Hydrochemical Extraction of Scandium from Alumina Production Red mud

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Abstract: Red mud is a large-tonnage waste of alumina production and a promising secondary raw material for scandium recovery. This study aimed to increase scandium extraction from red mud by controlled transformation of its phase composition. Red mud from processing Krasnogorskoye bauxite at the Pavlodar Alumina Plant contained, wt.%: 15.0 Na_2O, 19.47 Al_2O_3, 1.3 CaO, 11.19 SiO_2, 26.95 Fe_2O_3, and 0.01 Sc_2O_3. The developed flowsheet combines preliminary alkaline treatment, thermochemical transformation in sodium bicarbonate solution, repulping in a sodium carbonate-bicarbonate solution, and selective scandium sorption. The optimized transformation at 260 °C for 6 h and L:S = 10 promoted decomposition and recrystallization of refractory mineral phases. Subsequent repulping at 80 °C for 3 h with CO_2 supply to pH <= 9 provided 86.5% scandium recovery. Lewatit TP 260 resin recovered at least 98% of scandium from solution, and desorption with 300-320 g/dm^3 Na_2CO_3 at 40-45 °C reached 99-99.8%.

Keywords: Red Mud, Scandium, Hydrothermal Treatment, Thermochemical Transformation, Repulping, Sodium Bicarbonate, Sorption.

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POSTER PRESENTATION

Id-3052

Integrated Processing of Demetallized Slag for the Recovery of Rare Earth Elements and Titanium

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Abstract: An integrated route for processing demetallized slag produced by reductive smelting of red mud and waste slurry was investigated for the sequential recovery of iron, aluminum, rare earth elements (REEs), and titanium. The process combines reductive smelting, magnetic separation, alkaline autoclave leaching, residue activation, sulfuric acid leaching, and hydrometallurgical separation of REEs and titanium.

Keywords: Red Mud, Demetallized Slag, Rare Earth Elements, Titanium, Magnetic Separation, Solvent Extraction.

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POSTER PRESENTATION

Id-3053

Production of Aluminate Solutions for Carbonation by Leaching Red Mud Sinter

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Abstract: Low-grade, high-silica bauxite processing by the Bayer process is accompanied by alkali and alumina losses due to silicon binding in sodium hydroaluminosilicates discharged with red mud. This study determines rational conditions for leaching red mud sinter with recycled soda-caustic solutions to obtain a high-caustic-modulus aluminate solution suitable for subsequent aluminum hydroxide precipitation by carbonation. Under the selected conditions, Al_2O_3 extraction reached approximately 92%, producing an aluminate solution with a caustic modulus of 6 and a silica modulus of 31.1.

Keywords: red mud, sinter, leaching, aluminate solution, soda-caustic solution, carbonation, aluminum hydroxide

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POSTER PRESENTATION

Id-3055

Symbolic Regression for Input Variable Selection and Sensitivity Analysis Plasma Torch

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Abstract: The Energy and Environmental Technology Centre (ENET) at VSB – Technical University of Ostrava has long been engaged in the development and application of advanced technologies for energy and environmental applications, including technologies based on plasma processes. An important area of research is the development of plasma torches for high-temperature processing of various types of materials, particularly in waste gasification and energy recovery processes. The development of these devices involves the design of the plasma torch, optimization of its operating parameters, and experimental investigation of its behaviour under different operating conditions. For further development of these technologies, it is essential to correctly identify the parameters that have a decisive effect on the resulting characteristics of the plasma torch while limiting the influence of parameters with low significance.

In this context, symbolic regression was used as a tool for analysing relationships between operating parameters and the resulting plasma torch temperature. The method makes it possible not only to develop a mathematical model of the investigated process but also to automatically identify and eliminate input variables with a limited influence on the output quantity.

Symbolic regression is a machine-learning method that enables the approximation of relationships between input and output variables while simultaneously automatically identifying input variables with a significant influence on the investigated output. This paper investigates the use of symbolic regression as a tool for sensitivity analysis and reduction of the number of input parameters. The proposed approach is validated on three energy-related problems: prediction of the mean temperature of a plasma torch for waste gasification, prediction of the active power of a photovoltaic power plant, and determination of pipe diameter from a known flow rate and pressure drop.

The results show that symbolic regression can automatically exclude parameters with no or only limited influence while simultaneously identifying simple and physically interpretable mathematical relationships. In the plasma torch case, the arc voltage level was excluded from the original four input parameters, while the resulting model based on power, nozzle geometry, and filling pressure achieved very high accuracy. For the photovoltaic power plant, solar irradiance was identified as the most significant variable, and its model achieved an R^2 value of 0.828. After the most significant parameters were progressively removed, a time dependence of the power output was also revealed. In the third problem, the possibility of neglecting the effect of kinematic viscosity when determining the pipe diameter was confirmed.

The proposed approach therefore enables the computational complexity of models to be reduced while maintaining their accuracy and, at the same time, improving their interpretability. Symbolic regression thus represents a suitable complementary tool for sensitivity analysis and the pre-selection of significant input parameters in engineering and energy applications.

Keywords: Plasma, Torch, Regression, Waste, Energy Conversion, Mathematical Modeling.

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POSTER PRESENTATION

Id-3071

Development and Characterization of Plane Tree Leaf-Derived Porous Carbon for Supercapacitor Electrode Applications

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Abstract: The valorization of biomass waste into functional carbon materials offers a sustainable and cost-effective strategy for the development of energy-storage electrodes. In this study, plane tree leaves were investigated as a renewable precursor for the preparation of porous carbon materials with potential application in supercapacitors. Four samples representing different processing stages and chemical treatment conditions were systematically investigated. Raw plane tree leaves (PTL-0) were used as the reference material. The biomass was carbonized under a nitrogen atmosphere and subsequently treated with KOH to obtain PTL-1. To investigate the influence of acid-assisted treatment and treatment duration, the carbonized material was further subjected to HCl treatment followed by KOH treatment for short and prolonged durations, resulting in PTL-2 and PTL-3, respectively.

The structural, morphological, chemical, and textural properties of the obtained materials were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM), Fourier-transform infrared spectroscopy (FTIR), and Brunauer–Emmett–Teller (BET) surface-area analysis. The characterization results revealed distinct changes in the structure, surface morphology, surface functional groups, and porous characteristics of the plane tree leaf-derived carbon materials depending on the applied treatment conditions. Acid treatment contributed to the removal of residual inorganic species, while subsequent KOH treatment promoted the development of a porous carbon structure. Comparative evaluation of the samples indicated that prolonged chemical treatment led to more favorable structural and textural characteristics, with PTL-3 exhibiting the most promising features among the investigated materials. Overall, these findings demonstrate that plane tree leaf waste can serve as a sustainable and readily available precursor for porous carbon production and highlight the potential of the resulting materials for future supercapacitor electrode applications.

Keywords: Plane tree leaves; Biomass-derived carbon; Porous carbon; KOH activation; electrodes.

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POSTER PRESENTATION

Id-3074

Thermochromic Switching and Thermoelectric Transport in Sn-Doped VO_2 Thin Films Prepared by Spray Pyrolysis

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Abstract: Vanadium dioxide (VO_2) exhibits a metal–insulator transition (MIT) accompanied by pronounced changes in optical transmission and electrical transport. While its thermochromic properties are widely investigated for passive smart windows, its thermoelectric response offers an additional route toward multifunctional energy coatings. This work investigates how Sn incorporation modifies the MIT, thermochromic switching, and thermoelectric properties of spray-deposited VO_2 thin films, with the objective of assessing their potential to combine solar heat regulation with thermal energy harvesting.

Undoped and Sn-doped VO_2 films were prepared on c-plane Al_2O_3 substrates by spray pyrolysis, a scalable, non-vacuum deposition method. X-ray diffraction, Raman spectroscopy, and X-ray photoelectron spectroscopy confirmed VO_2 formation and identified structural and chemical changes associated with Sn incorporation. Temperature-dependent electrical measurements revealed a pronounced MIT, whose temperature and width varied with Sn content. Optical transmittance measurements demonstrated temperature-dependent modulation within the visible–near-infrared spectral range, supporting the potential of these films for thermochromic glazing.

The thermoelectric measurements revealed Seebeck coefficients on the order of 102 $\mu V\ K^{-1}$ and sharp changes across the MIT. The combined evolution of thermopower and electrical conductivity produced enhanced thermoelectric power factors near the transition. For highly Sn-doped films, the power factor approached $10^{-3}\ W\ m^{-1}\ K^{-2}$. This enhancement reflects the coexistence of appreciable thermopower and increased electrical conductivity, highlighting the transition region as a useful temperature range for investigating thermoelectric transport in VO_2.

These results establish Sn incorporation as a means of modifying the coupled optical and transport properties of VO_2 coatings. Thermal conductivity measurements are being incorporated to determine the dimensionless thermoelectric figure of merit, ZT, and evaluate whether the increased power factor translates into improved overall thermoelectric performance. The findings provide a basis for developing multifunctional oxide coatings for thermochromic windows and exploring energy harvesting under appropriately maintained temperature gradients, alongside potential applications in thermal sensing and switching.

Keywords: Vanadium dioxide (VO_2), Metal–insulator transition (MIT), Thermoelectric properties.

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POSTER PRESENTATION

Id-3081

Pulsed Laser Processing of Chemically Synthesized Cr_2O_3 in Water: Comparative Optical Response at 355 and 532 nm

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Abstract: Chromium(III) oxide (Cr_2O_3) is a functional metal oxide of interest for catalytic, protective, sensing, energy-related, and environmental applications. In this study, chemically synthesized Cr_2O_3 was further processed by pulsed laser irradiation in water to examine changes in its optical response. Cr_2O_3 was prepared from $K_2Cr_2O_7$ through chromium sulfate formation, precipitation of $Cr(OH)_3$, washing, drying, and calcination. Before laser processing, the material was dispersed in water and ultrasonically treated at 35 °C for 10 min. Laser experiments were performed at LATARUM, Kocaeli University, using 355 and 532 nm wavelengths. In both cases, the pulse duration was 6 ns, repetition rate 10 Hz, and processing time 1800 s; the pulse energies were 2 mJ at 355 nm and 19.5 mJ at 532 nm. Transmittance and color measurements showed distinct optical behavior for the two laser-treated suspensions (Fig.1). The 355 nm processed sample exhibited higher transmittance over a broad part of the measured visible–near-infrared range than the 532 nm processed sample, while the colorimetric curves also differed clearly. These results indicate that pulsed laser processing in water can modify the optical characteristics of chemically synthesized Cr_2O_3 suspensions. Because wavelength and pulse energy differed between the two experimental conditions, the observed differences are interpreted as a combined effect of the applied laser-processing parameters rather than wavelength alone. Further SEM, EDX, FTIR, and XRD analyses are planned to correlate the optical changes with morphology, elemental composition, bonding structure, and crystallinity.

Keywords: Cr_2O_3; pulsed laser ablation in liquid; 355 nm; 532 nm; optical transmittance; color measurement.

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POSTER PRESENTATION

Id-3082

The Effect of Hvof Spraying Conditions on the Structure and Properties of High-Entropy CoCrFeNiMn Coatings

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Abstract: High-entropy alloys of the CoCrFeNiMn system are of considerable interest as protective coating materials due to their combination of mechanical strength, ductility and wear resistance. One promising method for depositing such coatings is high-velocity oxygen fuel (HVOF) spraying, which enables the production of dense coatings with limited oxidation of the material. The aim of this work was to investigate the effect of the oxygen-to-fuel (O/F) ratio on the microstructure, phase composition, mechanical and tribological properties of CoCrFeNiMn coatings. CoCrFeNiMn powder with a particle size range of 32–45 μm was used as the feedstock. The coatings were deposited onto SS316L stainless steel substrates using the HVOF method with a JP 5000 system at three O/F ratios: 1.7, 1.5 and 1.3. Thermodynamic modelling in Thermo-Calc, using the Scheil–Gulliver model, was employed to predict phase formation. The microstructure and phase composition of the coatings were investigated using X-ray diffraction (XRD), scanning electron microscopy (SEM) and energy-dispersive spectroscopy (EDS). In addition, the microhardness, elastic modulus and wear resistance of the coatings were determined. It was found that the coatings are characterised by a dense lamellar structure and a relatively uniform distribution of the main elements. Calculations based on the Scheil–Gulliver model predicted the predominant formation of the FCC phase during rapid cooling, which is consistent with the XRD results. The coatings obtained under HVOF 1 and HVOF 2 conditions retained the single-phase FCC structure of the starting powder almost entirely, whereas under the HVOF 3 condition, approximately 7 mass.% of Mn_3O_4 was additionally formed, indicating an intensification of oxidative processes. The highest mechanical and tribological properties were obtained under HVOF mode 1 (O/F = 1.7): the microhardness of the coating was 783.8 ± 18.5 HV, whilst the specific wear rate reached a minimum value of 7.45×10^{-5} mm³/(N·m). For the HVOF 2 and HVOF 3 modes, the wear rate increased to 10.27×10^{-5} and 12.20×10^{-5} mm³/(N·m), respectively. The results obtained demonstrate a significant influence of HVOF spraying parameters on the phase composition and performance characteristics of CoCrFeNiMn coatings and confirm the potential of thermodynamic modelling for predicting phase formation during the gas-thermal spraying of high-entropy alloys.

Keywords: high-entropy alloy, CoCrFeNiMn, HVOF, gas-thermal spraying, microstructure, microhardness, wear resistance.

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