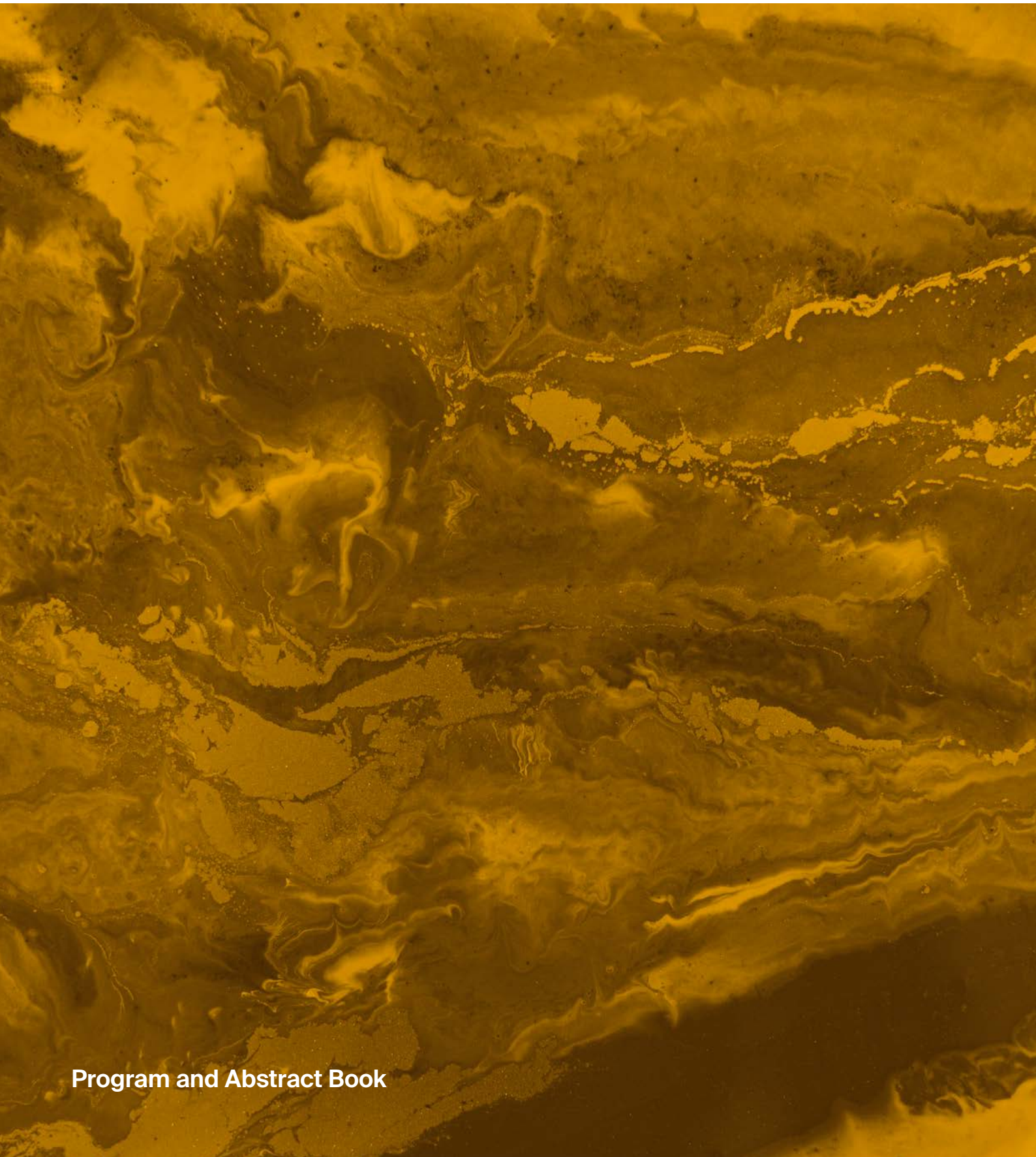
CIC
2025
Conference

4th Coatings and Interfaces Online Conference

21–23 May 2025 | Online



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The 4th Coatings and Interfaces Online Conference

21–23 May 2025 | Online

MDPI

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Welcome from the Chair

Dear Colleagues,

After the success of the past three virtual editions, we are thrilled to announce the **4th Coatings and Interfaces Conference (CIC2025)!** The **CIC** has established itself as a leading platform for scientists and industry professionals to connect, share groundbreaking research and explore the ever-expanding potential of coatings and interface technologies that are freely available worldwide.

The impact of coatings and interfaces on various technological advancements is undeniable. From sustainable energy solutions and pollution control to cultural heritage preservation and healthcare innovations, this field is pivotal in addressing critical challenges in society and research.

CIC2025 promises to be an even more dynamic and stimulating event, bringing together leading actors in academia and industry. Participants will learn about leading research in the field and explore cutting-edge applications and methods. Our conference will foster innovative and timely collaborations in the following exciting fields:

- Plasma Coatings, Surfaces & Interfaces;
- Laser-Coating Technology: Deposition, Structuring and Cladding;
- Coatings and Thin Film Deposition;
- Corrosion, Erosion and the Tribological and Mechanical Aspects of Coatings;
- Novel Methods/Techniques for Coating Deposition and Characterization;
- Protective Coatings in Cultural Heritage, Conservation and Preservation;
- The Biomedical Application of Coatings.

The *Coatings* journal welcomes outstanding contributions to the Conference Special Issue with a 20% APC discount to all participants at the conference.

We look forward to your participation!

Dr. Emerson Coy
Conference Chair
Adam Mickiewicz University in Poznań, Poznań, Poland

Coatings (ISSN 2079-6412) is an international, peer-reviewed and open access journal devoted to the science and engineering of coatings, thin and thick films, surfaces and interfaces. *Coatings* publishes original research papers and brief communications that report on the latest finding of research together with review papers that systematize the remarkable points on the state of the art. Our aim is to encourage scientists to publish their experimental and theoretical results in as much detail as possible. There is no restriction on the maximum length of the papers. Full experimental and/or methodical details must be provided.

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Dr. Antonio Riveiro Rodríguez
University of Vigo, Vigo, Spain

Professor Vasileios Koutsos
Institute for Materials and Processes, School of Engineering, The University of Edinburgh, Edinburgh, UK

Prof. Dr. Chi-wai Kan
The Hong Kong Polytechnic University, Hong Kong, China

Professor Bocong Zheng
School of Physics, Beijing Institute of Technology, Beijing, China

Invited Speakers

Prof. Dr. Kan Zhang
Department of Materials Science, Jilin University, Changchun, China

Prof. Dr. Yung-Kang Shen
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Lecturer, Department of Physics, Egerton University, Egerton, Kenya; Future Africa Research Leadership Fellow, University of Pretoria, Pretoria, South Africa; Africa Futures fellow, Michigan State University, East Lansing, MI, USA

Program Overview

	21 May 2025	22 May 2025	23 May 2025
Morning	S3. Coatings and Thin Film Deposition-Part 1	S6 Protective Coatings in Cultural Heritage, Conservation and Preservation	S5. Novel Methods/Techniques for Coating Deposition and Characterization S2. Laser-Coating Technology: Deposition, Structuring and Cladding
Afternoon	S3. Coatings and Thin Film Deposition-Part 2	S4. Corrosion, Erosion and the Tribological and Mechanical Aspects of Coatings S1. Plasma Coatings, Surfaces & Interfaces	S7. The Biomedical Application of Coatings

CIC 2025 Program

21 May 2025 (Wednesday)

Session 3. Coatings and Thin Film Deposition

Time: 9:00 (CEST, Basel) | 03:00 (EDT, New York) | 15:00 (CST Asia, Beijing)

CEST Time	Speaker	Title
9:00–9:10		Open Message from the Event Chair: Dr. Emerson Coy
9:10–9:20		Welcome Message from Session Chair: Assoc. Prof. Adrian David
9:20–9:40	**Assoc. Prof. Marie Dallocchio** Invited speaker	Perovskite oxide thin films on unconventional substrates: polycrystalline, nanosheets and freestanding
9:40–9:55	**Lukasz Maj** Selected Speaker	Microstructure characterization of titanium oxide coatings with nanoparticles deposited with micro-arc oxidation method on plastically deformed titanium
9:55–10:10	**Jonatan Gomez** Selected Speaker	Exploring the Performance of Phosphate-Functionalized Waterborne Binders on AZ31 Magnesium Alloy
10:10–10:25	**Marina Alves** Selected Speaker	Influence of thermal treatment on micro-Cu(In,Ga)Se2 solar cells for micro-concentrator photovoltaic applications
10:25–10:40	**Ewa Agnieszka Wojtiuk** Selected Speaker	Structure and Properties of W1-xAlxB2-z Coatings
10:40–10:55	**Dujearic-Stephane Kouao** Selected Speaker	Electrochemical water splitting over heterostructure of titania nanotubes and Ni encapsulated within MXenes
10:55–11:10	**Saiful Islam Khan** Selected Speaker	Semitransparent Gold-Embedded Anodic Titania Nanotubes: Harnessing Plasmonic and Photoelectrochemical Synergies for Visible-Light Applications
11:10–11:25	**Tsvetanka Babeva** Selected Speaker	Tailoring the optical and sensing properties of sol–gel niobia coatings via doping with silica and gold nanoparticles
11:25–11:45	**Flash Poster Part**	

Session 3. Coatings and Thin Film Deposition

Time: 14:00 (CEST, Basel) | 08:00 (EDT, New York) | 20:00 (CST Asia, Beijing)

CEST Time	Speaker	Title
14:00–14:10		Welcome Message from Session Chair: Assoc. Prof. Adrian David
14:10–14:30	**Dr. Lucia Iglesias** Invited speaker	Democratizing nickelates superconductors: Topotactic reduction induced by aluminum sputter deposition
14:30–14:45	**Zuzanna Kaczmarska** Selected Speaker	Elastic properties and moisture response of polydopamine films and multilayers
14:45–15:00	**Katarzyna Zielińska** Selected Speaker	Comparison of wear resistance and biological properties of Ag/W1-xTixB2,5 nanocomposite and pure-silver coating
15:00–15:15	**Gabriel Santos** Selected Speaker	Enhancing Colour and Performance of Black Double-Layered Nickel Coatings
15:15–15:30	**Aida Maria Diez Sarabia** Selected Speaker	Usage of Metal Organic Frameworks as water-splitting catalysts
15:30–15:45	**Grazia Giuseppina Politano** Selected Speaker	Localized Effects in Graphene Oxide Systems: A Pathway to Hyperbolic Metamaterials
15:45–16:00	**Aikaterini Baxevani** Selected Speaker	Superhydrophobic copper foams for use as marine water purification filters
16:00–16:15	**Oliwia Ufniarz** Selected Speaker	Innovative Solvent-Based Pressure-Sensitive Paints for Aerodynamic Testing in Wind Engineering
16:15–16:40	**Flash Poster Part**	

22 May 2025 (Thursday)

Session 6. Protective Coatings in Cultural Heritage, Conservation and Preservation

Time: 9:00 (CEST, Basel) | 03:00 (EDT, New York) | 15:00 (CST Asia, Beijing)

CEST Time	Speaker	Title
9:00–9:10	**Welcome Message from Session Chair Assoc. Prof. Claudia Pelosi**	
9:10–9:40	**Prof. Dr. Giuseppe Cavallaro** Keynote Speaker	Halloysite Clay Nanotubes for Preservation of Cultural Heritage
9:40–10:00	**Prof. Claudia Mazzuca** Invited Speaker	Coating paper artworks with cellulose nanocrystals: results and future perspectives
10:00–10:15	**Doree Carrier** Selected Speaker	Historic Paint Coatings applied to Historic Fibrous Plaster
10:15–10:30	**Laura Andrés Herguedas** Selected Speaker	Assessment of colour protectors and fixing primers for preserving contemporary mural artwork
10:30–10:45	**Ioannis Karapanagiotis** Selected Speaker	A multifunctional coating for the protection of natural stone
10:45–11:00	**Mariana Ramos** Selected Speaker	A highly hydrophobic siloxane-nanolignin hybrid coating for the protection of heritage wood
11:00–11:15	**Marzena Nowicka-Nowak** Selected Speaker	New fire-retardant coatings for modular buildings
11:15–11:40	**Flash Poster Part**	

Session 4. Corrosion, Erosion and the Tribological and Mechanical Aspects of Coatings
Session 1. Plasma Coatings, Surfaces & Interfaces

Time: 14:00 (CEST, Basel) | 08:00 (EDT, New York) | 20:00 (CST Asia, Beijing)

CEST Time	Speaker	Title
14:00–14:10	**Welcome Message from Session Chair: Prof. Dr. Huirong Le**	
14:10–14:40	**Prof. Dr. Chi-wai Kan** Keynote Speaker	Some Applications of Coating in Textiles
14:40–15:00	**Dr. Florian Pape** Invited Speaker	Enhanced Rolling Bearing Surfaces through Tailored Forming Coated Raceways
15:00–15:15	**Eleni Lamprou** Selected Speaker	The impact of oxidative amine degradation on the corrosion behavior of 304L and 316L stainless steels in MEA solutions containing SOx and NOx contaminants
15:15–15:30	**Marlon H. Guerra-Mutis** Selected Speaker	Potassium Permanganate–Fluorozirconate Conversion Coating as a Precursor for Flash-PEO Coatings on AZ31B Magnesium Alloy
15:30–15:40	**Welcome Message from Session Co-Chair: Dr. Mukul Dubey**	
15:40–16:10	**Prof. Bocong Zheng** Keynote Speaker	Kinetic investigation of magnetron sputtering discharges
16:10–16:30	**Dr. Nina Baul** Invited Speaker	Interlayer optimization for nitrogen-incorporated tetrahedral amorphous carbon thin film optically transparent electrode
16:30–16:50	**Dr. Tabitha A. Amollo** Invited Speaker	Thin films deposition by Single-Beam Plasma Source enhanced magnetron sputtering
16:50–17:05	**Stefanos Chaitoglou** Selected Speaker	Deposition, processing and functionalization of vertical graphene nanowalls and their application on energy harvesting and storage
17:05–17:20	**Esther López Martínez** Selected Speaker	The study of a multilayer PEO/HAp/PCL coating for the corrosion protection of an additively manufactured WE43 magnesium alloy
17:20–17:35	**Maximilian Grimm** Selected Speaker	Particle–plasma interactions: particle melting state and its impact on the phase composition and deposition efficiency in atmospheric plasma-sprayed alumina coatings
17:35–17:55	**Flash Poster Part**	

23 May 2025 (Friday)

Session 5. Novel Methods/Techniques for Coating Deposition and Characterization
Session 2. Laser-Coating Technology: Deposition, Structuring and Cladding

Time: 9:00 (CEST, Basel) | 03:00 (EDT, New York) | 15:00 (CST Asia, Beijing)

CEST Time	Speaker	Title
9:00–9:10		Welcome Message from Session Chair: Dr. Heping Li
9:10–9:40	**Prof. Vasileios Koutsos** Keynote Speaker	Fibre sizing in fibre-reinforced polymers (FRPs)
9:40–10:00	**Prof. Dr. Kan Zhang** Invited Speaker	Design of Strengthened and Toughened Thin Film Materials Based on Nano-Ordered Structures
10:00–10:20	**Prof. Dr. Yung-Kang Shen** Invited Speaker	Surface modification of Ti6Al4V alloy using femtosecond laser to investigate its effect on osseointegration
10:20–10:35	**Orlando Lima Júnior** Selected Speaker	Enhancing Road Safety with Smart Road Marking Paints: Self-Cleaning and Thermochromic Capabilities
10:35–10:50	**Stefano Colace** Selected Speaker	Monitoring the evolution of optical coatings during thermal annealing with in situ spectroscopic ellipsometry
10:50–11:00		Welcome Message from Session Chair: Dr. Rafael Comesaña
11:00–11:30	**Dr. Antonio Riveiro Rodríguez** Keynote speaker	Illuminating Surfaces: Emerging Trends in Laser Surface Texturing Applications.
11:30–11:45	**Paolo Tallone**	Laser-Induced Copper Oxidation for Improved Performance in Anode-Free Lithium Metal Batteries
11:45–12:10	**Flash Poster Part**	

Session 7. The Biomedical Application of Coatings

Time: 14:00 (CEST, Basel) | 08:00 (EDT, New York) | 20:00 (CST Asia, Beijing)

CEST Time/CST Asia Time	Speaker	Title
14:00–14:10		Welcome Message from Session Chair Dr. Michele Ferrari
14:10–14:25	**Alexandre Emelyanenko** Selected Speaker	The Development of Extreme Wettability Coatings to Combat the Spread of Bacterial Infections and their Testing in Hospital Conditions
14:25–14:40	**Antonios Kelarakis** Selected Speaker	Carbon-based nanocoatings with advanced antimicrobial performance
14:40–14:55	**Fabricio Bezerra** Selected Speaker	Development of Biofunctional Textiles: Microencapsulation of Lemongrass Oil and Salicylic Acid for Dermocosmetic Applications
14:55–15:10	**Francesco Iannielli** Selected Speaker	Novel Composite Films Starting from Black Soldier Fly Protein Extract
15:10–15:25	**Sara Ferraris** Selected Speaker	Natural coatings as promising green solution for tailoring the degradation of AZ91-magnesium alloy in orthopedic applications
15:25–15:40	**Anna Rossanese** Selected Speaker	Quorum Quenching on Titanium Surfaces: A Strategy to Reduce Virulence in Resistant Bacteria
15:40–15:55	**Anna Buling** Selected Speaker	Development of ceramic-like surfaces on Mg-based screw implants for orthopedic application via PEO (plasma electrolytic oxidation) process
15:55–16:10	**Margherita Izzi** Selected Speaker	Experimental design-based optimization of bioactive coatings for sustainable antimicrobial applications
16:10–16:25	**Shaghayegh Javad** Selected Speaker	Effect of hybrid hierarchical PEO/PLA coatings on corrosion performance of additively manufactured Ti6Al4V in simulated body fluid
16:25–16:50	**Flash Poster Part**	

Session 1. Plasma Coatings, Surfaces & Interfaces

sciforum-113573: Room-Temperature Hydrogen Absorption in Mg-Based Thin Films

Lesław Smardz

Institute of Molecular Physics, Polish Academy of Sciences, Smoluchowskiego 17, 60-179 Poznań, Poland

The growing interest in the study of reversibly hydrogen-absorbing thin films is mainly due to their potential application as hydrogen sensors or switchable mirrors (smart windows) in electronics. From an economic point of view, magnesium would be the most suitable material for such applications. In contrast to bulk magnesium, Mg thin films covered with a palladium layer can absorb hydrogen at room temperature and pressures of up to 1 bar. One important experimental problem that still needs to be solved is the improvement of the too-slow absorption kinetics. This paper presents the results of studies leading to a significant improvement in hydrogen absorption kinetics by depositing an ultrathin Ni (Al or C) layer between the top Pd catalytic layer and the Mg base layer. A significant improvement in the absorption kinetics was also achieved by replacing pure Mg with a Mg_2Ni alloy. In addition, in order to determine the mechanisms responsible for the improvement of absorption kinetics, the effect of atom mixing in the interface region was studied in detail using X-ray photoelectron spectroscopy. The obtained results confirmed the important role of the Ni interlayer in improving hydrogen absorption kinetics in Pd/Ni/Mg trilayers. In Pd/Mg_2Ni bilayers, the Ni interlayer is formed spontaneously due to the segregation of Mg atoms on the surface. In the case of Al and C interlayers, the improvement of absorption kinetics occurs due to the spontaneous formation of small islands in the interface region containing Al atoms and magnesium carbide, respectively, which can form heterogeneous nucleation centres. The optimal thicknesses of Ni, Al and C layers are 3.0, 0.5, and 1.4 nm, respectively. The obtained results can be used to obtain new thin-film metallic nanomaterials with improved functional properties at room temperature.

sciforum-100489: Deposition, Processing and Functionalization of Vertical Graphene Nanowalls and Their Application on Energy Harvesting and Storage

Stefanos Chaitoglou *, Enric Bertran-Serra and Roger Amade

University of Barcelona, 08007 Barcelona, Spain

Graphene-based materials exhibit a series of desired properties, e.g., electrical conductivity, high surface-to-volume ratio and tuning of surface chemistry between others, which make them a Swiss army knife for use in energy-related applications. In the present talk, I present the latest experimental results from our research on vertical graphene nanowall (VGNW) use in the above applications. VGNWs are characterized by the perpendicular orientation of graphene nanosheets with respect to the growth substrate, which is advantageous for homogeneous functionalization with other nanoparticles via vapor deposition techniques. I provide insights on the deposition of VGNWs as a coating on planar and three-dimensional nanostructured substrates via plasma chemical vapor deposition [1]. Then, I present results on the processing of VGNWs by laser pulses as a means to tune their crystal structure and control the density of defects [2]. I will conclude the talk showing the results on the preparation of VGNW-based compounds for application in electrocatalytic hydrogen evolution [3-5] and supercapacitor applications [6], focusing on their role as a template for the efficient anchoring of nanostructures.

References

[1] S. Chaitoglou, R. Amade, E. Bertran Applied Surface Science 592 (2022) 153327
[2] S. Chaitoglou, A. Klini, N. Papakosta, Y. Ma, R. Amade, P. Loukakos, and E. Bertran-Serra J. Phys. Chem. Lett. 15 (2024) 3779–3784
[3] S. Chaitoglou, R. Ospina, Y. Ma, R. Amade, X. Vendrell, J. Rodriguez-Pereira, E. Bertran-Serra Journal of Alloys and Compounds 972 (2024) 172891
[4] S. Chaitoglou, R. Amade, R. Ospina, E. Bertran ACS Appl. Energy Mater. 6 (2023) 6120-6131
[5] S. Rodriguez-Miguel, Y. Ma, G. Farid, R. Amade, R. Ospina, J. Luis Andujar, E. Bertran-Serra, S. Chaitoglou Heliyon 10 (2024) e31230
[6] Y. Ma, S. Chaitoglou, G. Farid, R. Amade, R. Ospina, A. Munoz-Rosas, E. Bertran-Serra Chemical Engineering Journal 488 (2024) 151135

sciforum-115569: Improvement in the Contact Between TiAlV and Organic Tissue Through TiO_xC_y Organometallic Multilayer Coatings for Improving Osseointegration

Sandra Rubio * and Laurent Houssiau

Physics Department, University of Namur, Rue Grafé, 2 5000 Namur, Belgium

Titanium alloys like TiAlV are biocompatible materials widely used in dental implants [1]. Hydrophilic surfaces enhance adhesion between the implant screw and tissue, promoting osseointegration and improving success rates through optimized chemical properties [2].

A novel multilayer coating approach is developed to avoid early implant failure by optimizing surface properties. This research focuses on creating innovative TiO_xC_y organometallic multilayer coatings on $Ti_{90}Al_6V_4$ substrates to improve osseointegration. These coatings are prepared using Plasma-Enhanced Chemical Vapor Deposition (PECVD), varying deposition parameters such as reactive gas flow, power, and time to modify the chemical composition, hydrophilicity, and layer thickness.

Comprehensive characterization of the surface is conducted using X-Ray Photoelectron Spectroscopy (XPS) to determine the chemical environment, and using the contact angle to evaluate wettability. To further understand the chemical composition within each layer, XPS depth profiling analyses are performed.

The preliminary results revealed that a multilayer designed with a decreasing reactive gas flow exhibits a gradient in its composition. Near the substrate, the layers display a mineral-like, low-carbon structure, transitioning to an organic-like, high-carbon composition (with a carbon percentage 3 times higher) at the outermost surface. This outer layer, engineered to interact with organic tissue, has a higher hydrophilic surface, resulting in superior osseointegration.

This innovative multilayer design not only represents a significant advancement in dental implant technology but also sets a precedent for the development of functional coatings for biomedical applications.

References

[1] Marin, E., Lanzutti, A. (2023). Biomedical applications of titanium alloys: a comprehensive review. Materials, 17(1), 114.

[2] Gittens, R. A., Scheideler, L., Rupp, F., Hyzy, S. L., Geis-Gerstorfer, J., Schwartz, Z., Boyan, B. D. (2014). A review on the wettability of dental implant surfaces II: Biological and clinical aspects. Acta biomaterialia, 10(7), 2907-2918.

sciforum-114256: Infrared Thermography of Thermal Spray Coating Processes as Quality Monitoring Tool

Thomas Lindner *, Sahib Kaur, Kay Schlegel and Thomas Lampke

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The evolution of substrate surface temperature during coating deposition is a decisive property-determining factor in thermal spraying. Local heat development is influenced by various factors such as thermal conductivity and substrate thickness. High fluctuations in surface temperatures promote the formation of residual stresses in the coating layers during cooling. Therefore, the risk of oxidation, cracking, or delamination increases. Therefore, limiting the surface temperature appears beneficial for quality assurance. Infrared (IR) thermography offers the possibility to determine the surface temperature in the coating process without contact. Determining factors in temperature evolution during the thermal spray process were identified by using IR thermography. The interaction between the substrate and coating material was taken into account. Furthermore, application limits for IR thermography (Optris XI80) in comparison to thermocouple measurements for the temperature range of 0–250 °C were determined. For this purpose, the stainless steel AISI 316L was coated on aluminum and steel sheets by atmospheric plasma spraying (APS). The influence of substrate thickness was evaluated. A correlation between the temperature history during the coating process and the corrosion properties was established. Current density potential measurements using gel electrolytes were used for this purpose. Clear correlations between the development of the surface temperature and the resulting coating properties werederived.

sciforum-106854: Nanocrystalline Diamond-like Carbon Coatings Boost Field-Emission Efficiency of Silicon Nanowires

Kalyan Sarkar * and Sucharita Saha

Senior Research Fellow, Energy Research Unit, School of Materials Sciences, Indian Association for the Cultivation of Science, Kolkata, India

Nanocrystalline diamond-like carbon (nc-DLC) films were synthesized using CH_4 and H_2 precursor gases in a capacitively coupled plasma chemical vapor deposition (CCP-CVD) system at 450 °C and 250 W RF power. Plasma pressure optimization (1–7 Torr) identified 4 Torr as optimal, yielding films with intensity ratios, with a ratio of disordered to graphitic structures (I_D/I_G) of 0.63, diamond-like to graphitic structures (I_{Dia}/I_G) of 0.69, diamond to the disordered structures (I_{Dia}/I_D) of 1.09, and a high sp^3 content of 66.75%. These films were coated on vertically oriented Si nanowire (SiNW) arrays, previously optimized via a metal-assisted chemical etching (MACE) process, to investigate the impact of coating time (T_{DLC} = 10–60 min) on field emission (FE) performance. At T_{DLC} = 40 min, Raman and XPS analyses revealed an I_D/I_G ratio of ~0.67 and an sp^3 content of 68.73%, correlating with enhanced FE properties, including a reduced turn-on field (E_{ON}) of 4.60 V/µm, increased current density (J), and an elevated field enhancement factor (β) of 1676.01, compared to uncoated SiNWs (E_{ON} = 5.80 V/µm, β = 1107.93). Heating the hybrids to 150 °C further improved performance, reducing E_{ON} to 3.2 V/µm and increasing J to 4500.67 µA/cm^2. The DLC layer at T_{DLC} = 40 min, featuring ~5 nm diamond 111> nanocrystals and ~68% sp^3 content, significantly lowered the potential barrier for electron emission, demonstrating SiNW/nc-DLC hybrid structures have a strong potential for applications in flat-panel displays and advanced electron emitters, such as electron microscopes.

sciforum-113868: Non-Thermal Plasma (NTP) for Continuous H_2O_2 Production from Water and Oxygen

Niwesh Ojha

Indian Institute of Technology Roorkee, Roorkee, Uttarakhand 247667, India

Conventional methods for hydrogen peroxide (H_2O_2) synthesis, such as heterogeneous catalytic processes, require hydrogen (H_2) and oxygen (O_2) as feedstocks, along with expensive noble metals and organic solvents. These methods are energy-intensive and hazardous. In contrast, non-thermal plasma (NTP) generated within a dielectric barrier discharge (DBD) coaxial reactor provides 1 to 10 eV energy, sufficient to even drive thermodynamically unfavorable reactions by breaking molecular bonds. This study investigates the direct synthesis of aqueous H_2O_2 by passing oxygen through varying flow rates in a non-thermal plasma reactor. The outlet gas from the plasma reactor is then bubbled into water, facilitating H_2O_2 production. This method relies solely on water, oxygen, gas, and electricity, offering an environmentally friendly alternative to traditional processes.

This study also explores the role of a water–ethanol solution in enhancing product yield by approximately 10 times in the continuous production of concentrated aqueous hydrogen peroxide (H_2O_2). Experiments were initially conducted without catalysts, and the impact of various gas flow rates, plasma power, and residence time on conversion efficiency was examined. Electron Spin Resonance (ESR) studies indicate that oxygen radicals play a crucial role in the selective production of H_2O_2. Our findings present a proof-of-concept for utilizing low-cost aluminum electrodes in a dielectric barrier discharge (DBD) reactor, relying solely on electricity, water, and dioxygen for the generation of H_2O_2. This ongoing process ensures continuous improvement and provides the scalability needed to achieve high technology readiness levels.

sciforum-114107: Particle–Plasma Interactions: Particle Melting State and Its Impact on the Phase Composition and Deposition Efficiency in Atmospheric Plasma-Sprayed Alumina Coatings

Maximilian Grimm *, Thomas Lindner and Thomas Lampke

University of Technology Chemnitz, Group of Materials und Surface Engineering

Plasma–particle interactions strongly influence the formation of atmospheric plasma-sprayed (APS) coatings. Especially for alumina, which usually undergoes a complex phase transformation of α-Al_2O_3 to metastable phases such as γ-, η- or δ-Al_2O_3 during thermal spraying, the heating and cooling behavior of the particles is of great importance.

This study therefore investigates the effect of plasma fluctuation and particle morphology on the melting behavior of aluminia and alumina-based powder particles. In particular, the impact of the degree of particle melting on the known phase transformation and the deposition efficiency is being investigated. In addition to the phase analysis of the coatings, powders collected during the spraying process were examined to evaluate their changes in the plasma. The particle morphology of the powders collected provides clear indications of their degree of melting. Moreover, both the plasma fluctuations and important particle parameters, such as particle temperature and velocity, are recorded.

The results show that the degree of particle melting in strongly linked to the plasma fluctuations, which can be significantly influenced by adjusting the process parameters. While higher α-Al_2O_3 contents in the collected powder cannot be transferred into the coating if they are attributed to non-melted particles, coatings with higher α-Al_2O_3 contents can be achieved by partially melted particles or the use of Al_2O_3-based solid solutions without negatively affecting the deposition efficiency.

sciforum-114249: Surface Functionalization in Selective-Laser-Melted 17-4 PH by Plasma Polishing and Interstitial Diffusion Hardening

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Developments in processing technology and feedstocks are key drivers for new product innovations in the field of additive manufacturing. In the area of complex and filigree geometries, additive manufacturing technologies are often superior to conventional processes. Selective laser melting (SLM) as a powder bed process allows components of different scales to be manufactured by variation in the grain size range of the feedstocks. However, the surface quality achieved is a critical factor. The powders used as feedstock in the selective laser melting (SLM) process fundamentally limit the surface quality of these components. Particle contamination on the surfaces of the parts can remain rounded or agglomerated, contributing to a very rough surface at the microscale. Furthermore, the manufacturing advantages of a closed component design lead to limitations in the mechanical finishing process, especially regarding undercuts and cavities. In addition to corrosion protection requirements, demands for wear resistance become increasingly important. This study deals with the development of a process chain for the surface functionalization of selective-laser-melted 17-4 PH by plasma polishing and interstitial diffusion hardening. In this context, both the leveling of the surface topography and the development of graded coating properties are of particular interest. In addition, this technology can be used to protect thin films against locally acting forces by providing sufficient support for the substrate materials.

sciforum-114137: The Study of a Multilayer PEO/HAp/PCL Coating for the Corrosion Protection of an Additively Manufactured WE43 Magnesium Alloy

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Additive manufacturing (AM) is presented as a great alternative to produce new metal alloys. Mg alloy WE43 is one of most relevant alloys for bioimplants due to its good mechanical properties and biocompatibility. However, its low corrosion resistance requires the use of coatings that can improve the corrosion behaviour of these alloys. Plasma electrolytic oxidation (PEO) is based on the growth of an oxide layer by means of high voltages (300V – 600V) that incorporates various species from the electrolyte that can enhance corrosion resistance. Nevertheless, PEO coatings usually require an additional procedure post treatment in order to seal their external porous layer. Hydroxyapatite (HAp) is usually employed to promote bone growth and biocompatibility; additionally, its porous microstructure allows for the adhesion of other sealings that might improve the corrosion resistance. Polycaprolactone (PCL) is one of most used polymers for biomedical applications, mainly because of its biocompatibility and limited production of acid by-products. This study focuses on the development of a multilayer PEO/HAp/PCL system to investigate its effect on the corrosion behaviour of an AM WE43 Mg alloy after a heat treatment of 400°C over 24h. The substrate before and after the heat treatment is characterized using several techniques such as: optical and scanning electron microscopy (SEM), X-ray diffraction (XRD), energy dispersive X-ray spectroscopy (EDS), atomic force microscopy (AFM), and transmission electron microscopy (TEM). The coatings were also characterized by SEM, EDS, and XRD, their roughness was measured with an optical profilometer, and water contact-angle measurements were performed. For the corrosion evaluation, electrical impedance spectroscopy (EIS) measurements were performed up to 3 days on Hank's solution at 37°C. The results reveal the influence of the multilayer coating on the corrosion behaviour, providing a comparative analysis with the substrate.

sciforum-114123: Correlating Hydrophobicity to Surface Chemistry for Low-Frequency Vibration Energy-Harvesting Applications

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The relationship between hydrophobicity and surface chemistry is crucial for optimizing materials used in vibration energy harvesting (VEH) applications, where environmental resilience and charge transfer efficiency are essential. Aluminum alloys, commonly used in the automotive, aerospace, and energy sectors, naturally develop an oxide layer that offers limited corrosion resistance in humid and saline environments. A promising strategy to improve performance and durability consists of modifying the wettability of aluminum surfaces.

In this study, we produced highly hydrophobic aluminum surfaces using a one-step etching method, yielding microstructured roughening of the surfaces that facilitates air trapping, enhancing hydrophobic behaviour. Contact Angle Goniometry (CA), Scanning Electron Microscopy (SEM), and X-ray Photoelectron Spectroscopy (XPS) were employed to correlate surface wettability with sub-micrometer-scale morphology and chemical composition. We found that surface hydrophobicity is governed by the interplay between hierarchical micro/nanostructures and the chemical composition of the outermost layers. We used the optimized aluminum surfaces for a portable VEH device, specifically leveraging Reverse Electrowetting on Dielectric (REWoD) technology, that efficiently harvests energy from low-frequency vibrations (10 Hz) typical of human motion. We realized the device using off-the-shelf polyacrylamide (PAAm) hydrogels loaded with saline solutions using a heat treatment that extends the hydrogel drying times significantly. The laboratory prototype generated an average power of ~1.55 μW at 7 Hz, achieving a power density of 9 nW/μl.

Session 2. Laser-Coating Technology: Deposition, Structuring and Cladding

sciforum-114188: Considering Scaling Aspects in Interface Design for Adhesion-Promoting Laser Structures in Polymer–Metal Hybrids

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When combining materials with divergent property profiles, such as polymers and metals, adhesion is mainly determined by mechanical interlocking—for example, in thermal joining or thermal spraying. For this, surface structuring is necessary in order to form undercuts and other adhesion-promoting profile elements. In this respect, laser-beam machining enables the production of complex structures, e.g., cone-like protrusions, grooves, or pins. However, despite a high flexibility in interface design, the influence of the scaling of profile elements has not been investigated so far. Although, understanding the effect of altering the initial surfaces on the functional properties, in particular the adhesion strength, offers potential for optimizing processing time or cost as well as overall adhesion performance. Therefore, the fractal dimension, a unitless measure of the structured interface, has been introduced previously, as it correlates quantitatively to the bonding shear strength. In this study, hence, the influence of structure scaling and the suitability of the fractal dimension as a strength prognosis criterion have been investigated on laser-beam-machined groove structures on aluminum 6082 prior to joining to polyamide 6. In parallel, modelled, virtual groove structures were considered for comparison. Finally, the fractal dimension served as a scale-independent measure, yielding similar values for constant aspect ratios for structures differing in their respective scale for both the model and experiment. Moreover, the adhesion strength in lap shear tests, ranging from 3.5–18.5 MPa, appeared independent of the scaling of profile elements for similar structure densities. So, a quantitative correlation of the fractal dimension of the interface to the adhesion strength could be confirmed and the influence of scaling could be excluded.

sciforum-117430: High-Power Laser Surface Structuring of Bioactive Glasses: Recent Advances and Perspectives

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Introduction

Bioactive glasses are a type of biomaterial widely used when high osteoconductive or osteosynthesis capabilities are required. In recent years, research on bioactive glasses has been partially directed towards obtaining more stable compositions with increased network connectivity. Thus, it is possible to use this biomaterial in diverse applications with high surface/volume ratios, such as scaffolds, in which the most reactive bioactive glasses experience excessively rapid dissolution. The micro-structuring of the surface of these biomaterials is a research niche that has been scarcely explored, mainly because the osteoconductivity mechanism that occurs during the interaction with biological fluids is associated with the dissolution of the glass surface layer. However, it has recently been shown that surface modification by laser can produce permanent long-term surface changes.

Methods

For this work, recent reports in the field of laser surface modification of bioactive glass have been critically studied and analysed. In addition, laboratory experiments have been carried out on the structuring of the surface of glasses with different network connectivities. The in vitro behaviour when in contact with simulated physiological fluid has been characterised.

Results and Conclusions

In this work, the latest advances in laser surface modification of bioactive glasses are presented, discussing the different types of lasers used and the radiation–matter interaction phenomena, particularly in terms of surface energy density and interaction times. Furthermore, the properties of the micro-structured surfaces are presented as a function of the parameters of the laser surface modification process and their evolution when they are subjected to contact with simulated physiological fluids.

The in vitro behavior of the laser-modified bioactive glass surface demonstrates that, by selecting the appropriate laser radiation and the appropriate process conditions, it is possible to produce a selective change in the osteoconductivity process.

sciforum-117367: Illuminating Surfaces: Emerging Trends in Laser Surface Texturing Applications

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Surface functionalization plays a crucial role in advancing material performance across various industries, enabling tailored properties such as enhanced tribological behavior, improved wettability, increased adhesion, better biocompatibility, and superior optical characteristics. As demand grows for precise and efficient surface modification techniques, laser surface texturing (LST) has emerged as a promising technology due to its high precision, repeatability, productivity, and ability to create micro- and even nanoscale surface features with minimal material waste. Unlike conventional methods, LST offers a non-contact, environmentally friendly approach (as chemicals can be avoided) that allows for the localized and controlled modification of the surface topography and even chemistry, thereby optimizing the performance in applications ranging from biomedical implants to energy storage systems.

This communication explores the latest advancements in laser surface texturing, highlighting novel and emerging trends. These key developments include, among others, the production of extreme wetting surfaces (superhydrophilic or superhydrophobic), the production of self-cleaning surfaces, the potential of laser surface texturing to produce superior biomedical surfaces, and the application of laser surface texturing to control the corrosion behavior of biomaterials. By illuminating these evolving trends, this study aims at providing insights into the future potential of laser surface texturing as a transformative tool for next-generation functional surfaces.

sciforum-114029: Laser-Induced Copper Oxidation for Improved Performance in Anode-Free Lithium Metal Batteries

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Introduction

Anode-free lithium metal batteries (AFLMBs) are promising for high-energy-density applications due to their reduced manufacturing complexity. However, challenges such as lithium dendrite formation, inactive lithium accumulation, and capacity degradation hinder their practical implementation [1]. This study explores a novel reagent-free approach to address these issues by leveraging laser-induced copper oxidation to enhance the electrochemical performance of AFLMBs.

Methods

Using a Nd:YAG laser under ambient conditions, a copper current collector (CC) was oxidized to produce controlled CuOx surface layers. The surface morphology and composition were analyzed using SEM, EDS, UV-Vis spectroscopy, Raman spectroscopy, and XRD. Electrochemical performance was evaluated through cyclic voltammetry, galvanostatic cycling, and impedance spectroscopy in half-cell and full-cell configurations.

Results

Laser-induced oxidation formed a CuOx layer that electrochemically converted to Li_2O during the first charge, creating a stable, artificial solid electrolyte interphase (SEI). This SEI reduced the lithium nucleation overpotential and enhanced uniform lithium deposition [2]. Moderately oxidized samples (Cu_LS1000) demonstrated optimal electrochemical performance, achieving >97% Coulombic efficiency over 100 cycles in half-cell tests and superior capacity retention in full-cell tests compared to unprocessed copper. Excessive oxidation (Cu_LS300) reduced the cycling stability due to increased polarization and lithium consumption during activation.

Conclusion

Laser-assisted copper oxidation is a scalable, cost-effective, and environmentally friendly technique for improving AFLMBs' safety and efficiency. The findings highlight the potential of precise surface engineering in advancing anode-free lithium battery technology, providing a pathway toward industrial scalability and enhanced energy storage solutions.

sciforum-117374: Superhydrophobic Aluminium Surface Obtained via Laser Structuring and Stearic Acid Grafting with Corrosion Protection and Anti-Icing Abilities

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Aluminium and its alloys are widely used in the automotive, aerospace, and marine industries due to their excellent mechanical properties and corrosion resistance. However, their susceptibility to corrosion in chloride-rich environments necessitates effective protection strategies. One promising approach is the development of superhydrophobic surfaces, which exhibit extreme water repellency (contact angle >150°) by combining hierarchical surface structures with low-surface-energy materials.[1,2]

This study aimed to enhance corrosion resistance and anti-icing properties by integrating laser surface structuring with stearic acid grafting. Different laser structuring parameters (selected scanning line spacings) were explored to optimize surface roughness before applying a stearic acid coating. Surface morphology, wettability, and roughness were analyzed using scanning electron microscopy, a contact profilometer, and a goniometer. Corrosion resistance was evaluated via electrochemical testing in 0.1 M NaCl, while the anti-icing effect and droplet-bouncing behaviour were assessed.

Results demonstrated that the optimal laser parameter (scanning line spacing) combined with stearic acid grafting significantly improved corrosion resistance and water repellency. This method offers a cost-effective, scalable approach for enhancing aluminium surfaces, making it suitable for applications requiring improved durability and anti-icing performance.

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Session 3. Coatings and Thin Film Deposition

sciforum-114288: Influence of Thermal Treatment on Micro-Cu(In,Ga)Se_2 Solar Cells for Micro-Concentrator Photovoltaic Applications

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The micro-concentrator photovoltaic concept consists in miniaturizing asolar cell to the micrometer scale and using an optical concentrator to collect and focus sunlight onto the micro solar cells. As a result, this approach reduces the use of critical raw materials, while potentially reducing module costs and enhancing power conversion efficiency (PCE). Thin-film Cu(In,Ga)Se_2-based solar cells currently hold a record power conversion efficiency of 23.6% and 23.3% under concentrated illumination.

In this study, micro-holes with diameters of 200 and 250 μm were patterned into a SiO_x insulating matrix on a SLG/SiON/Mo substrate using photolithography [3]. A 1 μm thick Cu-In-Ga precursor was deposited by sputtering; this was followed by selenization at 480 °C in a tube furnace to form CIGS micro-absorbers. One of the precursors underwent a thermal treatment at a nominal temperature of 450 °C prior to selenization. The micro solar cells were completed with a CdS buffer layer deposited by chemical bath deposition and an i-ZnO/ZnO:Al window layer deposited by RF sputtering.

The Cu-In-Ga precursor exhibited a rough surface characterized by island-like grains, with CGI and GGI ratios of 0.75±0.04 and 0.24±0.03, respectively. The thermal treatment resulted in small areas of exposed Mo; however, both thermally treated and untreated micro-absorbers exhibited smooth surfaces after selenization. The treated CIGS micro-absorber exhibited improved elemental composition with a CGI ratio of 0.81±0.06, compared to 0.76±0.13 for untreated micro-absorber.

The annealed CIGS micro-cells display better overall performance, with higher average open-circuit voltage (V_{oc}). The best annealed CIGS micro-cell achieved a maximum PCE of 1.44%, with a V_{oc} and J_{sc} of 249 mV and 16.5 mA/cm^2. In contrast, the untreated CIGS micro-cells achieved a PCE of 0.47%, with a V_{oc} of 198 mV and a J_{sc} of 9.2 mA/cm^2, respectively.

sciforum-114553: Glass Coatings and Optical Interfaces: Improving Energy Efficiency and Daylight in Architectural Structures

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Introduction

Contemporary architectural approaches prioritise energy-efficient designs that focus on occupant comfort and sustainability. Glass facades and windows are integral to these efforts, providing ample natural light and maintaining visual coherence. However, uncontrolled solar radiation, glare, and poor insulation can undermine a building's thermal comfort and increase energy use. Recent advancements in thin-film coatings for architectural glass present innovative solutions for optimising daylight, regulating solar heat gain, and enhancing thermal efficiency.

Methods

This study investigated various commercially available and prototype thin-film coatings intended for use on architectural glass. Different deposition techniques were examined, including magnetron sputtering and chemical vapour deposition (CVD). The samples underwent testing under controlled laboratory conditions to assess their optical transmission coefficients, reflection properties, and emissivity. Complementary testing in real-world room conditions further enhanced findings, facilitating a comprehensive evaluation of daylight effectiveness, glare reduction, and their associated impact on internal temperature.

Results

The data obtained indicate that multilayer thin-film coatings can substantially enhance solar radiation control by reducing the transmission of infrared radiation by up to 50% while maintaining an improved transmission coefficient for visible light. Additionally, low-emission coatings effectively diminish heat transfer through glass, resulting in an approximately 20% increase in insulation performance compared to conventional uncoated glazing. Measurements of the interior revealed a notable reduction in glare and a more consistent indoor temperature, enhancing residents' comfort.

Conclusions

The findings indicate that thin-film coatings on glass serve as an effective solution for architects aiming to balance the benefits of natural light with thermal and visual comfort. These coatings support sustainable development goals and foster a healthier, conducive indoor environment by optimising solar radiation, mitigating glare, and enhancing insulation performance.

sciforum-114538: Surface Roughness and Fractal Analysis of TiO_2 Thin Films by DC Sputtering

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This study investigates the surface roughness and fractal characteristics of TiO_2 thin films deposited via DC reactive magnetron sputtering, using an Ar/O_2 gas mixture and varying sputtering powers. The films' surface morphology was characterized using Scanning Electron Microscopy (SEM) and topographic mapping. Roughness parameters such as Ra (average roughness), Rq (root mean square roughness), Rt (total height of the roughness profile), and Rz (peak-to-valley roughness) were quantified to assess the surface quality. Additionally, fractal analysis was conducted to evaluate the complexity of surface features across multiple length scales, using both "length-scale" and "area-scale" frameworks to explore hierarchical structures. The key analyses were performed using MountainsMap® software, which enabled 3D surface reconstruction, fractal dimension evaluation, and advanced surface metrology. The TiO_2 thin films were deposited under various O_2 ratios and sputtering powers to explore the influence of these parameters on surface roughness and fractal characteristics. This investigation combines both roughness and fractal metrics, offering a comprehensive framework for analyzing the interplay between deposition conditions and surface properties. The results provide valuable insights for tailoring TiO_2 thin films for use in applications such as photocatalytic devices, sensors, and other technologies that require precise control of surface topography, enhancing their functionality and performance.

sciforum-114286: Assessment of the Inhibitive Effect of Papaya (*Carica papaya*) Leaf Extract from Ultrasound–Microwave-Assisted Extraction (UMAE) on the Corrosion of Mild Steel

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Corrosion poses significant challenges to metals used in construction and machinery. This study evaluated the inhibitive effect of papaya (*Carica papaya*) leaf extract, obtained through Ultrasound–Microwave-Assisted Extraction (UMAE), as an eco-friendly corrosion inhibitor for mild steel. Papaya (*Carica papaya*) leaves are rich in phytochemicals such as alkaloids, flavonoids, tannins, and saponins, which form protective layers on metal surfaces and reduce degradation. UMAE, combining ultrasonic and microwave-assisted extraction, proved more efficient than conventional Soxhlet extraction, yielding 63.43% compared to 6.78%, while preserving bioactive compounds. Papaya (*Carica papaya*) leaf extract (PLE)-coated mild steel (MS) strips were immersed in hydrochloric acid (HCl) solutions (0.5 M, 1 M, 1.5 M) and monitored over various exposure times. Weight loss, corrosion rates, and inhibition efficiency were measured, with the lowest weight loss of 2.1798 g under four coatings of PLE after 336 hours and a peak efficiency of 97.63%. Characterization techniques such as SEM-EDX, FTIR, and UV-Vis confirmed the formation of corrosion-resistant barriers and identified key functional groups responsible for the PLE's protective properties. Statistical analysis using ANOVA revealed that PLE has a significant relationship with inhibition efficiency, with an F-value of 13.69035, p-value of 0.001638, and F crit less than the F-value. These findings position PLE as a promising, sustainable solution for corrosion prevention in industrial applications.

sciforum-108423: Bio-Based, Sustainable, Green, and UV-Curable Polymer Formulations for Coating Applications

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The goal of bio-based, sustainable, and green coating formulations is to replace conventional petrochemical-based materials, thereby reducing VOC emissions and dependence on non-renewable resources. The present research focuses on the synthesis and characterization of UV-curable, bio-based, sustainable, green coating formulations derived from plant oils and other sustainable feedstock. This system uses bio-based epoxidized soybean oil (ESBO) and itaconic acid as major renewable precursors. We prepared the resin by ring-opening of ESBO with polyol, involving an etherification reaction and finally esterification with a bio-based acid. The progress of the reaction was monitored by the oxirane oxygen content (OOC) and acid value. Several formulations were attempted by varying the ratio of oil and polyol. The resin thus prepared was used for coating formulations by varying percentages of the photoinitiator and reactive diluents. Thus, the prepared formulations were applied to the substrate and cured by exposure to the UV radiation source.

The cured films on the substrate were investigated for mechanical and chemical properties. Properties such as scratch hardness, pencil hardness, adhesion, gel content, solvent rub resistance, and gloss were studied. The chemical changes during the reaction and after curing were confirmed by FTIR. The increased renewable content (above 70%) and non-volatile matter in the coating formulations demonstrate their sustainability and green nature. The mechanical properties were observed to be on par with the traditional petroleum-based coatings, showing their enormous potential in UV-curable coating applications. This work demonstrates that incorporating bio-based components into UV-curable systems can produce high-performance, sustainable coatings that contribute to environmental conservation and resource efficiency. This advancement contributes to the development of greener coating technologies that align with global sustainability goals.

sciforum-114206: Comparison of Wear Resistance and Biological Properties of Ag/$W_{1-x}Ti_xB_{2,5}$ Nanocomposite and Pure-Silver Coating

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Transition-metal borides have exceptional mechanical properties, such as high hardness and fracture toughness. They also have high thermal and chemical stability. Silver, on the other hand, is an attractive material for antibacterial applications due to its biological properties. Combining these materials can make it possible to produce super-hard coatings with antibacterial properties that are also wear-resistant, even under extreme temperature conditions.

In this work, Ag/$W_{0.84}Ti_{0.16}B_{2.5}$ nanocomposite layers were deposited,comparing their properties with a film made of pure silver. The silver film was produced by pulsed laser deposition (PLD), while the titanium-doped tungsten boride layer was synthesized by high-power pulsed magnetron sputtering (HiPIMS). The structure and chemical composition of the films were characterized by scanning electron microscopy (SEM) and X-ray energy spectroscopy (EDS). The silver particles were uniformly covered with a coating of borides. The surface roughness of the composite was about 100 nm (Ra) and was much higher than the roughness of the layer consisting only of metal borides.

Mechanical properties such as hardness were tested using The Micro Combi Tester MCT3, while wear resistance was verified by abrasion under a reciprocating motion. The silver layer can favorably affect mechanical properties by improving the material's ductility and tribological properties, at the expense of lowering hardness. Biological tests were carried out in a liquid suspension of Staphylococcus Aureus bacteria (a Gram-positive bacterium). Incubation was carried out for 20 hours in a greenhouse at 37°C. Unfortunately, from the studies so far, the composite has not been found to show antibacterial properties in the classic suspension test.

sciforum-107057: Crystal Structure of Filled Single-Walled Carbon Nanotubes for Coatings

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Single-walled carbon nanotubes (SWCNTs) with different properties are prepared for applications. The control of the structure of the SWCNTs is important. The analysis of the structure of the pristine and functionalized SWCNTs is needed for biosensor applications. The investigation of the characteristics of the crystal structure of the substances encapsulated inside SWCNTs opens ways to revealing the parameters of the structure. The diameters of the SWCNTs are chosen precisely, and crystal structures are modified for particular applications. It becomes possible to tailor the crystal structure of the compounds in the SWCNTs with different metallicities, diameters, and numbers of walls. The aim of this work is the investigation of the crystal structure in the SWCNTs and modified SWCNTs, and the analysis of the electronic features in modified SWCNTs. The crystal structure of silver chloride inside the SWCNTs with a metallicity-mixed and semiconducting conductivity type was investigated. New one-dimensional structures were obtained inside the SWCNTs with a diameter of 1.4 nm, as revealed by scanning transmission electron microscopy (STEM). The analysis of the electronic features of filled SWCNTs gives information on doping. Raman spectroscopy showed modified electronic properties of the filled metallicity-mixed and semiconducting SWCNTs. Doping was observed in the filled SWCNTs. These data are useful for biosensor applications of filled SWCNTs.

sciforum-113252: Deposited Thin-Film Nanoelectrocatalysts of Non-Noble Metals for Co-Capture of CO_2 and Reduction of Nitrates

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Introduction

Co-electrolysis of nitrate and CO_2 can contribute to urea production with low carbon oxide emission rate, and at the same time can reduce NO_3^- to extremely low permissible concentrations . Synthesis of thin-layer nanoelectrocatalysts containing transition metal nanoparticles is a promising task. The study proposes the use of precipitated electrocatalysts from base metals. Such a method makes it possible to obtain an electrocatalyst selective to the reduction reaction of CO_2 or NO_3^- to their joint reduction product is urea. The electrocatalyst coating should firmly bind C-N, and can proceed with the formation of intermediate compounds (such as $*CONH_2$) and others.

Experimental

The material for the electrocatalyst were synthesized by the authors, and characterized using the methods SEM, XPS and DRS. Electrochemical methods of voltammetry, chronoamperometry, electrochemical double layer capacity, electrochemical impedance spectroscopy were used in this work.

Results and Discussion

In this study, a selective thin-layer electrocatalyst is to be synthesized and used for the reaction of CO_2 and NO_3^- binding and their conversion to urea. The reaction will be carried out using electrochemical reduction under galvanostatic and potentiostatic conditions. As a result, the rate of synthesis of the target product will be determined and the Faraday efficiency of the process will be calculated. The unique electronic structure of transition metals allows them to be active catalysts in the co-reduction reaction of nitrate and carbon dioxide. The choice of metal or different combinations of components in bimetallic catalysts, as well as the search for conditions of electrochemical synthesis, may allow to improve the kinetics of the process and increase the selectivity of the process.

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sciforum-111692: Design, Synthesis, and Property Tuning of Spin-Coated Chiral Polymer Films for Advanced Photonic Applications

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Chiral photonics research is increasingly centered on developing thin films that manipulate optical properties through enantioselective methods, offering promising applications in optical signal processing, sensing, and molecular spintronics. These thin films provide unique opportunities for controlling linear and nonlinear optical behavior, making them ideal candidates for advanced photonic devices and coatings. In this study, we focus on the development of thin spin-coated chiral polymer films, synthesized through the copolymerization of chiral fluorene monomers with thiophene comonomers via the Suzuki polycondensation method. By modulating the conjugation units within the monomer, we precisely control the chiroptical properties of the thin films, enabling their use in various photonic applications. We employ several strategies to enhance the optical activity of these films, including the incorporation of supramolecular softeners (PEM-OH) and plasmonic doping during the film deposition process. These approaches facilitate spatiotemporal control over the chiroptical properties via in situ photopolymerization, demonstrating significant enhancements in the optical performance of the thin films. Furthermore, we achieve substantial improvements in magneto-optic (MO) properties in these thin films, with a high Verdet constant, surpassing the performance of existing MO materials. The spin-coated chiral polymer films demonstrate great potential for applications such as optical isolation, weak magnetic field mapping, and advanced coating technologies for metamaterial design. The ability to manipulate the electric and magnetic dipole coupling in these thin films opens new possibilities for controlling MO effects across a wide range of wavelengths, positioning these materials at the forefront of chiral photonics and optoelectronics

sciforum-114241: Elastic Properties and Moisture Response of Polydopamine Films and Multilayers

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Polydopamine (PDA) has the rare ability to attach to surfaces traditionally resistant to adhesion, making it a promising candidate for use as a coating. Membranes approximately 20 nm thick PDA were synthesized using cyclical voltammetry electropolymerization and used to produce four examined samples, comprising subsequently higher numbers of PDA stacked layers (from 1 to 4). The stacking of the membranes resulted in a few layered membranes with thicknesses of approximately 20-60 nm. Brillouin light scattering spectroscopy was utilized to investigate the samples' Young moduli and residual stress, determining their mechanical properties through the dispersion of GHz acoustic phonons. The samples exhibited substantial magnitudes of Young modulus, higher than for classical polymers, with the higher values retained in multilayer samples. The freestanding PDA membranes' responses to varying concentrations of water vapor in the air wereobserved under an optical microscope for all samples. The experiments showed a reversible wrinkling/flattening of the membranes at different relative humidity values. A similar response to laser light, attributed to heat-induced water desorption, was investigated by a home-built setup that allowed for stroboscopic imaging of the membrane morphology with temporal resolution. The process was characterized by relaxation times, attributed to parts of the experiment when the laser light was turned on (flat) and off (wrinkled). The obtained actuation times indicate that the ultrathin membranes react to red laser light in millisecond timeframes, with the multilayer samples having longer relaxation times that remained within the same order of magnitude.

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sciforum-114159: Electrochemical Water Splitting over Heterostructure of Titania Nanotubes and Ni Encapsulated Within MXenes

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Introduction

MAX phases are stacked layers of ternary carbides composed of a transition metal, an A-group element, and carbon/or nitrogen. MXenes are a class of materials produced through selective etching of the A-group element within their corresponding MAX phases parents. The traditional etching method for the synthesis of MXenes involves the use of hazardous substances and highly corrosive chemicals, namely the fluorine-based salts. As an alternative, MXenes can be also produced by an electrochemical etching method. One of the main advantages of this method is the use of salts with moderate toxicity and the ability to control the entire etching process by adjusting the applied potential. In this work, an electrochemical method was explored for the production of Ti_3C_2Tx MXene.

Methods

First, Ti_3C_2Tx was synthesized by the electrochemical etching of Ti_3AlC_2 in an electrolyte containing choline chloride and tetrafluoroboric acid at different applied voltages. Then, a heterojunction was fabricated by the drop casting of the synthesized Ti_3C_2Tx, previously modified with Ni, on titania nanotubes (Ni-MXene-TiO_2) and underwent rapid thermal treatment in a hydrogen atmosphere (h-Ni-MXene-TiO_2).

Results

The recorded Raman spectra indicate that the MXene structure can be obtained after 8 h of bipolar etching. However, the yield of the produced MXene decreases significantly with increases in the applied voltage. The SEM images showed that the accordion structure of Ti_3C_2Tx appears when a voltage of 1 V is applied between the electrodes for 16 h.

This material has been selected for further characterization by X-ray photoelectron spectroscopy and X-ray diffraction. In addition, the electrochemical characterization shows much improved activity for the fabricated h-Ni-MXene-TiO_2 regarding water splitting compared to its Ni-MXene-TiO_2 counterparts.

Conclusion

This study presents a facile approach for the synthesis of MXenes and paves the way for the use of h-Ni-MXene-TiO_2, as a promising catalyst for the water-splitting process.

sciforum-113121: Electrodeposition of Nickel-Based Thin-Layered Double Hydroxide Electrocatalyst for 2,5-Diformylfuran Production

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The 2,5-diformylfuran (DFF) is a significant biomass derivative that is employed in a variety of industries. One approach is to synthesize it by an oxidation process of 5-hydroxymethylfurfural (HMF). The challenges in DFF manufacture come from the necessity for extreme conditions, the overoxidation issue, and the limitations of noble materials employed in neutral or acidic environments. By using mild alkaline as an electrolyte, DFF can be produced electrochemically alongside hydrogen gas generation, eliminating extreme conditions and allowing for the study of a wide range of transition metals. Moreover, the performance of bimetallic electrocatalysts has been studied, and it has been found to be more active in many kinds of processes, particularly Layered Double Hydroxides (LDHs). Electrodeposition, once widely chosen among various LDH production methods, is preferred for producing controlled and uniform thin layers. This work examines the electrocatalytic properties of NiCo-LDH and NiFe-LDH in the production of DFF. Cobalt, which has a high adsorption characteristic, is compared to iron, which has a weak adsorption characteristic towards HMF. This study demonstrates that NiCo-LDH has a higher activity but lower DFF selectivity compared to NiFe-LDH for the same amount of passed charge. Strong adsorption promotes reactant activation and reduces the energy barrier while reducing DFF selectivity due to overoxidation. To achieve optimal electrocatalyst performance, a careful balance of adsorption strength and reaction pathway management is required. Proper optimization of these parameters is required to improve efficiency and selectivity in the electrocatalytic process.

sciforum-114562: Enhancing Architectural Coatings Through Nanotechnology for Better Performance and Reduced Environmental Impact

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Introduction

Architectural coatings are crucial in contemporary eco-friendly design, as they protect the appearance of buildings, extend their service life, and enhance aesthetic appeal. However, traditional formulations often contain volatile organic compounds (VOCs) and other harmful chemicals. The field of nanotechnology offers an innovative approach to improve coating efficiency while minimising environmental impact. This study focuses on the development and application of nano-enhanced coatings, particularly those which are self-cleaning, antimicrobial, and heat-reflective. Additionally, it assesses their potential effects on the maintenance and operation of the structure by increasing durability and reducing resource consumption.

Methods

Our research concentrated on synthesising and characterising nanocomposites derived from silicon dioxide, titanium dioxide, and silver nanoparticles, which were integrated into both water- and solvent-based polymer matrices. The samples were subjected to laboratory evaluations that simulated real-world conditions, including UV exposure, thermal cycling, and prevalent microbial challenges. Performance metrics such as surface hydrophobicity, microbial inhibition, and thermal reflection coefficients were quantified through agar diffusion analysis and infrared spectroscopy.

Results

Preliminary results indicate that nano-enhanced coatings offer significant operational advantages compared to traditional systems. Self-cleaning formulations exhibit enhanced water-repellent properties, which reduce dirt accumulation and decrease cleaning intervals. Antimicrobial coatings have effectively decreased bacterial proliferation and biofilm formation, as demonstrated by standardised testing parameters. Furthermore, heat-reflecting options show reduced heat absorption, minimising cooling requirements in controlled simulations.

Conclusions

Using nanotechnology, architectural coatings can achieve excellent multifunctional performance while reducing resource consumption and pollutant emissions. The widespread use of nano-enhanced coatings can significantly improve the environmental friendliness and cost-effectiveness of buildings and structures that do not require special care.

sciforum-114041: Enhancing Colour and Performance of Black Double-Layered Nickel Coatings

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Coatings are undeniable cornerstones of the industry. This technology serves a variety of different purposes, ranging from functional coatings to protective and/or decorative ones. Indeed, a plethora of coating deposition techniques may be described, specifically low-cost, resourceful and practical ones like electrodeposition, that also benefit from its scale-up potential and production feasibility. Electrodeposition techniques are regularly under scrutiny for environmental reasons, yet their relevance and pertinence continue to endure. In this context, numerous efforts are being made to simplify electrolytes, which might influence the nature of chemical waste and the complexity of subsequent treatments. In this study, electrolytes were composed of a limited number of compounds. In line with this, replacing the common but challenging chromium-based electrolytes was also under consideration, with strong alternatives like nickel-based ones emerging. Therefore, the main target of the present work was the achievement of electrodeposited double-layered nickel coatings, specifically dull-nickel pre-coatings followed by black nickel coatings, deposited onto steel substrates. This study highlighted colour quality and decorative potential, as well as the possible enhancement of mechanical properties, such as the coefficient of friction. Additionally, the effect of substrate immersion in HCl for surface activation was also evaluated and adjusted. As a result, the pre-coating characterisation was established. The Scanning Electron Microscope (SEM) analysis unveiled a homogeneous surface and a medium superficial feature of 2.56 μm. As well, the Energy-Dispersive X-ray Spectroscopy (EDS) and X-ray Diffraction (XRD) investigations disclosed the high content of Ni and its crystallinity, respectively. As for the black coatings, the XRD analysis confirmed an amorphous structure. In particular, sample BL10, which corresponds to the black nickel coating deposited for 10 minutes, demonstrated optimal outcomes in terms of colour and roughness, achieving the lowest brightness (L*) value and the least heterogeneous roughness.

sciforum-117087: Experimental Investigation of the Optoelectronic Properties of Carbazole-Based Hole Transport Layers for Photovoltaic Applications

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Perovskite solar cells (PSCs) have emerged as a groundbreaking photovoltaic technology, achieving power conversion efficiencies exceeding 25% with the integration of organic small-molecule hole transport materials (HTMs). Despite this significant advancement, large-scale commercialization remains hindered by the high cost of HTMs and the inherent instability of perovskite materials. Among the most widely used HTMs, Spiro-OMeTAD exhibits excellent optoelectronic properties; however, its complex synthesis and costly purification pose major barriers to widespread adoption. Overcoming these challenges requires the development of alternative, cost-effective HTMs with comparable or enhanced performance to improve both the efficiency and stability of PSCs.

This study explores the optoelectronic properties of carbazole-based derivatives as potential HTMs for PSC applications. Thin films were fabricated via the sol–gel spin coating technique on glass substrates, using chlorobenzene as the solvent. The molecular structure of the investigated compounds was confirmed through FTIR analysis, while UV-visible absorption and photoluminescence spectroscopy were employed to assess theiroptical properties. The resulting films exhibited high transparency in the visible spectrum and strong UV absorption, highlighting their suitability for photovoltaic integration. The estimated optical bandgap of the studied compounds was approximately 2.8 eV. Furthermore, a strong green emission in the visible region further underscores their potential for optoelectronic applications.

sciforum-114250: Exploring the Performance of Phosphate-Functionalized Waterborne Binders on AZ31 Magnesium Alloy

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Organic coatings are among the most effective solutions to enhance the corrosion resistance of metals. Traditionally, solvent-based coatings have been widely used in industrial applications. However, due to environmental regulations, water-based coatings are in demand due to their lower toxicity. One of the main challenges associated with water-based coatings is how to avoid flash rust corrosion on the metal/coating interface. Typically, this phenomenon is mitigated by incorporating additives such as inorganic corrosion inhibitors. An alternative is the novel approach of using phosphate-functionalized waterborne binders, which has only been explored on mild steel [1].

In the present work, a waterborne binder (consisting of methyl methacrylate (MMA) and butyl acrylate (BA)) was obtained using a polymerizable phosphate-based surfactant and applied on AZ31B magnesium alloy. Different surface pretreatments were used to explore the adhesion and corrosion performance: a) mechanical grinding, b) chemical cleaning, c) zirconium conversion coating (ZrCC), and d) layered double hydroxides (LDHs). The coated samples were cured in a climatic chamber at 23°C for 24 hours under 60% of relative humidity.

This study included sample characterization in terms of morphology and composition through SEM-EDX and the evaluation of corrosion protection using EIS in a 3.5 wt. % NaCl solution. Additionally, water contact angle measurements and roughness parameters were evaluated.

sciforum-116959: Fabrication and Characterization of DPPS-Introduced Perovskite Solar Cells

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Various halide perovskite crystals based on $CH_3NH_3PbI_3$ (abbreviated $MAPbI_3$) are expected to become next-generation solar cell materials and are currently undergoing research and development worldwide. However, despite its high photoelectric conversion efficiency, $MAPbI_3$ has an unstable structure due to the presence of CH_3NH_3 (MA) organic molecules, and the decomposition of CH_3NH_3 from $CH_3NH_3PbI_3$ in the atmosphere results in the formation of PbI_2. The expensive 2,2',7,7'-tetrakis (*N,N*-di-p-methoxyphenylamino)-9,9'-spirobifluorene (spiro-OMeTAD) is widely used throughout the world as a hole transport material in perovskite solar cells. To enhance hole transport, spiro-OMeTAD needs dopants such as lithium bis(trifluoromethane sulfonyl) imide and 4-*tert*-butylpyridine, which are highly hygroscopic and accelerate degradation of the perovskite layer when moisture is absorbed. Therefore, it is necessary to find alternative hole transport materials. In this study, decaphenylcyclopentasilane (DPPS) was selected as a material to modify the perovskite surface, and fabrication of perovskite photovoltaic devices in air and under unsealed conditions was attempted. DPPS is stable in air at temperatures up to 300°C and has the potential to suppress MA desorption; additionally,high-temperature heat treatment can form dense cubic perovskite, which is a stable phase at high temperatures. Polysilane has also been reported to function as a hole transport material, and is also expected to improve photoelectric conversion properties by using the DPPS as a hole transport layer. The fabrication of perovskite photovoltaic devices with DPPS by the air blow method in air could greatly simplify the manufacturing process without using a glove box and stabilize the solar cell characteristics.

sciforum-117016: Fabrication and Evaluation of DMA-Doped Perovskite Solar Cells

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In recent years, photovoltaics has attracted attention as a clean energy source. Although silicon-based materials are the mainstay of solar cells, organic–inorganic hybrid perovskite crystals are a candidate alternative. Perovskite solar cells can be lightweight and flexible devices manufactured by easy methods, and some have been developed to achieve photoelectric conversion efficiencies comparable to silicon-based materials. However, one of the organic cations present in perovskite crystals, methylammonium (MA), is prone to decomposition and desorption, leading to device instability. To address this issue, composition control using additives and optimizations of device structures through passivation techniques have been actively explored. In addition, encapsulation with films and improvements in film fabrication techniques have been pursued to achieve uniform thin-film formation. Various additives have been studied, including organic molecules such as guanidinium (GA) and ethylammonium, as well as alkali metal cations like cesium (Cs). Among these, dimethylammonium (DMA) has a larger molecular radius and possesses high molecular symmetry. The introduction of DMA into formamidinium (FA)-based perovskite crystals has been reported to limit the motion of FA, and to promote crystal growth in Cs-based perovskite crystals. In this study, the effects of DMA addition to MA-based perovskite crystals were investigated, and the photovoltaic properties of solar cells fabricated using these crystals were reported. Additionally, first-principles calculations were also carried out to evaluate performance in conjunction with experiments.

sciforum-114366: Formation and Microstructural Characterization of Copper Oxide Thin Films

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Metal-based oxide semiconductors have garnered significant attention as promising materials for solar energy applications. Being composed of metal oxides, oxide semiconductors exhibit superior crystalline stability and lower toxicity compared to organic- and lead-containing perovskite crystals. Additionally, they possess advantageous optical properties, including high light absorption and a band gap width suitable for solar cell applications. Among oxide semiconductors, copper oxides are recognized as one of the most promising materials for p-type semiconductors, with a long history of research. Research and development of solar cells based on copper oxides is accelerating, and some with photovoltaic conversion efficiencies of more than 10% have been fabricated. For solar cells employing oxide semiconductors, sputtering and vacuum deposition methods are primarily utilized. On the other hand, a spin-coating method is widely applied in the fabrication of perovskite solar cells and has attracted attention as a simple and cost-effective thin-film deposition technique, which is necessary for future mass production. Although annealing at high temperatures is commonly used to form thin films of metal oxides, it is also important to reduce the annealing temperature to make this technology widely available. In the present study, copper oxide thin films were fabricated using the spin-coating method, and microstructural analyses were conducted. The successful formation of copper oxide thin films was confirmed, and the microstructures of the thin films were investigated.

sciforum-113750: Hybrid Nanostructures of Transition Metal Oxides on Vertical Graphene for Enhanced Electrochemical Performance

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Transition metal oxide (TMO) nanostructures have attracted particular interest due to their multifunctionality, ranging from biomedical devices to electrochemical sensors for wastewater treatment in the textile industry, food processing and packaging, energy storage systems, catalysts, and solar cells. Among the different materials studied, In2O3 nanostructures have the advantages of remarkable physicochemical properties, high specific surface area, high surface-to-volume ratio, substantial chemical and environmental stability, and high electron mobility. Over the years, different substrates have been studied for the deposition of TMO thin films to meet the requirements of the targeted fields. In the present work, In_2O_3 nanostructures were obtained by chemical synthesis, and the process conditions and thermal treatment parameters were controlled, with these factors being considered the determining factors with effects on particle size and morphology. To ensure that the oxide nanostructures were compatible with the substrate of interest, graphene hydrophilization was performed. The next step consisted of dispersion of In_2O_3 powders in different media, drop-casting a suspension of oxide particles on the surface of the vertical graphene substrate, and evaporation of the solvent by heat treatment. The analytical methods used indicate a slight tendency of the particles to agglomerate at the surface but also to penetrate between the graphene sheets. FTIR spectroscopy studies and XRD diffraction measurements were carried out to determine their structure. The surface wettability was determined by measuring the contact angle to confirm the hydrophilicity. Furthermore, the electrochemical activities were investigated by cyclic voltammetry.

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sciforum-114351: Influence of Composition and Geometry on the Electrical Resistivity of Titanium–Gold Thin Films for Flexible Dry Electrodes

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With the global ageing population, the demand for innovative healthcare solutions for rehabilitating motor disabilities among the elderly is on the rise. Traditional healthcare facility-based rehabilitation is costly and time-consuming, limiting access to electrostimulation therapy for over 50% of the 2.4 thousand million potential beneficiaries. Dry electrodes, designed for extended use on sensitive skin, offer promise for monitoring surface electromyography and supporting muscular rehabilitation at home. These electrodes, which do not require conductive gels, improve patient comfort and reduce skin irritation in long-term biopotential recordings. Nevertheless, low impedance, stable electrochemical noise, flexibility, and biocompatibility are mandatory requirements for these electrodes. In this study, titanium–gold (Ti-Au) thin films were deposited on silicon and glass substrates using magnetron sputtering, and Glancing Angle Deposition (GLAD) was used to fully characterize them. The films were produced with gold compositions varying from 0 at.% to 44 at.%, growing in different geometries—conventional, inclined, and zigzag—using deposition angles ranging from 0° to 90°. The films' microstructure revealed a noticeable influence on the electrical properties of Ti-Au thin films, with electrical resistivity increasing by an order of magnitude at a deposition angle of 80° relative to the films prepared at 0° (conventional geometry). For the same deposition angle, no significant differences in electrical properties were observed between the inclined and zigzag geometries. This study intends to evaluate the influence of the chemical composition and the films' growth geometry in terms of electrical properties, supporting the development of flexible Ti-Au thin film-based dry electrodes.

sciforum-113709: Localized Effects in Graphene Oxide Systems: A Pathway to Hyperbolic Metamaterials

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Graphene oxide (GO) has emerged as a carbon-based nanomaterial providing an alternative pathway to graphene. One of its most notable features is the ability to partially reduce it, resulting in graphene-like sheets through the removal of oxygen-containing functional groups. Herein, the effect of localized interactions in a Ag/GO/Au multilayer system was studied to explore its potential for photonic applications. The Ag/GO/Au structure was fabricated through a sequential deposition process. First, silver thin films (10 nm) were deposited onto glass substrates using a DC magnetron sputtering system. Subsequently, graphene oxide (GO) layers (8 nm) were applied onto the silver films via a dip-coating technique. Finally, gold thin films (15 nm) were deposited over the GO/Ag/glass substrates using the same sputtering system. Micro-Raman Spectroscopy, SEM (Scanning electron microscopy) and Variable Angle Ellipsometry measurements were performed on the Ag/GO/Au structure.

Micro-Raman measurements confirmed that the atomic frame of sp^2 carbon formed in RGO (reduced graphene oxide), thus indicating the transition from sp^3 (oxidized regions) to sp^2 (graphitic regions) hybridization.

An interesting behavior of the GO dip-coated on magnetron sputtered silver with the formation of Ag nanostructures on top of the GO layer was reported using SEM. Furthermore, the dispersion laws estimated for the glass/Ag/GO/Au structure by ellipsometry characterization seemed to confirm the morphological behavior observed with SEM measurements. The gold thin film adjusted elastically on the GO/Ag /glass sample, without modifying its overall optical behavior, whereas the interface GO/Ag was more complex. Additionally, calculations based on effective medium theory (EMT) highlighted the potential of Ag/GO structures in multilayer hyperbolic metamaterials for photonic applications.

sciforum-118118: Microstructure Characterization of Titanium Oxide Coatings with Nanoparticles Deposited with Micro-Arc Oxidation Method on Plastically Deformed Titanium

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Antibacterial coatings produced on the surface of biomaterials have received considerable attention due to the possibility of protecting medical implants placed in the human body against bacterial colonization resulting in inflammation of the surrounding tissues. According to various sources, the percentage of all infections can reach up to 30% of all implanted materials, leading to serious consequences including the necessity of surgical intervention. Thus, a number of methods allowing the production of antibacterial coatings has been developed. Micro-arc oxidation, considered as a simple and environmentally friendly method of functional coating deposition on top of so-called “valve metals”, is gaining in importance in this field. The relative simplicity in the mixing of electrolyte constituents makes the incorporation of antibacterial elements possible.

In the present work, the coatings were produced by the micro-arc oxidation method on the surface of commercially pure titanium subjected to plastic deformation by means of hydrostatic extrusion. Metallic (Ag) and ceramic (ZrO_2/ ZnO/CeO2) types of antibacterial agents were applied. The substrate material presents strong substrate anisotropy, which strongly affects the microstructure and the functional properties of the produced coatings. Therefore, the use of advanced methods of scanning and transmission electron microscopy and X-ray photoelectron spectroscopy allowed us to optimize the parameters of the micro-arc oxidation process and reveal the mechanisms of the incorporation of antibacterial additions into the titanium oxide coating.

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sciforum-116882: Modulable Longwave Pass Filters Based on Kapton Films

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Kapton can be classified as an optical-grade plastic material because its amorphous nature does not allow light-scattering phenomena. Kapton films are amber-colored and have a unique optical absorption spectrum, characterized by a high transmittance value above 500nm (from yellow-red to near-infrared spectral regions) and an extremely high absorbance value below 500nm (from blue-violet to ultra-violet spectral regions). Owing to these special optical characteristics, Kapton films can be used as optical limiters (i.e., absorption-type optical filters), specifically as longwave pass (LWP) filters, and such optical devices can be used as 'optical windows' for many technological applications like the protection of sensors, optoelectronic devices (e.g., IR sensors and detectors), etc., from high-energy radiation (e.g., UV light, X-ray, etc.). This thermoplastic polymer has a very high thermal stability; indeed, its maximum service temperature is ca. 400°C. However, Kapton can be carbonized/graphitized by heating at very high temperatures (above 1000°C) to produce well-oriented graphite films. This process can be controlled and used to change Kapton's absorption profile. In particular, it is possible to modulate Kapton's optical absorption behavior by heating the polymer at temperatures slightly above 400°C. In particular, heating Kapton above 400°C leaves the film's optical transparency practically unmodified but causes a red-shift of the cut-on edge wavelength because of the formation of conjugated structures, with delocalized π-bonded electrons, in the Kapton chemical structure (very mild carbonization process). Therefore, it is possible to tune the cut-on edge wavelength of this LWP filter simply by applying a controlled thermal annealing treatment to the pristine film. Here, the optical properties of Kapton films modified by thermal treatment at temperatures higher than 400°C have been investigated by absorption optical spectroscopy (UV-Vis spectroscopy).

sciforum-115499: Nanoceramic-Enhanced Cement and Coatings: Pioneering Advanced Materials for Enhancing Performance and Durability

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Introduction

Nanoceramic materials are playing a pivotal role in advancing the development of high-performance coatings and thin films, significantly improving the performance and durability of cementitious composites and surface treatments. These materials, including nano-silica, nano-titania, and nano-alumina, have shown exceptional promise in enhancing key properties such as mechanical strength, chemical resistance, and environmental resilience. The incorporation of these nanoceramics into coatings has led to substantial improvements, making them an ideal solution for various industrial applications.

Methods

The addition of nano-silica to cementitious materials has been shown to increase compressive strength by up to 20%, primarily due to its pozzolanic activity, which facilitates the formation of additional cementitious compounds and refines the microstructure at the nanoscale. This refinement process results in a more compact and homogeneous material, enhancing its mechanical properties. Similarly, nano-titania and nano-alumina contribute significantly to reduced permeability and enhanced chemical resistance, improving the durability of coatings under harsh environmental conditions. These nanoparticles fill voids within the material matrix, refining the interfaces between particles and enhancing overall structural integrity.

Results

In recent studies, microstructural investigations have provided visual confirmation of these enhancements, showing denser, more uniform networks within the material. These improved structures not only contribute to the mechanical properties but also the longevity and environmental performance of the coatings, ensuring that they can withstand the effects of weathering, chemical exposure, and physical wear.

Conclusion

The integration of nanoceramic materials into coatings represents a significant breakthrough in surface engineering, offering new opportunities for creating sustainable and high-performance materials in the construction industry. Future research will focus on optimizing nanoparticle concentrations, assessing long-term durability and performance under real-world conditions, and evaluating the environmental and economic impacts of these advanced materials. With continued innovation, nanoceramics have the potential to revolutionize the field of coatings and surface treatments.

sciforum-114300: Novel Large-Scale PDA/rGO Free-Standing Nanofilms—Perspectives in Photoelectronics

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Polydopamine free-standing films form at the air–water interface through the self-assembly of dopamine oxidation products, creating large-scale, nanometer-thin films with remarkable mechanical properties and a two-dimensional structure. This experiment aimed to develop a PDA/rGO nanocomposite transferable onto almost any surface, offering potential for targeted functionalization. Our research revealed unexpected electronic and photonic effects arising from the distinctive structure and properties of the PDA films.

This approach utilized a novel one-pot synthesis method with boric acid as an antioxidant. The process led to the formation of 2D-like nanocomposite films of PDA and rGO. Their morphology was characterized using SEM and AFM, while their chemical composition was analyzed with UV-vis, Infrared, Raman Spectroscopy, and XPS. Boric acid enhances the mechanical properties of PDA and is crucial in reducing GO. This synthesis method harnessed the synergy of these processes, enabling the nanocomposite to be transferred onto various surfaces, creating possibilities for advanced photoelectronic applications.

The conductivity and light-interaction tests were noteworthy. Sensitive 4-Point Probe measurements revealed a decrease in the conductivity of PDA/rGO films under mild irradiation (white LED, UV light). Notably, these changes are reversible and quantifiable, attributed to structural and morphological alterations under light activation. Time-resolved reflectivity was employed to study the contraction and relaxation of the film during light on/off cycles. Unlike pure PDA, PDA/rGO films respond primarily to thermal expansion rather than moisture adsorption/desorption. This results in a significantly faster response compared to PDA, enabling the creation of expansive and contractive films through a simple synthesis process. Conductive AFM measurements revealed a complex electronic phase nanostructure, consisting of higher-conductivity domains surrounded by a nanocomposite polymer matrix with lower but notable conductivity.

These findings, although preliminary, open pathways for photoelectronic applications and offer insights into controlling the intermolecular interactions of PDA within composite materials.

sciforum-113999: Semitransparent Gold-Embedded Anodic Titania Nanotubes: Harnessing Plasmonic and Photoelectrochemical Synergies for Visible-Light Applications

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Anodic titania nanotubes are characterized by their high degree of vertical alignment, resulting in structures with exceptional surface area, physical, and electrochemical properties. However, their intrinsic wide band gap (ca. 3.2 eV for anatase form) limits their absorption to the UV spectrum, necessitating strategies such as doping and plasmonic decoration to extend their activity into the visible range. Additionally, the semitransparency of these structures can be leveraged to enhance light management and integration into optoelectronic and solar-energy-harvesting devices.

Gold nanoparticles decorated anodic titania nanotubes, exhibiting localized surface plasmon resonance, can potentially improve photocatalytic activity, visible-light absorption, nonlinear optical behavior, and the efficiency of solar energy and photonic devices. These materials can be synthesized through various approaches, including laser-treated titania nanotubes coated with a gold thin film or the laser treatment of oxide nanotubes formed from TiAu homogeneously co-sputtered alloys. However, laser processing often results in non-uniform gold nanoparticle distribution, predominantly on the nanotube surface area, leading to issues like melting, agglomeration, or polydispersity. To address these challenges, we have developed semitransparent anodic nanotubes embedded with gold nanoparticles. These structures were fabricated by anodizing a multilayered film stack composed of alternating Ti-sputtered layers and TiAu co-sputtered layers. SEM analysis revealed well-formed, uniformly distributed nanotubes and the Raman spectra confirmed the presence of the anatase phase in the prepared materials, with up to 7 % of Au content. The UV–vis spectra also revealed a redshift of the absorption band beyond 400 nm, and energy band-gap reduction was observed compared to the bare titania material. Furthermore, the samples exhibited superior anodic current densities, particularly favoring oxygen evolution reactions, reaching up to 2.7 $mAcm^{-2}$ for the sample with 5 % Au content. These results underscore the potential of such gold nanoparticle-embedded nanotubular architectures for advanced photoelectrochemical applications.

sciforum-114204: Structure and Properties of $W_{1-x}Al_xB_{2-z}$ Coatings

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In the pursuit of advanced materials with exceptional properties, tungsten borides have attracted significant attention due to their remarkable hardness, thermal stability, and wear resistance. The crystallographic structure of such materials plays a pivotal role in determining their physical, mechanical, and thermal characteristics. Among these, aluminum-doped tungsten borides ($W_{1-x}Al_xB_{2-z}$) stand out, offering excellent mechanical and thermal properties. These materials show great promise for applications as protective coatings capable of maintaining stability at high temperatures.

To achieve the desired material structure, an innovative magnetron deposition method was employed, combining direct-current magnetron sputtering (DC) and High-Power Impulse Magnetron Sputtering (HiPIMS) techniques. The layer was deposited using two targets: AlB_2 (DC) and $WB_{2.5}$ (HiPIMS). An original method involving mass measurements and microscopic observations was applied to determine the density, which was subsequently used to calculate the thermal conductivity. The measured thermal conductivity values (5–8 W/(mK)) classify these materials as thermoelectric. Mechanical testing revealed very high hardness (~30 GPa for doping below 10% atomic aluminum) and a favorable plasticity index (H/E*). As aluminum content increased in $W_{1-x}Al_xB_{2-z}$ layers, a slight reduction in density and hardness was observed, along with an increase in thermal conductivity.

Experimental results were compared with theoretical values obtained via DFT calculations. All $W_{1-x}Al_xB_{2-z}$ structures analyzed through DFT were found to be mechanically and thermally stable. The experimentally determined hardness values exceeded those predicted by DFT, underscoring the significant influence of aluminum doping.

This study highlights how deposition processes affect crystallinity, texture, and microstructural features, which in turn influence the material's mechanical and thermal properties. Optimization of deposition conditions and doping strategies enabled the development of $W_{1-x}Al_xB_{2-z}$—a promising material with potential industrial applications.

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sciforum-114261: Superhydrophobic Copper Foams for Use as Marine Water Purification Filters

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This research addresses marine pollution, a critical environmental issue, by developing an innovative solution to overcome the limitations of traditional cleaning methods. Existing techniques are often inefficient due to their complexity, time-intensive processes, specialized personnel requirements, and high costs. This study explores a novel approach: the development of a superhydrophobic coating on copper foams as an efficient alternative for marine depollution.

Various efforts in creating hydrophobic porous materials, such as electrospinning and chemical vapor deposition, have faced challenges like high equipment costs, energy demands, and the use of harmful chemicals. In contrast, this study proposes a cost-effective and simplified method. A superhydrophobic coating was successfully fabricated on copper foams with varying levels of surface roughness through a two-step immersion process in silver nitrate and stearic acid solutions. Importantly, the substrate's surface roughness significantly influenced the growth of silver dendrites and the morphologies of stearic acid, resulting in distinct structural differences between rough and smooth copper foams. This process requires minimal chemicals, simple equipment, and fewer steps, making it a practical and sustainable option.

The hydrophobic coatings achieved exceptional contact angles of 180°, significantly higher than those reported in most studies. The coatings demonstrated remarkable thermal and chemical stability when subjected to different temperatures (100°C and -15°C) and immersion in water and NaCl, HCl, and NaOH solutions, even after a 40 h exposure. The separation efficiency remained consistently above 94% across various pollutants, demonstrating excellent stability and durability regardless of the substrate's surface roughness. The mechanical durability of the modified copper foams was evaluated through dragging tests and exposure to ultrasound, exhibiting promising results.

This study offers a transformative approach to marine depollution, presenting cost-effective and robust solutions that align with existing environmental strategies to protect and restore marine ecosystems.

sciforum-114099: Tailoring the Optical and Sensing Properties of Sol–Gel Niobia Coatings via Doping with Silica and Gold Nanoparticles

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Niobium pentoxide (Nb_2O_5 or niobia) exhibits several key properties that make it an excellent optical material. These include exceptional stability, resistance to acidic and basic environments, high optical transmission and refractive index, and minimal light scattering, which further enhance its performance in optical applications. Among the various methods for depositing Nb_2O_5 thin films, sol–gel stands out as a particularly promising approach due to its versatility, scalability, and the ability to precisely tailor material properties for a broad range of applications.

In the current study single- and multi-layered niobia coatings were prepared by spin-coating a niobium sol, which was synthesized using niobium chloride as the precursor and ethanol and water as solvents, followed by annealing at 320°C to form the niobia film. Doped niobia films were prepared by incorporating commercially available SiO_2 (Ludox) and Au nanoparticles (NPs) into the sol before spin-coating of the films. After annealing the silica-doped films, they were subjected to chemical etching for varying durations to remove the silica phase. This process generated porosity within the films, which in turn enabled the tailoring of both their optical and sensing properties.

The morphology of the films was investigated using transmission electron microscopy (TEM). The optical parameters and film thicknesses were determined by nonlinear curve fitting of the reflection spectra, and the results were cross-validated through additional ellipsometric measurements. Effective medium approximation was used to assess the degree of porosity. The sensing properties of the films were evaluated by using both quartz crystal microbalance (QCM) and optical reflectance spectra measurements, recorded prior to and during exposure to the analyte (acetone vapors).

The study demonstrated that silica NPs enhanced the porosity of the niobia coatings, resulting in vapor-sensitive films with tunable optical and sensing properties. The gold NP doping further improved the sensing performance of the studied films.

sciforum-113874: Usage of Metal Organic Frameworks as Water-Splitting Catalysts

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Introduction

Electrochemical water-splitting processes have arisen as an alternative for fighting energy source shortages through H_2 generation. However, this process requires the usage of catalysts in order to reduce the energy input. Metal organic frameworks (MOFs) are novel materials which may act as water-splitting catalysts due to their stability, crystal structure and high conductivity.

Methods

MOF NH_2-MIL-101(Fe) was synthetized through a solvothermal method (20 h, 110°C) using $FeCl_3 \cdot 6H_2O$, 2-aminoterephthalic acid and dimethylformamide. For the electrochemical water-splitting process assessment, different dosages of MOF-Fe were placed on the working electrode by different means (dropwise, dip-coating, ultrasonic dispersion), with Ni foam for alkaline and neutral pHs or carbon paper for acid pH (1 cm^2), using graphite sticks and $HgCl_2$ electrodes as counter and reference electrodes, respectively. This three-electrode cell was connected to a PGSTAT302N potentiostat (Methrom).

Results

MOF-Fe was tested for the hydrogen evolution reaction (HER) and oxygen evolution reaction (OER) at neutral, acid, and alkaline pHs. MOF-Fe showed a high performance in the alkaline OER. Moreover, 0.25 mg/cm^2 was found to be the optimal MOF-Fe dosage. Thus, 10, 50 and 100 mA/cm^2 were obtained by applying low overpotentials of 300, 347 and 372 mV. This catalyst also exhibited high stability for 90 h at such current densities, defeating the benchmark catalyst (IrO_2) in both activity and stability. Characterization analysis showed that MOF-Fe's performance could be explained by its high crystallinity, elevated functional group presence, and great surface area.

Conclusions

The noble metal-free MOF-Fe was a suitable alternative for applying electrochemical water-splitting processes in a more environmentally friendly and economic approach, opening a path for the future application of these processes.

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sciforum-115537: Zinc Oxide Nanoparticles in Cement-Based Antibacterial Coatings: A Pathway to Hygienic and Durable Construction Materials

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Introduction

Antibacterial coatings are becoming essential in construction materials to prevent microbial growth and improve hygiene, particularly in environments prone to bacterial contamination. Zinc oxide (ZnO) nanoparticles have emerged as a highly effective antimicrobial additive, offering unique properties such as high surface area, photocatalytic activity, and the ability to generate reactive oxygen species. When incorporated into cementitious coatings, ZnO nanoparticles provide dual benefits by enhancing both mechanical properties and antimicrobial functionality.

Methods

Recent advancements highlight the potential of ZnO-enhanced cement coatings to inhibit common pathogens, including Escherichia coli and Staphylococcus aureus. The antibacterial activity stems from the nanoparticles' ability to disrupt bacterial membranes and produce reactive oxygen species, effectively controlling microbial growth.

Results

The addition of ZnO improves the durability and compressive strength of cement, ensuring the material's structural integrity. The uniform dispersion of zinc oxide nanoparticles in the cement matrix contributes to consistent antibacterial performance and increased durability.

Conclusion

Recent studies have shown that ZnO-based antibacterial coatings represent a sustainable and innovative approach to addressing hygiene challenges in construction while maintaining high material performance. Future research is needed to optimize nanoparticle concentrations, ensure long-term antimicrobial efficacy, and evaluate the environmental and economic impacts of these coatings. This integration of functionality and durability underscores the transformative potential of ZnO nanoparticle-based coatings in modern construction and infrastructure.

sciforum-112994: Advanced Thin Film Deposition Techniques for Doped Metal Oxides and Chalcogenides: Applications in TCOs, Photovoltaics, and Sensing

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There is significant interest in the development and application of doped metal oxides and metal chalcogenide thin films due to their versatile properties and potential for integration into advanced technologies. These materials find applications in various domains, including transparent conducting oxides (TCOs) for optoelectronic devices, thermographic phosphors for temperature sensing, and buffer layers in solar photovoltaic (PV) cells, among others.

This study focuses on three promising thin film deposition techniques—Metal Organic Chemical Vapor Deposition (MOCVD), Sol-Gel, and Spray Pyrolysis—each tailored to fabricate specific doped thin films with desirable properties. Aluminum-doped zinc oxide (Al:ZnO) thin films were synthesized using MOCVD to achieve high electrical conductivity and optical transparency, essential for TCO applications. Europium-doped titanium dioxide (Eu:TiO_2) films, prepared via the Sol-Gel method, were optimized for luminescent and photocatalytic functionalities, making them suitable for applications in sensors and environmental remediation. Finally, tin disulfide (SnS_2) thin films, deposited through Spray Pyrolysis, were developed for their potential as an efficient light-harvesting material in photovoltaic devices.

The presentation highlights the synthesis processes, characterization techniques, and the resulting structural, optical, and electronic properties of these thin films, emphasizing their suitability for specific applications. These advancements underscore the importance of tailored deposition methods in the research and development of high-performance materials for next-generation technologies

sciforum-114134: Biobased and Home-Compostable Blend Films and Layers for Protecting Perishable Foods

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Biobased and home-compostable films were produced by blending poly(lactic acid) (PLA) and poly(butylene succinate-co-adipate) (PBSA). These films, which can be applied on different substrates by exploiting their thermoplastic feature, were found to be easily recyclable in an industrial environment. The composition of PLA/PBSA blends, produced using a mini-extruder, was varied to identify the films with the best barrier properties for perishable liquid foods, such as whey. The weight of the whey contained in the sealed film was measured over time. The blends were also evaluated for their mechanical and melt fluidity properties, as well as their surface composition, using infrared spectroscopy. The results demonstrated that the composition of the blends significantly influenced the barrier properties of the films.

These findings are not only applicable to dairy products but also hold potential for packaging perishable fruits, which are abundant in the Mediterranean region. Fruits such as strawberries, dates, and tangerines could benefit from this innovative packaging solution. The high availability of these fruits in the Mediterranean area makes the hereby proposedapplication particularly relevant. The development of such films could contribute to reducing food waste and improving the shelf life of perishable goods, thereby offering a sustainable and practical packaging alternative. This research highlights the importance of material composition in designing effective and environmentally friendly packaging solutions.

sciforum-102891: Deposition Enhanced by Coacervation in Mixtures of Chitosan and a Non-Ionic Sugar-Based Surfactant

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This study investigates the use of chitosan-alkyl polyglucoside (APG) mixtures as environmentally friendly ingredients in 2-in-1 shampoo formulations. For this purpose, experiments were performed by varying the surfactant concentration and ionic strength at a fixed chitosan concentration. The results show that chitosan–APG mixtures exhibit a phase diagram strongly influenced by APG concentration. At constant chitosan concentration, two different types of regions emerge: one characterized by the formation of transparent mixtures at low and high surfactant concentrations, and another with turbid mixtures at intermediate concentrations where no macroscopic phase separation was observed. These turbid mixtures result from a coacervation process that is critical for the formation of conditioning deposits. The ionic strength affects the phase transition, causing shifts from transparent mixtures to coacervates and back at lower APG concentrations, although the overall phase behavior remained qualitatively similar. Chitosan–APG mixtures promote the formation of conditioning deposits via coacervate deposition. When the system reached the coacervation region, deposition increased significantly regardless of ionic strength. This finding is critical to the development of effective hair care products and demonstrates the potential of these mixtures to provide conditioning benefits comparable to traditional formulations. In summary, this research enhances the development of sustainable and natural cosmetics while addressing key scientific questions about biopolymer behavior under varying conditions.

sciforum-117401: Fabrication of Thin-Film Composite Nanofiltration Membrane Employing Polyelectrolyte and Metal–Organic Framework (MOF) via Spin-Spray-Assisted Layer-by-Layer Assembly

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Spin-assisted layer-by-layer (LbL) assembly is an innovative method for producing nanostructured thin films, offering enhanced efficiency and precision over traditional dip-coating techniques. This method enables significantly faster deposition and bilayer cycle times while optimizing material usage. In addition, spray LbL systems present advantages in speed and scalability for large-area substrates. By integrating these approaches, spin-spray-assisted LbL assembly allows for rapid assembly and extensive coverage of substrates. In this study, we demonstrated the efficacy of spin-spray LbL assembly in fabricating a thin-film composite nanofiltration (NF) membrane.

In this work, TFC NF consists of multiple layers of polyelectrolyte, and a metal–organic framework (MOF-303) was fabricated to enhance the membrane's biofouling resistance. Polyethyleneimine (PEI) and poly (sodium-4-styrene sulfonate) (PSS) were sprayed alternately and deposited on the top of a spinning polyethersulfone (PSF) ultrafiltration support to construct thin-film composite NF.

The resulting membrane was examined using standard nanofiltration membrane testing, and its performance is comparable to commercial NF. For instance, five bilayers of PEI/PSS NF membrane, i.e., $(PEI/PSS)_5$, showed a rejection rate of 42.65 ± 0.17 % and a permeability of 9.46 ± 0.14 l/h.bar.$m^{2,}$ while a commercial NFX membrane from Synder Inc. showed a rejection rate of 53.66 ± 3.23 % and a permeability of 3.51 ± 0.42 l/h.bar.m^2. We fabricated a PEI/PSS membrane coated with MOF303 as the outermost layer. From our preliminary investigation, (PEI/PSS)5-MOF303 with an MOF concentration of 0.05 wt% exhibited a rejection rate of 18.94 ± 1.58% and a permeability of 0.91 ± 0.13 l/h.bar.m^2. Although this is still a preliminary result, this work shows that spin- and/or spin-spray-assisted layer-by-layer assembly is a promising method for fabricating membranes for various applications. Some further details, such as surface characteristics, are also provided in this work.

sciforum-114324: Innovative Solvent-Based Pressure-Sensitive Paints for Aerodynamic Testing in Wind Engineering

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This work introduces an innovative Pressure-Sensitive Paint (PSP) system based on solvent quenching mechanisms (SQ-PSP), tailored for precise aerodynamic testing in wind engineering applications. The SQ-PSP system enhances the capabilities of traditional PSP technology by employing a solvent to quench fluorescence, enabling accurate pressure distribution mapping on structural models tested in wind tunnels.

The system's polymer matrix incorporates luminescent pressure sensors that react dynamically to pressure changes, offering high sensitivity and stability. Validation tests demonstrated linearity in a pressure range from -500 hPa to +500 hPa, ensuring reliable performance across diverse aerodynamic scenarios. A key advantage of the SQ-PSP system is its ease of application and rapid data acquisition, making it a superior alternative to traditional pressure taps in terms of both efficiency and measurement precision.

Wind tunnel studies using architectural models confirmed the system's effectiveness, showing strong agreement with classical measurement methods in positive pressure ranges. However, challenges in capturing negative pressure variations highlight areas for further refinement. Despite these limitations, the SQ-PSP system presents significant potential as a cutting-edge tool for analyzing complex pressure distributions, contributing to the optimization of structural designs and improving urban wind comfort through enhanced aerodynamic modeling.

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sciforum-114073: Multifunctional Dark-Colored Coating for Roof Renovation: Combining Corrosion Protection and Heat Reduction in a Single Application

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In response to the growing challenges of global warming, one of the key phenomena affecting thermal comfort and energy efficiency in cities is the Urban Heat Island (UHI) effect. This refers to higher temperatures in urban areas compared to rural surroundings, caused by building materials like concrete and asphalt that absorb and store heat. In cities with dense buildings and limited green space, there is increased demand for air conditioning, leading to higher energy costs and greater air pollution. Mitigating the UHI effect is thus essential for sustainable urban development.

Roof surfaces, highly exposed to solar radiation, are among the main contributors to heat accumulation. Applying appropriate thermal insulation coatings can significantly improve building energy efficiency. Developing coatings with high Total Solar Reflectance (TSR) can reduce roof temperatures and decrease air conditioning demand, addressing rising energy costs and climate change.

This study aimed to develop dark-colored, multifunctional roof coatings combining corrosion resistance and heat-reduction properties. Direct-to-metal (DTM) coatings, which eliminate the need for an anti-corrosion primer, simplify application and reduce painting time. These formulations incorporated near-infrared (NIR) reflective inorganic pigments that reflect solar radiation in the NIR spectrum, improving thermal performance.

The coatings underwent extensive testing, including adhesion, impact resistance, flexibility, and accelerated aging in salt spray, humidity, and UV chambers. Optical and thermal properties were assessed with UV/VIS/NIR spectrophotometry, and emittance was measured with Total Hemispherical Emittance Measurements.

The coatings demonstrated excellent adhesion and corrosion resistance, with heat-reflective NIR pigments reducing substrate temperature even in dark-gray colors. These results highlight the coatings' effectiveness in mitigating the UHI effect and improving building energy efficiency.

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sciforum-117199: Optical Coatings and Thin Film Deposition: Selecting Deposition Materials for PVD and IAD

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Introduction

Thin film deposition is an essential process in various industries, including optics, electronics, and aerospace. Among the most effective techniques, **Physical Vapor Deposition (PVD)** and **Ion-Assisted Deposition (IAD)** provide high-quality coatings with improved adhesion, mechanical strength, and optical performance. The choice of deposition materials is critical, as it directly influences the film's durability, functionality, and efficiency.

Methods

PVD involves transferring material from a source to a substrate in a vacuum environment. Common methods include **evaporation** and **sputtering**, where the material is either thermally vaporized or ejected by high-energy ion bombardment. IAD enhances PVD by introducing ion beams during deposition, improving **film density, adhesion, and stress control**. The selection of deposition materials depends on properties such as **melting point, optical transparency, hardness, and chemical stability**.

Results

Studies show that materials like **titanium (Ti), silicon dioxide (SiO_2), and aluminum oxide (Al_2O_3)** perform exceptionally well in PVD coatings, particularly for optical and wear-resistant applications. When combined with IAD, these films exhibit **higher density, reduced defects, and better environmental resistance**. However, materials with low thermal stability or high volatility require optimized deposition conditions to achieve uniform coatings.

Conclusions

The effectiveness of thin film deposition relies on selecting suitable materials and optimizing process parameters. **PVD ensures high-quality coatings, while IAD further refines film characteristics, enhancing durability and performance**. As deposition technologies evolve, new material innovations will continue to expand thin film applications across multiple industries, driving advancements in **optics, electronics, and protective coatings**. Understanding the interplay between deposition techniques and material properties is essential for producing high-performance thin films.

sciforum-117305: Oxidation and Wear Protection of PULTRUDED C/C composites Using Atmospheric Plasma-sprayed Environmental Barrier Coatings

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C/C composites exhibit a unique property profile, including high specific strength, flexural strength, excellent thermal shock resistance and low density. These properties make C/C an attractive material with great potential for high-temperature applications such as furnace technology. However, the low oxidation resistance of the material at high temperatures as well as its low wear resistance are critical factors that restrict its in-service lifetime and can lead to premature material failure.

This study investigates to what extent oxidation and wear resistance can be increased by the deposition of atmospheric plasma-sprayed coatings. Therefore, different coating systems are investigated, which consist of Mo or Si as intermediate coating and Al_2O_3, Al_2O_3-8%Cr_2O_3, Al_2O_3-40%TiO_2, an experimental $(Al,Cr,Ti)_2O_3$ solid solution or $Yb_2Si_2O_7$ as top coat. The wear resistance is determined by means of a ball-on-disc test, while the oxidation protection and damage mechanisms of the coating systems are evaluated by thermocyclic tests up to 1000 °C and rapid cooling in air. The microstructure of the coatings is analyzed using a scanning electron microscope (SEM), energy-dispersive X-ray spectroscopy (EDX) and X-ray diffraction (XRD).

The results show that atmospheric plasma-sprayed coatings, despite their typical microstructure, which is characterized by pores and microcracks, can significantly improve the oxidation resistance of the C/C composite by reducing the rate of degradation in an oxidative environment. In addition, the oxide ceramic coatings provide considerably higher wear resistance than the C/C composite.

sciforum-113915: Pyrolysis Conditions Optimization for Biochar Synthesis as Catalyst for Water Splitting Applications by applying Response Surface Methodology

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Introduction

The global annual accumulation of food waste has been increasing in the last years. Thus, biomass-based catalysts have been selected as a solution to reduce this waste and obtain energy by water splitting process. Therefore, pyrolysis conditions have been optimised by Response surface methodology (RSM) to improve the obtain biochar properties and quality, diminishing overpotential and Tafel slope responses to deal with thermodynamic issues from water splitting. Moreover, our catalyst benefits for its simple coating, as the synthesized biochar is deposited into the selected support by drop deposition where the own material acts as adhesive agent, avoiding polymers as Nafion® or Sustainion®.

Methods

1 g of orange peel was pyrolysed in a tubular oven under different conditions, considering the reaction time (30-720 min) and the reaction temperature (300-900 °C), with a heating rate of 10°C/min. Thus, software DesignExpert® has been used for RSM, establishing both reaction temperature and time as input factors and overpotential and Tafel slope as response factors.

Results

Our results showed that the optimal pyrolysis conditions obtained by RSM were applying the highest temperature (900°C) with the lowest treatment time (30 min), attaining the minimise overpotential (374.8 mV at 10 mA/cm^2) for water splitting.

Conclusions

This work demonstrates competitive results in terms of overpotential and Tafel slope with the benchmark catalysts for water splitting, opening the importance of synthesis conditions optimization for catalytic properties.

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sciforum-113566: Tailoring Wettability Through Coating Deposition on High-Voltage Overhead Conductors to Decrease Corona Discharge Power Losses

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Meeting the demands of modern high-voltage transmission line applications requires novel functional coatings that minimize corona discharge losses while providing sufficiently low ice adhesion and adequate corrosion protection. This work presents comprehensive results from an extensive study of superhydrophobic (SHC), superhydrophilic (SPhil), hydrophilic (Phil), and slippery liquid-infused porous surfaces (SLIPSs) under alternating current corona discharge. Our experiments confirm that coatings at both extremes of the wettability spectrum—water-repelling SHC and water-attracting SPhil—can reduce corona discharge currents by two to four times under adverse weather conditions, whereas SLIPS coatings, despite their water repellency, may actually increase corona currents in rainy conditions.

Furthermore, we observed distinct differences in long-term coating stability under harsh corona discharge conditions, including ozone exposure, UV radiation, and ion bombardment. SLIPS coatings rapidly degrade due to depletion of the lubricating layer, while SHC coatings exhibit very slow, yet discernible deterioration. In contrast, Phil and SPhil coatings tend to improve their corona-protective properties upon exposure to corona discharge. Among these options, hydrophilic organosilane coatings offer the best overall balance: they significantly reduce corona power losses, maintain ice adhesion levels comparable to bare wires, and achieve a threefold reduction in corrosion currents. Meanwhile, superhydrophilic coatings demonstrate reduced corona discharge but suffer from increased ice adhesion and corrosion rates.

These findings underscore the importance of selecting and optimizing coatings to suit specific climatic conditions. In regions with significant icing, durable superhydrophobic coatings hold promise, provided further work is done to enhance their longevity. In warmer, humid climates, hydrophilic and superhydrophilic coatings are more suitable. Overall, our results highlight how tailoring surface wettability can mitigate corona discharge and other environmental impacts, paving the way for improved performance and reliability of high-voltage transmission lines.

Session 4. Corrosion, Erosion and the Tribological and Mechanical Aspects of Coatings

sciforum-117439: Development of Sustainable Anticorrosive Coatings Based on Pinus Radiata Bark Wax

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Corrosion is a natural phenomenon that significantly affects metal structures, leading to deterioration, reduced service life, and structural failures, with severe economic and environmental consequences. The Organization for Economic Co-operation and Development (OECD) estimates that corrosion accounts for up to 3% of the GDP in developed countries. In Chile, a country with an extensive coastline and a strong industrial sector, critical infrastructures such as bridges, power plants, and offshore platforms are continuously exposed to corrosive environments. Climate change exacerbates these conditions by increasing coastal salinity and acid rain, accelerating metal degradation, raising maintenance costs, and impacting sustainability.

Traditional anticorrosive coatings contain materials with significant health and environmental risks, including epoxy resins with bisphenol A (BPA), carcinogenic lead chromate pigments, volatile organic compounds (VOCs), and bioaccumulative biocides. Developing safer and sustainable alternatives is crucial to reducing these risks while maintaining corrosion protection effectiveness. This study explores the use of Pinus radiata bark wax extracts as a novel raw material for sustainable anticorrosive coatings. Utilizing this abundant forestry byproduct promotes circular economy principles by repurposing waste while reducing synthetic material dependency and carbon footprint.

Electrochemical impedance spectroscopy (EIS) tests were conducted following ASTM G106 standards to evaluate corrosion resistance. The developed coating exhibited impedance modulus values ranging from 10^8 to 10^{11} Ω/cm^2, demonstrating excellent corrosion protection. To complement the study, mechanical tests were conducted using commercial coatings. Additionally, in vitro cytotoxicity tests using human skin cells (HaCaT) showed cell viability and proliferation comparable to control samples, confirming low toxicity. These results validate the potential of Pinus radiata bark wax-based coatings as a multifunctional, cost-effective, and environmentally friendly alternative to conventional anticorrosive solutions.

sciforum-117415: Advanced Protective Epoxy Coatings with Photoactive TiO_2-LDO Nanofillers for Corrosion Protection and Potential NOx Mitigation

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Epoxy resins serve as anticorrosive coatings due to their robust mechanical properties, chemical resistance, and adhesion. Enhancing these coatings with nanoparticles—particularly titanium dioxide (TiO_2)—has proven effective in improving both corrosion resistance and other functional properties. In this work, we synthesized a photoactive TiO_2-based ZnAl-layered double oxide (TiO_2-LDO; 1:10) nanocatalyst via a wet impregnation method and incorporated it into an epoxy matrix. The epoxy resin, formulated with 2 wt.% TiO_2-LDO, was applied to AA2024 substrates using a coating bar coater, yielding a cured film thickness of 20 ± 2 µm. The developed TiO_2-LDO nanocatalyst exhibited high selectivity in the NOx abatement and a minimum NO_2 release (3-4%), achieving remarkably up to an 80% NO photoconversion efficiency under 20 W/m^2 of irradiation in a customized continuous-flow portable photoreactor, designed specifically for NOx studies. In comparison, while TiO_2 (anatase) achieved a similar NO conversion efficiency, it generated 20–25% NO_2 as a byproduct, which is even more toxic than NOx, whereas LDO alone produced minimal NO_2 but achieved a lower NO conversion efficiency of 25–30%.

Electrochemical impedance spectroscopy (EIS) over 28 days revealed that incorporating TiO_2-LDO into the epoxy coating provided a comparable corrosion resistance to the pure resin. However, the improvement was pronounced when the systems were exposed to UV irradiation (10 days of aging with fluorescent source with λ_{max} = 365 nm, 20 W·m^{-2}), which induces micropore formation in the pure epoxy film compared to epoxy with TiO_2-LDO, and thus improved corrosion resistance for the epoxy composite on AA2024. The results underscore the dual functionality of TiO_2-LDO as both a photoactive nanocatalyst (air pollution) and an effective anticorrosion additive, offering a promising, environmentally friendly solution for UV-resistant corrosion protection.

sciforum-113936: Corrosion and Electrochemical Properties of CrMoSiN Coatings for Bipolar Plates in Polymer Electrolyte Membrane Fuel Cells

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CrMoSiN films with varying Mo and Si contents were deposited on SS316L stainless steel by Physical Vapor Deposition (PVD) to evaluate their corrosion and electrochemical properties as bipolar plates for Polymer Electrolyte Membrane Fuel Cells (PEMFCs). The sputtering current of Mo and Si targets was adjusted to obtain different compositions in the CrMoSiN coatings, enabling a systematic study of the influence of these elements on the performance of the coatings. Scanning Electron Microscopy (SEM) revealed that the CrMoSiN coatings have a dense and uniform microstructure, which is essential for improving their mechanical and corrosion-resistant properties. X-ray Diffraction (XRD) analysis confirmed that the coatings exhibit a preferred orientation along the (200) direction, indicating good crystalline structure and stability. The effects of Mo and Si incorporation on the corrosion properties of CrMoSiN coatings were thoroughly investigated in simulated PEMFC environments, which mimic the harsh conditions within fuel cells. Potentiodynamic polarization tests and Electrochemical Impedance Spectroscopy (EIS) results demonstrated that the incorporation of Mo and Si significantly enhances the corrosion resistance of the coatings, making them more durable and effective in these environments. The findings suggest that CrMoSiN coatings, particularly those with optimized Mo and Si content, have promising potential as protective materials for bipolar plates in PEMFCs, significantly improving their efficiency and longevity under operational conditions. The corrosion mechanism of the CrMoSiN coatings was also investigated and discussed in detail.

sciforum-110719: Development of Biochar-Based Sustainable Corrosion-Resistant Coating

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Coating technology involves the application of a thin layer of material onto a substrate to enhance its surface properties, including protection, functionality, and aesthetics. Coatings can be made from various materials such as polymers, pigments, additives, and solvents, depending on the intended application. These coating layers serve multiple purposes, such as providing corrosion resistance, improving wear durability, reducing friction, or offering thermal and electrical insulation. The development of sustainable coating technologies is essential to addressing environmental, economic, and social challenges associated with conventional coatings. Traditional coatings often rely on petroleum-based resources and volatile organic compounds (VOCs), contributing to greenhouse gas emissions, air pollution, and health hazards. As global industries strive to reduce their environmental carbon footprint, the demand for eco-friendly coating alternatives has grown significantly.

Therefore, a biochar-based sustainable coating has been developed to achieve a sustainable alternative for conventional coatings. Biochar from different sources of biomasses were prepared by pyrolysis at varying conditions and characterized by FTIR, FESEM, BET, XRD, etc. Derived biochar offers unique properties such as high thermal stability and chemical inertness, making it an effective component for corrosion protection. When this biochar is incorporated into coating formulations, it forms a barrier that inhibits the diffusion of corrosive agents like water, oxygen, and chlorides to metal surfaces. Additionally, the carbon-rich structure of biochar enhances the durability of coatings and provides cathodic protection, reducing metal oxidation rates. These coatings have potential applications in industries such as the infrastructure, marine, and automotive sectors, where corrosion resistance is critical. Beyond these benefits, biochar-based coatings promote environmental sustainability by utilizing renewable biomass resources and reducing reliance on petroleum-based materials. However, further research is needed to optimize coating techniques and evaluate the long-term stability and environmental impacts of biochar-coated products.

sciforum-113855: Development of Sustainable PEA-PANI/MWCNT-Based Conductive Coating for Corrosion Resistance in Metallic Bipolar Plates and Applications in Proton Exchange Membrane Fuel Cells (PEMFCs)

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Metallic bipolar plates are widely used in proton exchange membrane fuel cells (PEMFCs) for mobile applications due to their high stack power density, mechanical strength, and electrical conductivity. However, these plates are susceptible to corrosion under PEMFC operating conditions, which necessitates the use of protective coatings to maintain or even enhance their performance. This study focuses on the development of sustainable, anticorrosive, and conductive coatings for metallic bipolar plates. The polyether amide (PEA) resin comprises modified linseed oil and hydroxyl-terminated resorcinol, with PANI/MWCNTs composites as conductive fillers. PANI/MWCNTs composite were prepared by PANI doped with p-toluenesulphonic acid (PTSA) and multi-walled nanotubes (MECNTs). Coatings with varying PANI/MWCNT concentrations were formulated to optimize electrical conductivity. The synthesized resin was characterized by FTIR and NMR. The resins were further cured with melamine formaldehyde to prepare the coating, which was then applied to the steel panels. The morphology of the coated samples was analyzed using FE-SEM, the thickness measured with a thickness gauge, and the adhesion tested via cross-hatch and tape pull-off methods. Electrochemical impedance spectroscopy (EIS) was conducted to evaluate the corrosion resistance and conductivity of the coating. This study paves the path toward the development of sustainable high-performing coatings that possess an anti-corrosive and conductive nature for bipolar metallic plates in PEMFC.

sciforum-113105: Evaluation of the Corrosion Behavior of Low-Temperature Nitrided AISI 316L Austenitic Stainless Steel

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Introduction

Low-temperature nitriding of austenitic stainless steels allows for the formation of a supersaturated solid solution of nitrogen in the austenite lattice (expanded austenite or S-phase), while inhibiting the precipitation of Cr nitrides. The corrosion behavior of the nitrided layers depends on their microstructure and phase composition, as well as on the environment characteristics. The testing conditions can also play a role, as observed when the repassivation characteristics are assessed. The aim of the present study is to evaluate the corrosion behavior of low-temperature nitrided AISI 316L austenitic stainless steel using different electrochemical techniques and, in particular, to assess the repassivation capability in NaCl solution.

Methods

AISI 316L samples were glow-discharge-nitrided at 380 °C, under 130 Pa, for 5 h. Microstructure, phase composition, and surface microhardness were assessed. Corrosion behavior was evaluated in 5 wt.% NaCl aerated solution using different electrochemical techniques (electrochemical impedance spectroscopy (EIS), cyclic potentodynamic, and galvanostatic techniques).

Results

The hardened nitrided layers mainly consisted of expanded austenite. EIS analysis showed that nitrided samples had higher impedance values than the untreated steel. The cyclic potentiodynamic test results were affected by testing conditions. Corrosion potential and pitting potential values of the nitrided samples were higher than those of the untreated ones, but the nitrided samples were not capable of repassivating. On the contrary, when the galvanostatic technique was employed, the potential value, below which localized corrosion phenomena did not occur, was usually higher than the corrosion potential of the untreated alloy, suggesting that repassivation could occur.

Conclusions

The experimental results suggested that the repassivation capability of nitrided AISI 316L austenitic stainless steel was particularly sensitive to the extent of damage. When minor damage occurred, from, for example, using the galvanostatic technique, high corrosion resistance was maintained. However, fairly significant corrosion damage, such as that occurring in cyclic potentiodynamic tests, hindered repassivation.

sciforum-114942: High-Temperature Fatigue Testing of Turbine Blades

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This study introduces an innovative experimental setup for high-temperature fatigue testing of full-scale nickel-based turbine blades protected with aluminide coating, aiming to replicate operational conditions and enhance service life predictions. A patented grip system was developed to enable precise determination of the S–N curve and hysteresis loop evolution under simulated extreme conditions. The blades were tested at 950°C with cyclic bending loads ranging from 5.2 kN to 6.6 kN at a frequency of 10 Hz. A preliminary bending test established the force–displacement relationship, providing critical input for fatigue testing parameters. The setup integrates an Inconel alloy testing stand with an induction heating system, ensuring uniform temperature distribution with deviations limited to ±3°C. Advanced monitoring techniques allowed for high-frequency data acquisition, facilitating the capture of force-displacement relations and hysteresis loop development. Results revealed distinct behavioral transitions, including elastic responses and plastic deformations at higher force amplitudes, contributing to a comprehensive understanding of fatigue-induced damage mechanisms. Key findings underscore the effectiveness of this methodology in capturing the complex mechanical responses of turbine blades under high-temperature cyclic loading. The proposed setup addresses the limitations of conventional standardized specimen testing by enabling full-scale component evaluation, thus offering significant advancements in material performance assessment for aerospace applications. This work represents a critical step toward optimizing the design and durability of high-temperature components, aligning with the demanding requirements of modern turbine technologies.

sciforum-117431: Impact of Surface Treatment and Surface Condition on Fatigue and Fracture Resistance of Materials in hot Forging of Aluminum Alloy Parts

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Introduction

High-performance steels have multiple applications; they are frequently used in tools for the manufacture of aluminium alloy parts, for instance, injection moulds, extrusion and stamping tools, or in forging dies. These materials provide high mechanical strength and high wear resistance during high-temperature operation. Their heat treatment determines the compromise between fracture toughness and hardness for each application. Thus, the degree of quenching and tempering is frequently selected based on these parameters. However, the mechanical durability of these materials is very sensitive to their surface condition and contact with potentially corrosive fluids. On the other hand, in the case of aluminium parts manufactured by this process, the use of surface treatments is very common in improving the finished component's performance. These treatments may or may not point to improvement in mechanical durability. Nevertheless, they can be a determining factor on the fatigue resistance of the manufactured component.

Methods

For this work, the effect of the surface state, the contact with operational fluids, and different surface treatments on fatigue resistance has been studied experimentally. The fundamental materials of the hot forging process, both the high-performance steels used for the dies, and the aluminium alloys of the manufactured components, have been studied. Surface modification treatments such as shot peening and anodisation have been tested, and their influence on the mechanical durability was assessed.

Results and Conclusions

The results of this work confirm the sensitivity of fatigue resistance, both in low-cycle and high-cycle regimes, for high-performance steels when exposed to aggressive environments that can generate surface corrosion. Likewise, the behaviours of high-strength aluminium alloys, when subjected to surface finishing treatments for increasing mechanical durability and corrosion resistance, such as shot peening and anodisation, respectively, are presented.

sciforum-114438: Inter-Splat Boundary Effect on Cold-Sprayed Nickel-Based Alloy Coatings Through Mechanical and Corrosion Performance

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Cold spraying is a prominent solid-state deposition technique for depositing nickel-based alloy coatings without causing microstructural changes due to its lower operating temperatures than other thermal spray processes. However, depositing nickel-based coatings via cold spraying is more challenging than other metals due to their thermo-mechanical behavior. Thermal sensitivity (m), a constant parameter in the Johnson–Cook (JC) plasticity model, is used to estimate the flow stress of plastically deformed materials at higher strain rates. Since nickel-based alloys such as NiCr, IN625, and IN718 alloys exhibit high thermal sensitivity (m>1), their deposition becomes easier at elevated particle temperatures, particularly when air is used as a process gas instead of more expensive gases like nitrogen or helium. In this work, higher particle temperatures were achieved by increasing the stagnation temperature and the nozzle convergent length. In cold-sprayed coatings, corrosion liquids percolate through unbonded inter-splat boundaries, significantly affecting the corrosion rate. These unbonded boundaries also contribute to a reduction in the elastic modulus. Hence, this study examines the effect of particle temperature on the inter-splat bonding percentage of as-sprayed and heat-treated coatings and its impact on oxidation, corrosion resistance, and elastic modulus. The inter-splat bonding is estimated through numerical simulation using ABAQUS explicit code. The results demonstrate that increasing the particle temperature enhances the oxidation resistance for NiCr coatings. The parabolic oxidation rate is constant for coatings deposited using air as the process gas, comparable to that obtained from other thermal spray techniques (such as Arc spray and HVOF). Corrosion resistance is higher and equivalent to the bulk Inconel after the heat treatment of the coating, which is deposited at a higher stagnation temperature. The elastic modulus was estimated through numerical simulation, and nanoindentation was validated. The obtained results demonstrated that the estimated modulus is improved with inter-splat bonding percentage.

sciforum-112987: Performance of Alternative Biowax Powders Replacing PTFE Fillers in Bio-Based Epoxy Coatings

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In view of sustainable-by-design issues, there is an urgent need to replace harmful coating ingredients with more ecological, non-toxic alternatives derived from bio-based resources. In particular, fluorine derivatives such as polytetrafluoroethylene (PTFE) are frequently applied in coatings because of their versatile role in rendering hydrophobicity and lubrication. In this research, a screening study is presented on the performance of alternative biowaxes derived from different natural sources, when used in protective coating applications. Micronized powders from carnauba wax, rapeseed wax, rice bran wax, palm oil wax, or sunflower wax are added into epoxy clear-coat formulations. When dispersed into a bio-based epoxy from epoxidized flaxseed oil and a proprietary acid hardener, the thermal curing process significantly affects the efficiency of the biowax additives. In concentration ranges of 1 to 10 wt. %, it was observed that the biowaxes consequently present higher hardness and hydrophobicity as coatings as compared to the PTFE additives, while similar abrasive resistance and scratch resistance could be obtained. Moreover, the proprietary mixture ratios of biowax to PTFE powders provide synergistic effects. The granulometry of the biowax powders is a crucial parameter as smaller micrometer grain sizes improve dispersibility in the coating. The mechanistic effects of micronized biowax powder in the epoxy coating are further evaluated through spectroscopic analysis, indicating their interference with the curing process of the epoxy coating.

sciforum-113022: Potassium Permanganate–Fluorozirconate Conversion Coating as a Precursor for Flash-PEO Coatings on AZ31B Magnesium Alloy

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Flash-Plasma Electrolytic Oxidation (Flash-PEO) is short anodizing surface treatment that has demonstrated outstanding corrosion resistance associated with self-healing mechanisms. However, similarly to conventional PEO, there is a limitation regarding the incorporation of certain species in the composition of the PEO coating. In that direction, precursor-driven functionalization is a novel approach that can be used in place of the classical one, where the final composition only depends on the electrolyte and the metal.

In this work, a commercial permanganate–fluorozirconate conversion coating (ZrCC) has been used as a precursor prior to a silicate–fluoride (SiF) Flash-PEO treatment. Coatings were characterized by X-ray diffraction (XRD), scanning electron microscopy (SEM) coupled with energy-dispersive X-ray spectroscopy (EDS), or X-ray photoelectron spectroscopy (XPS). The corrosion performance was evaluated by open circuit potential (OCP) and electrochemical impedance spectroscopy (EIS) after immersion in 0.5 wt. % NaCl. Results have revealed an improvement in the corrosion resistance up to 72h due to Zr and Mn incorporation as well as changes in the porosity and compactness of the Flash-PEO layer.

In summary, the use of precursors such as ZrCC (source of Zr and Mn cations) has been confirmed as an efficient strategy to vary the chemical composition of Flash-PEO coatings, improving their corrosion resistance.

sciforum-114336: Sealing PVD Coating Defects with Ti-O ALD Layers

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Previous investigations have revealed that Atomic Layer Deposition (ALD) layers on Physical Vapor Deposition (PVD) coatings lead to pinhole defect sealing, which results in improved coating corrosion properties. However, despite this, the influence of PVD defect size on the sealing efficiency of ALD layers remains poorly determined. This study aimed to evaluate the corrosion properties of hybrid PVD/ALD layers with a focus on how the influence of PVD defect size affects the sealing efficiency of ALD layers. The corrosion resistance of PVD TiN coatings and TiN combined with ALD Ti-O layers (amorphous and anatase phases) was investigated in phosphate-buffered saline solution (PBS). Corrosion experiments were conducted on circular areas of 4 mm in diameter using electrochemical impedance spectroscopy (EIS) and potentiodynamic polarization (PD) measurements. Confocal and tactile profilometry were performed before and after the corrosion tests to identify and quantify the PVD coating growth defects. To examine the thickness and uniformity of the ALD layers, scanning electron microscopy (SEM) was utilized on cross-sections of PVD defects prepared by focused-ion beam (FIB). The results revealed that the increased number of protrusion defects, with heights exceeding 2 µm, correlates with a decrease in impedance for PVD-coated samples. The deposition of ALD layers significantly improved the corrosion resistance of samples. Cross-sectional FIB-SEM analysis confirmed uniform coverage by the ALD layer without visible cracks across all investigated ALD layers. However, corrosion tests revealed that the amorphous TiO_2 ALD layer exhibited superior PVD defect-sealing efficiency compared to the anatase TiO_2 layer. This suggests that the presence of grain boundaries in the anatase TiO_2 ALD layer contributes to its lower sealing efficiency. The application of ALD layers on PVD-coated samples, by forming a hybrid coating, offers a promising solution for applications requiring enhanced corrosion resistance alongside adequate surface mechanical properties.

sciforum-114305: The Effect of Surface Roughness on Scratch Adhesion and Tribological Behavior of PVD Hard Coatings with Different Layer Designs

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The surfaces of industrial components intended to be coated with wear-resistant coatings are frequently not polished. On the contrary, during the coating development, its properties are always evaluated on highly polished surfaces. These differences in surface conditions may lead to erroneous estimation of the future coated part properties. Contemporary hard coatings that are used for enhancing tribological performance are produced with different layer designs, namely single layers, multi layers, and nanolayers. However, their performance on surfaces with different roughnesses is addressed to a minimal extent in the literature. This investigation examined three kinds of coatings of different layer designs deposited by magnetron sputtering, namely TiAlN (single layer), TiAlN/CNx (dual layer) and AlTiN/TiN (nanolayer) coating. Coatings were deposited on steel substrates with four degrees of roughness. The coatings' adhesion was evaluated by scratch test performed parallel and perpendicular to the grinding marks. The tribological behavior of the coatings was assessed by dry-reciprocating the sliding test against an Al_2O_3 counter ball. All samples were evaluated before and after the experiments through 3D tactile profilometry, confocal optical microscopy, and energy dispersive spectroscopy. In all cases, the surface roughness of the samples increased after the coating deposition, and these surfaces belong to the range of fine surface finishes, namely Sa=12–545 nm. Within the investigated range of surface roughness, coatings with different layer designs behaved differently according to changes in surface roughness. TiAlN and TiAlN/CNx coatings showed no dependence on scratch adhesion or tribological behavior on surface roughness. For the roughest surface, a reduction in adhesion and an increase in wear rate were both observed. The AlTiN/TiN nanolayer coating displayed the largest sensitivity of adhesion on roughness and scratching direction. The coefficient of friction and wear rate of AlTiN/TiN coating increased when the roughness was larger than Sa ≈ 100 nm. This indicates that future investigations should cover a wider range of nanolayer coatings.

sciforum-114238: The Impact of Oxidative Amine Degradation on the Corrosion Behavior of 304L and 316L Stainless Steels in MEA Solutions Containing SOx and NOx Contaminants

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Post-combustion CO_2 capture using aqueous amine solutions has gained significant popularity in recent years, owing to their exceptional absorption capacity, rapid reaction kinetics, and ability to regenerate efficiently. However, a major challenge lies in the corrosive nature of amines after reacting with CO_2, which can lead to significant operational issues in process equipment. Beyond CO_2, the oxidative degradation of amine solvents further influences corrosion. This degradation is accelerated by oxidative agents, such as O_2, SOx, and NOx impurities in flue gas, which interact with amine solutions to form various degradation by-products.

This study focused on investigating the corrosion behavior of 316L and 304L stainless steels (SS316L and SS304L)—widely used in carbon-dioxide capture units—when exposed to both degraded and non-degraded MEA aqueous amine solutions containing SOx and NOx pollutants, under both CO_2-loaded and unloaded conditions. The research assesses the impact of MEA degradation on the corrosion characteristics of these stainless steels, using Potentiodynamic Polarization and Electrochemical Impedance Spectroscopy. Scanning electron microscopy (SEM) was used to gain further insights into corrosion mechanism.

The results revealed that the degradation of the amine solutions, whether CO_2-loaded or unloaded, promoted the corrosion in both stainless steels. Corrosion rates were higher in degraded solutions compared to non-degraded ones, indicating reduced corrosion resistance. This was also verified by the lower total impedance values observed in Bode diagrams.

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sciforum-114259: Water Vapour Transmission Properties of Waterborne Coatings—Effect of Selected Parameters

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Water-based coatings materials, due to their desirable properties such as very good resistance to weather conditions and flexibility as well as easy application, are used for both decorative and protective purposes. The ability of the coatings to transport water can effect fungi growth, loss of adhesion, or the penetration of aggressive ions from rain into the substrate. Therefore, determining the water transport properties of water by paints is a key point in determining their protective properties.

This study investigated the effects of preparation, conditioning, and testing methodologies on the water vapour permeability properties of waterborne coatings. The study was divided into two parts. In the first part, the influence of the binder content of the paint product, the film thickness, and the presence of different substrates on the water vapour permeability values obtained was determined. In the second part, the influence of conditioning and testing methods was investigated. The conditioning method was selected based on the target use of the coating (indoor/outdoor), in accordance with the instructions in the PN-EN ISO 7783:2018-11 standard. However, due to the possibility of applying outdoor paints indoors, they were conditioned using both methods. Since the standard does not indicate how to select a test method for each group of prepared coatings, wet and dry cup methods were performed.

The results obtained show that the water vapor transmission rate decreases with increasing binder content, and the observed differences are greater for thicker coatings. The water vapor transmission through the coating on the substrate depends on the interaction between them. The coating conditioning method has the greatest influence on its ability to transport water; therefore, to determine the protective properties of the coating, it is important to choose test conditions that best represent the actual conditions in which the coating will be used.

sciforum-113546: Corrosion Fatigue Life Analysis of Chip-based Hot-Extruded Aluminum Alloy AA6060

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Secondary aluminum production through the recycling of aluminum chips originating from machining proceedings (e.g. milling, drilling) has occupied the top position among the exploitation procedures of wastes in the last decade. In particular, the solid-state method that replaces the conventional melting and casting stages with a cold pre-compaction stage before the final hot extrusion is a promising new field of interest, taking into account the energy consumption, material loss, processing steps, environmental contamination, cost, etc. The literature results reveal that material produced by the innovative processing route (including cold compaction followed by hot extrusion) is optimum, with very competitive mechanical properties. The present study explores the influence of different heat treatments (no heat treatment, natural aging, artificial aging) on the chip-based hot-extruded aluminum alloy AA6060's fatigue and fatigue corrosion behavior. Experiments were performed on cast-based hot-extruded specimens for comparison reasons. In addition, a detailed microstructural analysis of the micro-morphological fatigue failure features was carried out.

Although the results pointed out the supremacy of cast-based material in the majority of cases of fatigue and fatigue corrosion, the significance of microstructural coherency was highlighted among chip boundaries. Improving the chip bonding quality could lead to a remarkable enhancement in the fatigue life of the recycled chips subjected to hot extrusion and heat-treated processes.

sciforum-113902: Development of Innovative Antifouling Materials for Marine Environment Applications

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Marine biofouling is a phenomenon in which unwanted organisms adhere to submerged surfaces, altering their chemical, physical, and functional properties. This process begins with forming a biofilm, known as microfouling, composed of bacteria that modify the affected surface. Subsequently, larger organisms such as algae, mollusks, and crustaceans settle on the biofilm, intensifying the deterioration in a process referred to as macrofouling.

In response to this challenge, developing polymers with antifouling properties represents a disruptive advance in managing marine biofouling. These innovative materials integrate graphite oxide (GrO) nanomaterials and confer surfaces with properties that effectively inhibit organism adhesion. Polymers modified with 5% GrO have proven to be highly effective, achieving up to a 305% reduction in organism accumulation compared to untreated surfaces after one year of exposure to real marine conditions, demonstrating their durability and resistance in adverse environments.

These polymeric matrices excel in their capacity to combat biofouling and their remarkable versatility across various industrial applications. In the renewable energy sector, their integration into offshore wind turbines and tidal energy platforms would enhance operational efficiency by significantly reducing maintenance costs and efforts associated with the accumulation of marine organisms. In sustainable aquaculture, these matrices could extend the lifespan of nets and cultivation cages, considerably lowering cleaning and biofouling management costs. In maritime transportation, their application to ship hulls would optimize fuel consumption by reducing water friction, contributing to carbon emission reductions, and promoting more sustainable operations. Finally, these surfaces protect research equipment and sensors in ocean exploration, ensuring their functionality over extended periods in extreme and challenging accumulating conditions.

Developing these technologies is essential to addressing future challenges in marine environments. By combining operational efficiency and versatility, these polymeric matrices are positioned as a fundamental component in the design of advanced materials, with the potential to transform maritime industries and related sectors.

Session 5. Novel Methods/Techniques for Coating Deposition and Characterization

sciforum-114275: Enhancing Road Safety with Smart Road Marking Paints: Self-Cleaning and Thermochromic Capabilities

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Road markings (RMs) are infrastructure elements positioned to guide road users, regulate traffic, and enhance road safety. Significant advances in materials technology, such as the use of several types of paints and retroreflective materials, have contributed to improving the durability and day and night visibility of RMs. However, challenges in this field still remain, and recent developments have focused on using smart materials to incorporate innovative functionalities into RMs. Notable examples include semiconductors, which can photo-oxidize surface pollutants and provide self-cleaning properties, and thermochromic materials, capable of changing color at specific transition temperatures (TTs), offering visual feedback on pavement surface conditions. In this context, the objective of this study was to develop RM paints with self-cleaning properties (to enhance visibility and durability) and thermochromic properties (to indicate the potential presence of ice or snow on asphalt pavements). For the self-cleaning RM paint, different amounts of TiO_2 were incorporated into a water-based acrylic RM paint. The self-cleaning ability was assessed using CIELAB colorimetry to monitor the degradation of a model pollutant under UV light irradiation. For the thermochromic RM paint, thermocapsules with a TT equal to the freezing point of water (0 °C) were incorporated into a water-based acrylic RM paint. The thermochromic behavior was analyzed by the CIELAB system while the paints were exposed to negative and positive temperatures. The results showed that the self-cleaning RM paint achieved pollutant degradation capacity up to 3.2 times higher than the reference paint. The thermochromic RM paint demonstrated the ability to change to a pinkish color at temperatures below 0 °C, reversibly returning to the original white color at positive temperatures. Both properties showed potential to enhance road safety by improving visibility and providing visual feedback on usage conditions.

sciforum-114244: Aluminum-Based Electrospark Alloyed Coatings

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The aluminised coatings obtained on steels by the method of electrospark alloying (ESA) are investigated. Carbon steels were tested for the influence of the discharge energy and productivity (classic regimes, 2- and 4-fold reduction values) of the treatment process on the thickness of the hardened layer, its microhardness, continuity and surface roughness. Optical and scanning metallography, X-ray diffraction analysis, micro-X-ray diffraction analysis and micro hardness distribution tests were used for the study. Metallographic analysis showed that the structure of ESA coatings is layered, with a white layer not detectable in the reagent, diffusion zone or the substrate. The chemical and phase composition of the coating change when the discharge energy is increased during ESA. At low discharge energies, a layer consisting mainly of a-Fe and aluminium oxides is formed; as the discharge energy rises, the layer consists of iron and aluminium intermetallics and free aluminium. If the ESA productivity is reduced by factor 2, the thickness of the "white" layer increases to 75–110 μm, and its microhardness to 7450 MPa; the continuity of the coating approaches 100%. The deterioration of the coating quality parameters and the increase in roughness are due to a 4-fold decrease in process productivity. In order to improve hardening technology, it is important to study the influence of the energy parameters of ESA and the alloying time ('productivity') of the process. Aluminum-based coatings produced by the proposed ESA methods are recommended for use at high temperature.

sciforum-114080: Analytical Spectroscopic Characterization of Green Chitosan/Copper Nanocomposites for Food Packaging Applications

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Introduction

Reducing agrifood waste has become an important goal, considering that up to 50% of total production is lost due to contamination by harmful microorganisms. In this context, controlling the interface between food products and the external environment can be a powerful tool to prevent waste. The aim of this study was to produce a bio-based and biodegradable food packaging material loaded with copper particles, which act as a reservoir of cupric ions.

Methods

A green one-pot approach was used to synthesize copper particles using poly(N-vinylpyrrolidone) (PVP) as a capping agent (Cu@PVP), preventing aggregation through steric hindrance and eliminating the need for an inert atmosphere. The influence of PVP and reductant concentrations, as well as reaction time, on the oxidation state of copper phase, synthesis kinetics, and particle size was investigated by varying each of these parameters individually. Optimal conditions were identified to obtain an average particle diameter above 200 nm, while minimizing reagent and time consumption, to prevent nano-cytotoxicity effects. After a purification step, the Cu@PVP particles were suspended in ethanol and embedded in a chitosan (CS) polymeric matrix.

Results

Composite films were obtained by solvent casting. The polymer solution concentration was adjusted to maintain good rheological properties even in the presence of inorganic particles. Torsional rheology and water uptake measurements were performed to assess the mechanical behavior of the self-standing films obtained after solvent evaporation. The antimicrobial capabilities were demonstrated by ionic Cu^{2+} release kinetics, and *in vitro* by growth inhibition of three different model fungi responsible for agrifood spoilage.

Conclusions

This innovative material could be used for the production of biodegradable bags and envelopes destined for the storage of fruits and vegetables, extending the shelf-life of these horticultural products.

sciforum-114323: Carbon/Fiber-Reinforced ABS and Nanodiamond-Reinforced PLA 3D-Printed Hierarchical Honeycomb and Spiderweb Structures

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The investigation and construction of complex hierarchical structures from advanced composite materials through various additive manufacturing processes is developing rapidly worldwide and plays a particularly crucial role in the manufacturing and industrial sector. One of the most popular 3D printing techniques is Fused Filament Fabrication (FFF), which utilizes thermoplastic filaments as printing material. The mediocre mechanical performance of thermoplastic polymers has resulted in the rapid research and progress of advanced nanocomposite materials with the aim of improving the mechanical properties of complex structures. The objective of the current study is firstly to design and manufacture FFF 3D-printed hierarchical honeycomb and spiderweb constructs, using two advanced composite materials, polylactic acid reinforced with nanodiamonds (PLA/uD) and acrylonitrile butadiene styrene with carbon fibers as reinforcement (ABS/CF). At the second stage, there was an examination of the mechanical performance of these involute structures under experimental and theoretical tests. In particular, the compression behavior of the fabricated hierarchical honeycombs and spiderwebs was assessed by experiments along with finite element analysis (FEA) simulations. According to the results, the hierarchical cellular structures exhibited enhanced mechanical properties in comparison with the spiderweb structures. Specifically, augmented stiffness and compressive strength were observed. In addition, the increase of hierarchy in the honeycomb structures resulted in an improvement in the mechanical behavior in contrast to the spiderweb constructs. Finally, the convergence between the experimental and theoretical results was quite good for both hierarchical structures and materials.

sciforum-113593: Design of Strengthened and Toughened Thin Film Materials Based on Nano-Ordered Structures

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In the study of hard protective coating materials, the pursuit of higher hardness often comes at the expense of reduced toughness, leading to brittle fracture failure. To address this challenge, we propose a nanoscale structural regulation strategy from the perspective of material microstructure design to resolve the trade-off between hardness and toughness. Specifically, we employed a layered deposition process to activate the "solid-state dewetting" method, successfully fabricating a 3D coherent TaC@Ta nano-core-shell micro/nano-structured coating. This structure effectively suppresses interfacial crack initiation from three dimensions and overcomes the limitations of thermal-driven phase separation methods on toughening metals, thereby avoiding hardness deterioration caused by toughening efforts. Next, we proposed an atomic-scale tailoring strategy using "high negative mixing enthalpy + high lattice distortion" to induce localized disordered clusters. This approach transforms the topologically ordered structure of transition-metal high-entropy alloys into a novel high-entropy paracrystalline structure, with sub-nanoscale sub-crystals as structural units. This innovation achieved a 100% increase in hardness and a 69.2% increase in compressive strength, along with a significant enhancement in ultimate plastic deformation capacity. Furthermore, we developed a vertically aligned "bamboo-like" nanocolumnar copper coating material reinforced by an amorphous boron framework through bottom-up growth using magnetron co-sputtering. This structure achieved an indentation hardness of 10.8 GPa while maintaining excellent strength (yield strength ~1.36 GPa, flow stress ~2.58 GPa) and ductility (failure strain exceeding 50%). This series of works demonstrates the simultaneous enhancement of hardness, strength, and toughness in coating materials through the design of 3D coherent, nanoscale sub-crystalline structures, and "bamboo-like" structures. These findings provide new insights and approaches for the microstructural design and fabrication of toughened structural coating materials.

sciforum-117436: Electrical Behavior of Melt-Processed Polypropylene Composites with As-Grown Carbon Nanofibers

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This study investigates the electrical properties of polypropylene (PP) composites produced via melt-processing, incorporating varying concentrations of as-grown carbon nanofibers (CNFs). The electrical conductivity of PP/CNF composites exhibits a notable increase with the addition of CNFs, reaching approximately ~ 6×10^{-6} S m^{-1} for composites containing 3 wt.% CNFs [1]. In addition to electrical conductivity, the dielectric properties of PP/CNF composites were systematically analyzed. The results indicate a gradual increase in dielectric permittivity with CNF loading, reaching a maximum value of ~ 13 for composites with 3 wt.% CNFs at 1 MHz. This enhancement is primarily attributed to the development of interfacial polarization, also known as the Maxwell–Wagner–Sillars effect, which arises from the presence of conductive nanofibers within the insulating polymer matrix, significantly influencing charge distribution and dielectric behavior. Furthermore, the Cole–Cole model, applied through the electrical modulus formalism, is used to examine the influence of CNF content on the dielectric relaxation behavior and frequency-dependent response of the composites. The analysis reveals that incorporating CNFs increases the material's heterogeneity and relaxation dynamics while also prolonging relaxation times and modifying charge-transport mechanisms [2]. This work aims to enhance the fundamental understanding of the electrical behavior of polymer composites filled with as-grown CNFs synthesized via chemical vapor deposition (CVD) without thermal post-processing.

sciforum-114352: Energydispersive X-Ray (EDX) Analysis of Spin-Coated Zinc Oxide Nanoparticles by (Al, F) Co-Doping

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Energy-dispersive X-ray (EDX) analysis is an elemental analysis technique associated with Field Scanning Electron Microscopy (FESEM); it is frequently used in material science and engineering. EDX analysis enables both qualitative and quantitative studies to be carried out for a variety of applications. In this study, aluminum and fluorine (Al, F) co-doped zinc oxide nanoparticles were grown using the sol–gel route via the spin-coating method with various (Al, F) contents (1 at.%, 1 at.%), (3 at.%, 3 at.%), (5 at.%, 5 at.%), and (7 at.%, 7 at.%). The as-grown samples were characterized by energy-dispersive X-ray (EDX) and Scanning Electron Microscopy (FESEM) techniques. The results revealed that the nanoparticles have uniform morphology and hexagonal structure with a homogenous distribution. We can observe the incorporation of Al and F into the zinc oxide lattice when (Al, F) content is (1 at.%, 1 at.%) and (3at.%, 3 at.%) while the presence of Al and F peaks in the spectrum of EDX results was demonstrated in the two dopants with (Al, F) content (5 at.%, 5 at.%) and (7 at.%, 7 at.%), indicating the film's microstructure quality degradation. Grain sizes ranged from 10 to 13 nm. In conclusion, simultaneous co-doping improved the microstructure of FAZO nanoparticles when the (Al, F) content was (1 at.%, 1 at.%) and (3 at.%, 3 at.%); thus, EDX can be considered as a useful technique in all research works that require element determination.

sciforum-113414: High-Performance Bi-Layer TiO_2 Structures in DSSC Application

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A two-step hydrothermal process was employed to fabricate a highly efficient TiO2 film. In the first hydrothermal step, a bi-layer structure was synthesized, consisting of well-aligned one-dimensional (1D) rods and three-dimensional (3D) flower-like structures on an FTO substrate. Both morphologies exhibited a robust rutile phase, which is believed to provide direct conductive pathways and reduce electron-hole recombination. However, the compact nature of the bi-layer TiO2 structure limited dye absorption, resulting in suboptimal performance of Dye-Sensitized Solar Cells (DSSCs). To address this issue, an etching treatment using a highly acidic hydrochloric acid (HCl) medium was implemented as the second hydrothermal step. The samples' morphology was carried out using field emission scanning electron microscopy (FE-SEM). A 4Point Probe (Signatone Pro4-440N) was connected to the source meter to ascertain the resistivity properties of the samples. The etching treatment effectively increased the surface area of the TiO2 bi-layer, facilitating improvements in DSSC performance. The etching process transformed the morphology into a needle-like structure as revealed by FESEM images, while the reduction in electrical resistivity indicated a significant enhancement in the material's properties. The etched sample demonstrated superior performance, achieving a power energy conversion (PEC) efficiency of 10.05%, compared to 6.41% for the non-etched sample.

sciforum-114129: Optical and Thermal Behavior of Phase-Change Fibers for Enhancing Thermal Comfort

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Over the years, climate change has been intensifying global temperature fluctuations, bringing significant heatwaves to certain parts of the planet and vastly contributing to the Urban Heat Island (UHI) effect, while other parts of the world have experienced extreme cold spells. These global changes have impacted cities, leading to significant thermal discomfort and rising energy demands in heating and cooling. Developing sustainable solutions for these rising challenges has become crucial for enhancing urban living conditions and achieving good energy efficiency while keeping the population comfortable. One of the most promising solutions that has arisen in the last couple of years has been the incorporation of Phase-Change Materials (PCMs) into Civil Engineering materials. These materials can be encapsulated into Phase-Change Fibers (PCFs), which represent a novel technology in the literature. These PCFs utilize the latent heat principle, absorbing or releasing energy during phase transitions to maintain a stable temperature. In this context, this study produced PCFs via wet-spinning with commercial Cellulose Acetate (Mn 30,000) and polyethylene glycol (PEG 400 and 600). The fibers' structures were optically evaluated using Bright-Field microscopy and Attenuated Total Reflectance–Fourier Transform Infrared Spectroscopy (ATR-FTIR). The first test confirmed the PCFs' coaxial morphology and the proper PEG encapsulation within the CA sheath. Through ATR-FTIR, it was possible to confirm the key functional groups of the virgin materials and their successful integration during the production of the fibers. Thermal testing was conducted through Differential Scanning Calorimetry (DSC) and Thermogravimetric Analysis (TGA). PCFs incorporating PEG 400 and PEG 600 demonstrated phase-change temperatures of around -4 °C and 12 °C and an enthalpy of 26 J/g and 29J/g, respectively, showing great potential applications for different climates. The degradation temperatures were 234 °C and 300 °C, ensuring their resilience for integration into construction materials such as cementitious materials.

sciforum-113850: Optical Properties of Amorphous Coatings for Low-Temperature Applications

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Introduction

The performance of optical coatings in cryogenic environments is critical for advanced applications such as high-precision optical systems; however, little data are available in the literature about their properties at low temperatures. At low temperatures, changes in refractive index and potential ice formation on coatings can significantly impact their optical properties, requiring a dedicated characterization. Silicon nitride coatings have been extensively studied in diverse fields, for applications both at room and low temperatures. In this work, the optical properties of non-stochiometric silicon nitride coatings at low temperatures are presented. SiN_x coatings are candidate materials for the mirrors of next-generation interferometric gravitational wave detectors such as the Einstein Telescope.

Methods

A custom setup was employed for cryo-optic measurements to systematically study the optical properties of coatings at cryogenic temperatures. A cryostat with optical access, capable of reaching temperatures as low as 4 K, was designed to operate in ultra-high vacuum (10^{-8} mbar). In this study, we used real-time, in situ spectroscopic ellipsometry (iSE) coupled with the optical cryostat.

Results

We acquired broadband SE spectra from room temperature down to liquid nitrogen temperatures. We modeled the ellipsometry spectra by means of a Cody–Lorentz dispersion function, obtaining the refractive index, extinction coefficient, and thickness of the samples as a function of the temperature.

Conclusion

This study focuses on characterizing ion-beam-sputtered SiN_x optical coatings to investigate their behavior under cryogenic conditions. Characterization of the coatings at low temperatures assisted in the design of multilayer coatings operating at cryogenic temperatures. The accurate determination of the optical properties of the coatings was made possible by means of a proper modeling of few-nanometer cryodeposits (mainly water ice) that form on the cold surface of the coatings.

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sciforum-113929: Recent Advances in Tool Coatings and Materials for Superior Performance in Machining Nickel-Based Alloys

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Nickel-based alloys, including Inconel 718 and alloy 625, are indispensable in industries such as aerospace, marine, and nuclear energy due to their exceptional mechanical strength, high-temperature performance, and corrosion resistance. Despite their advantages, these alloys present significant challenges during machining owing to their hardness, and low thermal conductivity. To address these issues, advancements in tool coatings and materials have become critical, driving innovation in machining technologies. Coatings such as Titanium Aluminum Nitride (TiAlN) and Titanium Silicon Nitride (TiSiN) are recognized for their high thermal stability, hardness, and oxidation resistance, making them ideal for high-speed and elevated-temperature machining. Nano-Composite Coating (nACo) provides enhanced wear resistance, while Titanium Nitride (TiN) and Titanium Carbonitride (TiCN) offer anti-friction properties and toughness, respectively. Aluminum Oxide (Al_2O_3) delivers superior thermal stability and resistance to abrasive wear. Advanced solutions include multilayer coatings like TiAlN/TiN, which combine thermal resistance and toughness, and doped Ti_3AlN coatings enhanced with chromium or vanadium to improve hardness and machining efficiency. Tool materials have also seen significant advancements. Cemented carbides remain widely used due to their balance of hardness and toughness, while ceramic tools offer exceptional thermal stability for high-speed operations. Polycrystalline Cubic Boron Nitride (PCBN) excels in machining hardened alloys, and Polycrystalline Diamond (PCD) extends tool life significantly, particularly in milling applications. Nanoscale structured tools, often combined with optimized coatings, provide enhanced cutting efficiency. Tool wear caused by the hardness and work-hardening nature of nickel-based alloys necessitates robust coatings like TiAlN and multilayer systems to maintain thermal and mechanical stability. The integration of innovative coatings and tool materials has significantly improved the machinability of nickel-based alloys. Technologies such as TiAlN, TiSiN, and advanced multilayer systems, coupled with cutting-edge materials like PCD, continue to enhance wear resistance, reduce cutting forces, and ensure superior surface integrity.

sciforum-118014: Revolutionizing Wound Healing: Integrating 4D Bioprinting with Adaptive Bioactive Coatings for Dynamic Tissue Regeneration

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The field of wound healing has seen remarkable progress in recent years, and one of the most exciting innovations is the integration of 4D bioprinting with advanced coatings. 4D bioprinting, an emerging technology that adds the dimension of time to 3D printing, holds transformative potential in creating dynamic, adaptive, and self-regenerating tissue structures. This technology allows the fabrication of biocompatible materials that can respond to environmental stimuli, such as changes in temperature, pH, or mechanical forces, to enhance tissue regeneration.

By incorporating advanced coatings—composed of plant-based bioactive compounds (e.g., polyphenols) or nanomaterials (e.g., silver nanoparticles in hydrogels) and structured as thin, porous layers—into 4D-bioprinted scaffolds, we can create more effective, multifunctional systems for wound care. These coatings interact with the 4D structures by releasing therapeutic agents in response to the scaffolds' shape or porosity changes over time, facilitating controlled delivery to the wound site. This approach's novelty lies in the combination of time-responsive 4D-bioprinted structures with bioactive coatings that offer enhanced biocompatibility, antibacterial properties, and promote cellular activities necessary for wound closure, such as migration, proliferation, and extracellular matrix formation. Integrating such coatings with 4D-printed matrices creates dynamic wound-healing environments capable of responding to changes in the wound's condition over time, optimizing healing and reducing the risk of chronic wounds.

This abstract discusses the potential of 4D bioprinting combined with advanced coatings to revolutionize wound healing by providing customized, adaptive solutions that address both immediate and long-term challenges in tissue regeneration. The proposed technology could significantly improve the efficacy and sustainability of wound care treatments, paving the way for more personalized, precision medicine approaches in the management of complex wounds.

sciforum-113726: Surface Preparation of Carbonaceous Films to Increase Wettability and Integration with Nanoparticles for Electrochemical Applications

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The two most significant techniques for producing carbonaceous materials with exceptional conductivity for use in electrochemical devices are chemical vapor deposition and mechanical cleavage of graphite. The main advantage of using the CVD technique is represented by the ability to obtain materials that can be used on larger surfaces, with a uniformity superior to cleavage techniques. However, films of carbonaceous materials are hydrophobic, which makes it difficult to integrate nanoparticles. By adding nanoparticles (e.g., metallic, oxide), the electrochemical characteristics of carbonaceous materials can be improved, as a result of the increase in the specific surface of the electrode, catalytic effect, and enhanced electron transfer. In this paper, we present the methodology for modifying the wetting capacity of a graphene film grown on a copper substrate, which we transferred through a chemical process to the SiO_2/Si substrate. To modify the wetting capacity of these materials, both plasma treatment using reactive ion etching equipment and a chemical treatment in acid medium were carried out. For fundamental investigations of the graphene–liquid interface, it is necessary to ensure that the graphene surface is free of any kind of residue. This is important not only to ensure the persistence of favorable properties, but also to ensure an ideal sp^2 carbon surface to allow suitable chemical interactions with NPs, precursors, and analytical molecules. The research has focused on the use of spectroscopy, SEM, and goniometry as techniques for structural, morphological, wetting capacity, and percolation analyses of carbonaceous materials. Their applicability in the electrochemical field was studied by cyclic voltammetry after the incorporation of nanoparticles.

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sciforum-114120: Monitoring the Evolution of Optical Coatings During Thermal Annealing with In Situ Spectroscopic Ellipsometry

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Introduction

Optimizing the properties of amorphous optical coatings through thermal annealing is crucial particularly in the field of gravitational wave detection (GWD)[1,2]. Traditionally, the effects of annealing protocols on interferometry mirror coatings have been studied post-process, leaving the real-time dynamics during annealing largely unexplored. This study introduces a novel technique for real-time monitoring of optical properties during annealing, applicable to all transparent thin-film materials. We applied this technique to Titania–Tantala, Hafnia–Tantala and Titania–Germania thin films to investigate the impact of annealing parameters on their optical properties.

Methods

We employed real-time, in situ spectroscopic ellipsometry (SE) to track changes in the refractive index and thickness of transparent thin-film coatings during a controlled annealing process. The standard annealing protocol for current GWD mirrors was utilized, involving a heating ramp from room temperature to 500°C, a 10-hour plateau at 500°C, followed by cooling. Continuous SE measurements were recorded throughout the cycle. Additionally, various annealing protocols were tested on multiple samples to fine-tune the annealing parameters.

Results

For Titania–Tantala coatings, significant changes in thickness and refractive index were observed during the heating ramp, beginning at approximately 200°C and accelerating between 250°C and 350°C. A smaller, steady evolution was noted during the 10-hour high-temperature plateau. Similar trends were observed for other materials, each exhibiting interesting characteristic behavior.

Conclusion

Our results suggest potential improvements to the current annealing protocols for Titania–Tantala and other candidate materials for GWD mirrors, such as Titania–Germania and Hafnia–Tantala. Traditional ex post analysis fails to capture these real-time dynamics, highlighting the necessity of our approach for systematic, real-time investigations. This method not only enhances our understanding of how annealing parameters influence optical coating but also facilitates the optimization of protocols for new GWD mirror materials.

sciforum-112668: Composite Membranes Based on Chitosan Coated with Organosilane by Sol–Gel

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Synthetic products are becoming more popular in daily life as economic development levels rise. However, to create appropriate materials that may satisfy this need, researchers have been forced to concentrate on sustainable raw materials [1]. Therefore, this study focuses on the use of renewable raw materials to create novel CMs (composite membranes) with tailored properties for water purification [2-3]. Thereby, we propose a method for the modification of chitosan scaffolds by sol–gel, which can improve the stability of membranes. This method creates a one-phase solution when metal alkoxides and water react with an acid or base [4-5]. For the preparation of the CM coated with sol–gel, commercial chitosan (CC), TEOS (tetraethylortosilicate), and MPTMS (mercaptopropyl trimethoxysilane) were used. For chitosan dissolution, acetic acid was used. The chitosan membrane was coagulated in a sodium hydroxide solution and lyophilized, after which it was immersed into the mixture of silanes; the sol–gel reaction was performed in basic catalysis. A swelling study was performed at four values of pH (10 until 13) to determine if the chitosan membranes can withstand the basic conditions employed for the secondary step of coating by sol–gel. With the aim of highlighting the improvement inproperties for the CM, several characterization techniques were emplyed. FTIR spectra of the CMs confirmed the characteristic bands for chitosan and silane network, while TGA indicated that the CMs acquired higher thermal stability. SEM images confirmed that the chitosan membranes were coated with a thin sol–gel layer, and BET results highlighted the increase in the specific surface area and pore surface area after sol–gel coating of chitosan scaffolds; this indicates a potentially higher capacity for pollutant retention. New CMs based on chitosan coated with an organosilane layer, deposited by sol-gel, were developed. These materials show promising properties in terms of stability and capacity for pollutant adsorption, making them potential candidates for water purification.

sciforum-114252: Enzymatic Grafting as a Method for Wood Coating

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Wood is a natural material with structural and aesthetic roles in indoor and outdoor constructions. Wood treatments are performed to improve the material's natural drawbacks, such as biodeterioration, water absorption, microbial colonization, and flame sensitivity.

Conventional wood treatments, especially when wood is used outdoors, must normally be repeated regularly, because the compounds that are used are leached away, since a stable link between the wood and chemicals added is lacking. This leaching may also produce environmental pollution.

To improve the stability of wood treatments by promoting a stable coating, a new biotech method is proposed: the use of laccase to stably graft chemical compounds onto a wood surface. Laccase is an enzyme that can oxidize phenolic compounds to produce chemical radicals that may then link to a polymer chain, such as wood components, by means of covalent bonding. If the phenolic compounds also contain another functionality, it could be conferred to the wood after the grafting. This principle has been used to link several phenolic compounds to wood samples and, therefore, to modify their chemical composition and properties.

Using this biotechnological tool, a range of wood treatments were tested and analysed: the modification of the surface composition of wood, the hydrophobization of wood surfaces, the grafting of flame retardants, the design of new wood durability treatments, etc.

This new method opens up new possibilities in wood treatments by means of a mild and sustainable process.

Session 6. Protective Coatings in Cultural Heritage, Conservation and Preservation

sciforum-114554: Preservation of Heritage Through Modern Coatings: Protection of Historical Structures and Cultural Artefacts

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Introduction

Environmental factors such as moisture, ultraviolet radiation, atmospheric pollution, and biological organisms pose continuous threats to historical buildings and cultural relics. These risks compromise the structural integrity of these sites while diminishing their aesthetic and historical value. Modern innovative coatings present promising solutions for enhancing long-term preservation, lowering maintenance costs, and safeguarding their authenticity. This study explores innovative protective coatings, including silica-based nanocomposite layers and polyurethane-based healing systems, evaluating their potential as effective means to preserve historic masonry, limestone façades, and metallic artefacts in architectural heritage.

Method

A multiphase experimental approach assessed the effectiveness and compatibility of innovative coatings. Initial laboratory evaluations of accelerated weathering were conducted to quantify the extent of deterioration under controlled conditions, including exposure to ultraviolet radiation, humidity, and temperature variations. The adhesion properties and substrate compatibility were tested using tensile and micro-scratch tests on samples of masonry blocks, limestone samples and aged metal surfaces**.** Field tests were initiated on individual historical facades across various locations in the city on the same materials to verify real-world performance and gather data regarding durability and ease of application.

Results

Preliminary results indicate that coatings infused with silica-based nanocomposite demonstrate exceptional moisture and contaminant penetration resistance while preserving the substrate's permeability. Polyurethane-based self-healing systems have been proven to extend service life, reducing overall maintenance needs by autonomously repairing minor damage. Field evaluations illustrated minimal cracking, peeling, or discolouration across substrates, underscoring these coatings' resilience to varying environmental conditions.

Conclusions

This study confirms the viability of modern coatings as essential components of conservation initiatives. With targeted formulations and successful field application, these coatings offer broad prospects for sustainable and economical preservation of historically and culturally significant structures.

sciforum-113352: A Highly Hydrophobic Siloxane-Nanolignin Hybrid Coating for the Protection of Heritage Wood

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Wood has been used as a construction material for small objects, furniture, and large-scale buildings since antiquity. The protection of wooden objects and wooden buildings of significant cultural heritage from water-induced decay processes is of great importance. In the present work, hybrid coatings consisting of Sivo 121 and nanolignin were produced and deposited onto chestnut (*Castanea sativa*) and oak (*Quercus frainetto*) specimens. Sivo 121 is an aqueous siloxane-based product which is used for wood protection, whereas nanolignin was extracted from beechwood.

The effects of the nanolignin concentration on the wetting properties and surface structures of the hybrid coatings were investigated and an optimal Sivo/nanolignin mass ratio was found for each wood species. This optimal ratio provided enhanced hydrophobicity, as demonstrated by the elevated contact angles (CAs) of water drops. The maximum CA of 145° was measured for coated oak, which is approaching the threshold of superhydrophobicity. However, the rose-petal effect was evident, with water drops remaining pinned even when the coated samples were tilted to a perpendicular position. Notably, the drops rolled off the coatings' surfaces when the coated wood samples were agitated.

The performance of the hybrid coating with the optimal Sivo/nanolignin mass ratio was evaluated through a series of tests. The coating caused only minor alterations to the natural colour of the two untreated woods (ΔE5) and offered very good protection against water absorption through capillarity. The results of the graveyard durability test highlighted the treatment's protective efficacy. Furthermore, the coating exhibited excellent chemical and mechanical stability, as confirmed by applying drops of various pHs and conducting the tape peeling test. Finally, the CAs of the coated chestnut and oak were monitored over time after placing the samples outdoors and within an artificially accelerated aging chamber. The results showed that the CAs remained stable over time, confirming the coating's durability.

sciforum-116796: A Multifunctional Coating for the Protection of Natural Stone

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Multifunctional coatings for the protection and conservation of built cultural heritage are extremely useful for addressing the several and different degradation mechanisms that develop and threaten natural stones, which are exposed to environmental conditions. This study presents the development of a nanocomposite coating, consisting of zinc oxide (ZnO) nanoparticles and a polysiloxane binder, designed to protect limestone heritage by integrating three key properties: extreme water resistance, self-cleaning, and antimicrobial action. According to images obtained by Optical Profilometry, nanoparticles play a crucial role in forming a hierarchical, lotus-inspired structure and increasing surface roughness that imparts enhanced water-repellent properties. Since water is a primary factor in the deterioration of natural limestone, achieving effective water resistance is essential for its preservation. Notably, the wetting properties of the polysiloxane–ZnO composite are comparable with the wettabilities of other composite superhydrophobic coatings, consisting of polysiloxanes and silicon oxide (SiO_2) nanoparticles, which were developed in the past. The polysiloxane selected herein serves two purposes simultaneously: first, it acts as a binder for the nanoparticles, and second, it contributes to the consolidation of the stone. ZnO was selected, instead of other nanoparticles (e.g. SiO_2), because it has photocatalytic and antibacterial properties. The self-cleaning scenario is demonstrated with experiments, which were conducted using methylene blue as a model contaminant. Moreover, it is shown that the suggested coating hinders the incubation of *E. coli* and *S. aureus*. Extensive experiments confirm that the designed coating exhibits excellent mechanical, chemical, and thermal stability.

sciforum-117141: Assessment of Colour Protectors and Fixing Primers for Preserving Contemporary Mural Artwork

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Muralism is becoming increasingly significant in the field of urban art and a symbol of a city's identity. The works are endangered by diverse factors including vandalism and meteorological agents, among others. Consequently, the necessity to find methods to lessen degradation such as fading or cracking emerges.

This study evaluated the physical, chemical and mineralogical changes in two acrylic fluorescent and four alkyd paints applied to concrete samples under different conditions: samples with a pre-coating and/or colour protectors (varnishes manufactured by Proa or Ega and commonly used to protect murals). Thus, six conditions (paint-only, paint with Proa, paint with Ega, paint with pre-coating, paint with pre-coating and Proa, and paint with pre-coating and Ega) were assessed. In addition, paints, concrete, and protective products were mineralogically and chemically characterized by X-Ray Diffraction (XRD) and Fourier Transform Infrared Spectroscopy (FTIR), respectively. A total of 36 samples were exposed to the QUV accelerated weathering test for 1512h, and throughout the test, colour monitoring was carried out. After the exposure period, a multi-analytical evaluation based on stereomicroscopy, contact angle measurement, peeling tests, XRD, FTIR and scanning electron microscopy coupled with energy-dispersive spectroscopy was conducted.

The findings suggested that the orange alkyd and fluorescent (orange and green) paints experienced the most noticeable colour changes while the green alkyd paints were the most resistant. Unexpectedly, the colour differences at the end of the test were not slowed down by the fixing primer. Using a colour protector might help preserve murals. Even though both protectors studied altered the original colour, Proa was the most effective in terms of colour reduction, but it caused more intense craquelure and the existence of tiny whitish Ti-enriched deposits.

sciforum-114187: Beautiful Moment, Do Not Pass Away!: How to Extend the Life of Decorative Exterior Coatings

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Can ensuring the longevity of decorative exterior coatings be as difficult a task as Goethe wrote *Faust*? The answer is probably not. Fortunately, more and more advanced auxiliaries and binders come to our aid. Moreover, the durability of coatings is significantly influenced by the pigments themselves and their compositions used during formulation. The key assumption of this project is to assess the probability of selecting raw materials and modifying topcoats subjected to aging tests under cyclically changing conditions (temperature, humidity and radiation) in order to maximally extend their usability, by maintaining, among others, colour and gloss. Thus, colour compositions based on two polyurethane binders dedicated to topcoats and pigments in shades of yellow, red and blue were tested. The change in colour, gloss, water contact angles, chemical structure (FTIR) and morphology (SEM) of coatings placed in climatic chambers and exposed to xenon lamps and/or UV were determined. It was shown that the factor with the greatest influence on the change in the performance parameters of coatings is UV radiation. The preservation of the decorative values of coatings also depended on the qualitative composition of the pigments used in each colour group. Changes in humidity and temperature had a slightly smaller effect. In all tests, the surface free energy value and the structure and topography of the coatings did not differ significantly. Based on the obtained results, cycles with a full spectrum of impact on the coatings were selected and ranked, from those causing the least degree of degradation to those showing the most negative impact on the usability of the coatings.

Acknowledgments: The research work was carried out under the project ColourTune CORNET/31/20/2022 entitled "*Tuning the colour of topcoats – method for selection of pigments and safeguarding colour stability"* funded by the National Centre for Research and Development.

sciforum-114119: Composite Edible Coating from Cassava–Arabic Gum Incorporated with Oregano Essential oil for Preservation Fresh-Cut Mango

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Mango (*Manguifera indica* var. Azúcar) is known for its distinctive aroma and flavor that contrast with a short shelf life due to the fruit being highly perishable; thus, it is necessary to find mechanisms that help us extend its shelf life. Currently, the use of biopolymers obtained from plant sources as biodegradable, renewable, and low-cost materials for food packaging, combined with the use of essential oils obtained from plant matrices, is capable of improving mangoes' antioxidant, antimicrobial, and barrier properties. We evaluated the effect of the application of a composite edible coating from cassava–Arabic gum incorporated with oregano essential oil for the preservation of fresh-cut mango. A composite edible coating was prepared with different concentrations of cassava hydrocolloids (4, 6, and 8% w), Arabic gum (1%), and oregano essential oil (0.25 and 0.5% v/v). The physical properties of the coating solution were analyzed (color, rheology, and microstructure). Then, the composite edible coating was applied by dipping fresh-cut slices of mango into it, and these were stored for 30 days. The water loss, pH, titratable acidity, total solids, and color were evaluated. The experimental data were adjusted to a zero-order kinetic model. The composite edible coating solution presented non-Newtonian shear thinning behavior described by the Carreau–Yasuda model. Coated mango pieces with the highest addition of essential oil demonstrated a decrease of up to 10% in water loss rate and improved preservation of total solids and acidity, leading to a lower difference in color (ΔE) compared to the uncoated sample for up to 30 days. The results suggest that the application of this coating can extend the shelf life of this minimally processed product.

sciforum-116678: Historic Paint Coatings Applied to Historic Fibrous Plaster

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Fibrous plaster is a historic material of great prevalence within theaters and auditoriums within the UK, but until recently it has been almost completely unresearched. With the partial collapse of the Apollo Theatre ceiling in 2013, there is growing interest in the safe conservation of fibrous plaster. This study investigates the architectural paint coatings originally applied to fibrous plaster sampled from five London theatres and auditoriums built between 1856 and 1919.

A rigorous analysis of the individual paint layers was conducted using carefully prepared polished cross-sections. The finishes applied were identified using state-of-the-art characterisation techniques, including digital microscopy, SEM imaging, SEM-EDX mapping, Raman spectroscopy, Fourier transform infrared spectroscopy, and water solubility testing. The investigations demonstrated that for 20th-century theatres, lead white oil paint has been shown to constitute their early finish history, whereas venues built before the turn of the century were originally decorated with other materials, including distemper, gold size, and gilding.

This is the first systematic research on architectural finishes originally used on fibrous plaster. The results provide important physical and chemical information relating to the coatings used, informing on the most appropriate conservation approaches. It provides a foundation upon which further investigation into this under-researched material can be based.

sciforum-114326: Development of Self-Cleaning Cementitious Panels with Nano-TiO_2 and Micro-ZnO: Aesthetic and Photocatalytic Impacts of Epoxy Resin Application

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Self-cleaning materials are highly relevant for exterior surfaces, such as building facades, and for heritage conservation by preserving the original aesthetic appearance of surfaces with minimal effort and cost. The transparency of these coatings is essential to maintain the visual integrity of existing surfaces. In this context, nanotechnology has emerged as a promising alternative, introducing innovations in coatings and treatments that provide water resistance, self-cleaning properties, and protection against biological attack. Despite their potential, implementing these coatings on cementitious surfaces poses challenges related to long-term stability and performance. Unfixed particles are susceptible to displacement by environmental factors such as rain, wind, and wear, compromising durability and reducing their ability to degrade pollutants and maintain clean facades. This study developed self-cleaning cementitious panels by incorporating TiO_2 nanoparticles and ZnO microparticles at varying concentrations, applied using two deposition methods: spray and dip-coating. Rhodamine B (RhB), an organic dye, was used as a model pollutant to assess self-cleaning performance by monitoring dye degradation during irradiation cycles under simulated sunlight. A spectrophotometric analysis was conducted using the CIELAB color coordinate system to measure chromatic variation and evaluate self-cleaning efficiency. The effect of epoxy resin as a particle immobilizer was also examined, focusing on aesthetic preservation and photocatalytic performance. The results showed that neither the photocatalytic coating nor the resin significantly altered substrate aesthetics, confirming their suitability for facades and heritage preservation. Additionally, photocatalytic coatings improved the surfaces' self-cleaning properties; however, a slight reduction in photocatalytic efficiency was observed with resin application, likely due to a decrease in the photocatalyst's active surface area. This highlights the need for further research into alternative resins or surface treatments that optimize particle fixation while maintaining high photocatalytic activity.

sciforum-114180: New Fire-Retardant Coatings for Modular Buildings

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The issue of fire protection for buildings is prevalent primarily in public buildings. The building products used must be flame-resistant or non-combustible, depending on their place of use.

The topic of this presentation concerns innovative coatings for the fire protection of structural elements used in modern modular construction in order to increase their fire safety.

The developed products for painting modular building elements allow for the passive fire protection of structural elements thanks to their ability to delay the ignition of materials covered with them by reducing the spread of flames.

One of the directions we have taken in obtaining fire-retardant paint products was to replace toxic halogen systems with systems based on phosphorus compounds, which allow for their safe use in public buildings.

The focus of this study was on transparent products with short curing times. Both 1K and 2K water-borne and solvent-borne products were selected for testing.

A 2K PUR varnish based on a modified acrylic resin, a 2K epoxy varnish based on a modified epoxy resin, and a water-based varnish based on an acrylic dispersion resin were developed. A 20% addition of active flame-retardant fillers (polyphosphate and polyols derivatives) was introduced to each product.

The obtained varnishes exhibited excellent resistance to open flame exposure. The tests were conducted using a test stand to examine the ignitability of products under the influence of a small flame, in accordance with EN ISO 11925-2:2020.

In conclusion, during the research process, transparent flame-retardant varnishes for wooden substrates, both water-borne and solvent-based, were successfully developed. Careful selection of active fillers as retardants allowed the creation of user-friendly, easy-to-apply, and environmentally friendly products with high fire resistance.

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sciforum-114341: New, Biobased Adhesion Promoters for UV Curing Coatings for Metal Substrates

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UV curing technology is widely used in the furniture, plastic and printing industries. An interesting application of this technique may also be in the future protection of cultural heritage, with a specific focus on metal artifacts. The growing interest in this curing technique is due to its numerous advantages, including low energy consumption, almost zero volatile organic compounds (VOCs) and fast production speed. The use of UV-cured coatings on metal substrates is still very limited, despite many advances made in recent years. The main problems are a lack of adhesion to the substrate or limited corrosion resistance.

The essence of this research is to develop a new method for obtaining and determining the properties of biobased, (meth)acrylated, acidic adhesion promoters. Based on the results of the conducted studies, the conditions for the synthesis process were selected, raw materials were selected for obtaining new biobased adhesion promoters and their properties were tested. The assumed structure of the obtained compounds was confirmed and their basic properties were determined. The use of raw materials from renewable sources to obtain new adhesion promoters was also justified due to issues of environmental protection and sustainable development. Traditional commercial adhesion promoters were also selected for comparative studies.

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Session 7. The Biomedical Application of Coatings

sciforum-114237: Assessment of Hydroxyapatite Coatings Doped with Silver and Strontium Through Galvanostatic Pulse Technique

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Introduction

Hydroxyapatite coatings are a rapidly expanding field that focuses on the addition of various elements to obtain tunable properties. The electrochemical techniques enable the assessment of coatings based on hydroxyapatite doped with various elements that promote cell growth and osteogenic differentiation while exhibiting antibacterial properties.

Methods

The aim of this study was to obtain hydroxyapatite-based coatings doped with Sr and Ag through the galvanostatic pulse technique. The electrolytes were obtained by subsequently dissolving in ultra-pure water of the following chemical reagents, $Ca(NO_3)_2{\cdot}4H_2O$, $NH_4H_2PO_4$, $Sr(NO_3)_2$, and $AgNO_3$ in different concentration with respect to a Ca/P ratio of 1.67. The electrolyte's *p*H was adjusted to 5. The coatings were characterized in terms of morphology, elemental and phasic composition, wettability, and roughness. Subsequently, the hydroxyapatite-based coatings were tested in vitro by evaluating their electrochemical behavior and their cellular response to preosteoblast cell cultures.

Results and Discussion

The galvanostatic pulse technique has allowed the development of uniform and compact hydroxyapatite-based coatings, undoped and doped with Sr and/or Ag, that registered a Ca/P ratio closer to 1.67. The XRD analysis highlighted hydroxyapatite as the main phase in all coatings. The contact angle analysis with simulated body fluid (SBF) showed that all coatings have a strong hydrophilic character, registering contact angles within 8° - 10°. The average roughness (Ra) registered values between 300 and 700 nm and a tendency toward a symmetrical topography. The best electrochemical behavior was registered by undoped HAp-based coatings. The studies regarding the response of the preosteoblasts indicated that these surfaces favor the adhesion and proliferation capacity of preosteoblasts, while the addition of Sr exerted beneficial effects on preosteoblast response, irrespective of the presence or absence of Ag.

Conclusions

Thus, the undoped and doped hydroxyapatite coatings with strontium and/or silver obtained at *p*H 5 denoted enhanced and tunable properties for medical applications.

sciforum-114145: Synthesis and Characterization of Biodegradable Antimicrobial Chitosan Coatings with Added Silver and Copper Nanoparticles for Biomedical Applications

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One of the most important reasons for the removal of biomaterials and implanted medical devices is post-surgical infection. Such complications cause an increase in morbidity and mortality rates worldwide, as well as having a strong economic impact, especially in countries with low budgets.

A measure to face this health problem consists of the design of antimicrobial coatings that fulfill two key functions: they must gradually release antimicrobial compounds while in the tissue environment and biodegrade over time. In this work, these needs were considered, and chitosan films were formulated with antimicrobial metal nanoparticles.

The antimicrobial activity of the films was tested against Candida albicans, Staphylococcus aureus, Pseudomonas aeruginosa and Acinetobacter baumannii. Inhibition achieved against C. albicans was 100% in both treatments; in the case of S.aureus, it was 77% in AgNP films and 93% in CuNP films; P. aeruginosa inhibition was 89% in AgNP films and 97% in CuNP films; finally, the inhibition of A. baumannii was 77% in AgNP films and 93% in CuNP films. A possible explanation for the higher antimicrobial activity of the CuNP filmscould be the fact that these films degraded over a 24-hour period, releasing the antimicrobial agent faster, while silver films remained intact. The proposed hypothesis is that microbial enzymes that degrade high-molecular-weight carbohydrates are dependent on the copper. This result can be very useful for the design of coatings whose rate of biodegradation can be controlled and whose antimicrobial activity increases in the presence of pathogens.

In the future, a burn or subcutaneous implant model will be used to evaluate the biocompatibility of chitosan films with nanoparticles. These models will help assess tissue response, healing effects, and potential toxicity, ensuring that the materials are safe and effective for biomedical applications.

sciforum-114337: Application of P4VP Polymer Brushes with Embedded Cu Nanoparticles as Antibacterial CSE Platforms

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We developed a cell sheet engineering platform based on poly(4-vinylpyridine) (P4VP) polymer brushes modified with metal nanoparticles (CuNPs) and evaluated their physicochemical properties and biocompatibility. The fabricated coatings exhibited antibiocidal activity and biocompatible characteristics, as well as thermoresponsive behavior, enabling temperature-dependent modulation of their properties.

The chemical composition and surface morphology of the coatings were characterized using atomic force microscopy (AFM), X-ray photoelectron spectroscopy (XPS), and scanning electron microscopy (SEM). Additionally, the release of CuNPs from the P4VP coatings was quantified through XPS.

The thermoresponsive nature of the coatings was verified by measuring water contact angles and collecting UV-Vis absorbance spectra as a function of temperature.

The antimicrobial properties of the CuNP-modified P4VP brushes were assessed through microbiological tests targeting contact- and release-based killing mechanisms, both of which demonstrated significant antibacterial efficacy.

To assess brushes' biocompatibility, protein adsorption onto the polymer brushes was evaluated using immunofluorescence and immunochemistry assays. Furthermore, retinal pigment epithelium cells (ARPE-19 line) were cultured on the fabricated coatings, and cell viability was analyzed using the MTT assay. The results indicated sustained cell viability over time, suggesting biocompatibility of the coatings.

The thermoresponsive behavior of the P4VP brushes facilitated the spontaneous detachment of ARPE-19 cell sheets upon cooling. Post-detachment observations confirmed maintained viability of the released cells.

In conclusion, our study demonstrates the feasibility of creating biocompatible, thermoresponsive polymer coatings capable of spontaneous cell sheet detachment. These antibacterial, thermoresponsive coatings hold promise for applications in cell sheet engineering platforms for therapeutic purposes.

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sciforum-115829: Innovations in Biomedical Coatings: Nanostructured and Biodegradable Solutions

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Abstract

The use of nanostructured and biodegradable coatings is of great importance in the field of biomedical engineering with regard to implantable medical devices, drug delivery systems and even controlled release mechanisms for medicine. These types of coatings utilize the advantages of nanotechnology to improve the surface properties of diverse materials, which include structures that are more compatible with biological tissues, enhanced mechanical strength, and functionalization. Coatings that include nanoparticles or nanofibers, for example, are referred to as nanostructured coatings. These coatings have enhanced antimicrobial properties, greater cell adhesion, and controlled release of drugs. Such characteristics make them suitable for the treatment of wounds, surgical implants, and tissue engineering scaffolds.

Some biodegradable coatings are fabricated from polylactic acid (PLA), polycaprolactone (PCL), and even chitosan, which reduce environmental impacts and do not require surgical extraction after application. They are especially useful in drug-eluting systems, where the degradation of the coating material after the process is used to ensure that controlled and sustained release of the drug is achieved, which dramatically increases the desirable therapeutic action and significantly decreases side effects.

It is also noteworthy that the merging of nanostructured features and biodegradable materials produces hybrid coatings suitable for stents, orthopedic implants, and biosensors, which employ composite materials with composite properties. These coatings also aid in early diagnosis and treatment through personalized medicine. As materials science and nanotechnology progress, the world's focus is on integrating the use of nanostructured and biodegradable coatings, which will surely help modern biomedical applications with their great innovations, safety, and improvements in patient treatment.

sciforum-113545: Carbon-Based Nanocoatings with Advanced Antimicrobial Performance

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Introduction

The development of advanced coatings can play a pivotal role in combating antimicrobial resistance infections and the severe threats they pose to modern societies. To this end, the presentation will focus on a new family of layer-by-layer antimicrobial coatings that capitalise on the electrostatic attractions between negatively charged Nafion and positively charged graphene quantum dots (GQDs) and graphene oxide (GO).

Methods

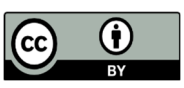
Quartz crystal microbalance is used to monitor the build-up of nanocoatings in real time. Zeta potential measurements, Fourier transform infrared spectroscopy (FTIR), atomic force microscopy (AFM), and contact angle measurements were used to characterise the materials that were also assessed with respect to their antimicrobial performance against *E. coli* and *S. aureus*.

Results

Nafion demonstrates superior chemical, thermal, and mechanical stability stemming from its Teflon-like backbone coupled with its long-range bacteria exclusion zone (EZ) associated with the presence of charged pendant groups. The chemical modes of the bactericide activity of GQDs and GO are related to the induction of membrane stress and the release of reactive oxygen species (ROS), as well as binding with DNA to restrain cell proliferation and arrest gene expression. The Nafion/GO and Nafion/GQD nanocoatings can effectively inhibit the growth of representative Gram-positive and Gram-negative bacteria by more than 99%, and this performance is not compromised following extensive thermal annealing.

Conclusion

In addition to their excellent antimicrobial performance, the nanocoatings combine a number of attractive characteristics including structural and chemical stability, non-toxic characteristics, superior UV barrier properties along with their waterborne, transparent, and colourless nature. The nanocoatings are able to withstand dry heat sterilisation and are ideal for surgical blades, surfaces used for food processing and storage, and packaging for cosmetics, drugs, and biological materials.



sciforum-113638: Cobalt Substitutes Beta-Tricalcium Phosphate in Nanocoatings to Increase the Pro-Osseointegration and Pro-Angiogenic Properties of Metallic Implants

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Tricalcium phosphate (TCP)-based nanocoatings are used in orthopedics as a bone substitute to favor osseointegration and vascularization processes. Cobalt ions are able to induce hypoxia and stimulate mesenchymal stem cells (MSCs) to produce the pro-angiogenic factor VEGF. Thus, cobalt-substituted TCP (Co-TCP) coatings, with different amounts of cobalt ions (0, 2, 5, 10 and 15 wt%), were realized through Ionized Jet Deposition.

Morphological and physico-chemical properties of the coatings were analyzed. The influence of deposition parameters, such as deposition temperature and amount of Co ions, on the properties were investigated. Fibroblast cells (L929) were cultured for 24-48 hours with material extracts to test the cytotoxic effects. Then, adhesion and proliferation of MSC directly seeded on the coatings were analyzed with also the evaluation of VEGF secretion, as representative pro-angiogenic factor.

All Co-TCPs could be deposited with a good chemical fidelity with respect to the targets, as observed by FT-IR and EDS analyses. Coatings were formed by globular aggregates. The use of 400°C as deposition temperature permitted us to obtain films with higher roughness and crystallinity degrees. Thus, this condition was used for the subsequent analyses. The films were hydrophilic and stable during medium immersion for up to 7 days. No significant cytotoxic effect was noticed on L929, which proliferated and were metabolically active. MSCs adhered and were able to proliferate from 24h up to 7d in all coatings. However, a lower area covered by MSCs was recorded for 15% Co-TCP coatings, a sign of cytotoxic effects due to the higher amount of Co ions. VEGF secretion by BM-MSCs increased significantly when cells were seeded on a 10% Co-TCP coating.

Based on these results, 5% and 10% Co-TCP coatings can be a possible solution for improving VEGF production, and they appear to be a promising tool for future applications.

sciforum-112119: Development of Biofunctional Textiles: Microencapsulation of Lemongrass Oil and Salicylic Acid for Dermocosmetic Applications

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Introduction

Textile finishes have long been used to add functional properties to fabrics. These functionalities can be applied to textile substrates in various ways. However, one of the most common approaches is through the use of microcapsules, which provide protection to the encapsulated active compounds against potential adversities. Microcapsules are widely employed in various fields, including textiles, pharmaceuticals, and cosmetics. In the textile sector, they are used in the development of biofunctional textiles, which serve as vehicles for transporting encapsulated actives, allowing them to come into contact with the skin and perform cosmetic or medicinal functions. This study introduces a novel textile finish based on microcapsules containing lemongrass essential oil and salicylic acid, produced via in situ polymerization—a unique combination not previously reported in the literature.

Methods

The microcapsules were characterized using scanning electron microscopy (SEM) for morphology, dynamic light scattering (DLS) for particle size, and Fourier-transform infrared spectroscopy (FTIR) for chemical composition. Loading efficiency, thermal stability (via thermogravimetric analysis, TGA), and free formaldehyde detection were assessed to ensure safety compliance. The microcapsules were applied to 100% cotton fabric using the pad-dry technique, with functionalization confirmed by SEM and TGA.

Results

SEM revealed an irregular morphology, while DLS indicated an average particle diameter of 1.95 µm. FTIR confirmed the chemical composition, and loading analysis showed 67.90 ± 1.41% lemongrass oil in the core. TGA and formaldehyde detection confirmed compliance with Brazilian Health Regulatory Agency (ANVISA) safety standards. Successful application to cotton fabric was validated by SEM and TGA, demonstrating effective functionalization.

Conclusion

The microcapsules produced via in situ polymerization show significant potential for dermocosmetic applications and textile functionalization. This study underscores the innovative potential of combining lemongrass oil and salicylic acid in microcapsules, paving the way for new cosmetotextile products and further exploration in this field.

sciforum-114618: Development of Ceramic-like Surfaces on Mg-Based Screw Implants for Orthopedic Application via PEO (Plasma Electrolytic Oxidation) Process

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Magnesium (Mg) and its alloys have recently arisen as promising biomaterials fulfilling the requirement of functional bone tissue support and aid to its regeneration. Permanent non-biodegradable implants such as titanium (Ti), cobalt–chrome, and stainless steel can cause inflammation, toxicity (infection), and sometimes improper bone healing. Thus, an additional or alternative surgical procedure is required to remove these implants from the body after the healing process. Mg shows bioresorbable, biodegradable, and biocompatible properties. Furthermore, it degrades without causing any toxicity, and henceforth, additional surgery can be avoided. Apart from its biocompatible properties, it also demonstrates good mechanical properties like low density and elastic modulus in the range compatible with bone structures [3].

Despite all the virtues of Mg, its swift corrosion rate and degradation in an in vivo atmosphere may cause early fracture before complete bone healing, greatly hindering its application as an implant material. Furthermore, gas evaluation due to fast degradation may cause encapsulating processes. To overcome such corrosion behavior, a refinement on Mg-based screw implants by a PEO (plasma electrolytic oxidation) process is developed, ensuring a dimensional stability of 2 months in a corrosive environment. The current work was accomplished under various PEO regimes to obtain the desired thickness and other essential properties best suited for Mg-based screw implants.

The microstructure, chemical composition, and surface properties of the PEO were investigated and compared via scanning electron microscopy (SEM) and energy dispersive X-ray spectroscopy (EDS). SEM/EDS analysis illustrated the morphology of PEO, the elemental/phase distribution, and the formed barrier layer at the substrate/oxide layer interface for different process parameters, drastically altering the corrosion behavior and mechanical properties. The corrosion resistance of various PEO surfaces was studied by using electrochemical analysis techniques such as electrochemical impedance spectroscopy in 0.9-wt% NaCl solution at 36°C. The results showed significant improvement in the corrosion behavior of PEO samples when compared with uncoated Mg surfaces.

sciforum-113020: Graft Copolymer of Cellulose and Saturated Polyester as a Compatibilizer in an Epoxy Composite

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Cellulose is a biopolymer of great interest for biomedical applications, providing increased rigidity and strength in polymer matrices, biocompatibility, and non–toxicity. However, the hydrophilic structure of cellulose leads to the aggregation of its particles in hydrophobic matrices. The presence of OH groups in the cellulose structure opens up wide possibilities for its chemical modification in order to improve compatibility. Most cellulose modification processes involve expensive toxic solvents, which helps to reduce the environmental friendliness of the process.

Graft copolymerization of cellulose and polyester resin based on sebacic acid was carried out by the method of mechanochemical activation, and a compatibilizer was obtained. The IR spectroscopy method shows the grafting of polyester to cellulose and selects the optimal amount of polyester for the complete interaction of the hydroxyl groups of cellulose. Epoxysmole was chosen as the matrix. Composites with different contents of graft copolymers of cellulose and polyester were obtained. The surface structure of the composites was analyzed using scanning electron microscopy. The uniformity of the filler distribution in the matrix and the uniformity of the structure were shown regardless of the amount of filler. The main physical, mechanical, and operational characteristics of the composites weredetermined. In comparison with the unfilled composite, the samples demonstrated an 8% increase in the strength of composites at a content of 0.5% and a 20% increase at a content of 1%; a significant increase was also observed in the modulus of elasticity (200% and 270%, respectively), and the deformation index increased with a low filler content, followed by a slight decrease. Thermal analysis of the composites did not show a noticeable decrease in the thermal stability of the samples.

Bisompatible and biodegradable graft copolymers of cellulose and polyester resin were obtained with the possibility of use in various polymer matrices for medical purposes.

sciforum-116328: Innovations in Needle Coatings: Reducing Tissue Trauma and Improving Accuracy in Medical Procedures

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Background

Needle penetration is crucial in various fields, especially in medical applications. Recent studies indicate that, in addition to size and point type, needle coatings significantly impact penetration forces. During needle insertion, the needle body directly contacts biological soft tissue, often leading to tissue adhesion and varying degrees of tissue damage. Therefore, coating needles can substantially reduce tissue trauma during insertion.

Methods

Optimizing the needle surface, particularly through coatings, can effectively address these issues. Various coatings, including biocompatible hydrophilic, metallic glass, silicone, and composite materials, have been studied. These coatings can reduce friction during insertion, minimize tissue adhesion, and decrease insertion and extraction forces.

Results

Coating surgical needles with a composite material (Polytetrafluoroethylene, Polydopamine, and Activated Carbon) reduced insertion and extraction forces, showing promising results with a reduction in insertion force by up to 49% and tissue damage by 39% in bovine kidney experiments. This coating also minimized tissue damage during percutaneous procedures. A biocompatible hydrophilic coating on a needle reduced tissue damage and adhesion during a puncture biopsy procedure. A silicone coating enhanced the durability and sharpness of surgical needles when passing through certain tissues, and a metallic glass coating on tattoo needles reduced skin trauma and improved tattoo quality.

Conclusions

These innovations in needle coatings show promise for minimizing tissue damage, improving precision, and promoting faster healing.

sciforum-114260: Natural Coatings as Promising Green Solution for Tailoring the Degradation of AZ91-Magnesium Alloy in Orthopedic Applications

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Mg alloys are promising materials for implants due to their biodegradability which can allow the gradual substitution of the implant with new bone. On the other hand, their degradation rate is actually too rapid to match bone regeneration, reducing their clinical application. Moreover, inflammation, pH rise and hydrogen development are often associated with Mg alloy degradation, representing a further obstacle. The aim of this research is the development of natural coatings able to tailor the degradation rate of AZ91 Mg alloy. Polyphenol-based coatings can also add anti-inflammatory and pro-osteogenic properties to the implant. AZ91 Mg alloy was considered as substrate in the form of plane samples or 3D porous structures (by a combination of 3D printing and investment casting). Aqueous solutions of tannic acid (TA) or green tea polyphenols (TPH) were used for the obtainment of natural organic coatings. The combination of the PEO (Plasma Electrolytic Oxidation) of the AZ91 substrate and subsequent polyphenol coating was also considered. The process was optimized to maximize coating homogeneity and absence of cracks. Soaking is a simple and suitable strategy for the treatment of various samples, including complex porous structures, thus assuring homogeneity. Continuous thin coatings were obtained with TA, but the presence of small (micrometric) cracks was evidenced on these surfaces. TPH coatings resulted in thicker layer, with a globular morphology and free of cracks. In static degradation studies (PBS soaking) pH and degradation control were reached more effectively for tannic acid coatings, compared to the TPH ones. On the other hand, TPH coatings resulted in more effective corrosion protection in electrochemical tests. Preliminary investigations showed the possibility of obtaining uniform thin TPH coating on PEO-coated AZ91 samples able to control pH rise and degradation in PBS. Tannic acid and Tea Polyphenols were successfully employed for the obtainment of natural organic coatings for degradation control in AZ91 Mg alloy for orthopedic applications.

sciforum-114128: Novel Composite Films Starting from Black Soldier Fly Protein Extract

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In the last decades, green biomaterials have been explored as alternatives to conventional petroleum-based polymers for applications in the health and food sectors [1]. Biomass-related proteins present intriguing biopolymers to be used as sustainable, biocompatible, and biodegradable building blocks to design innovative coatings and films [2]. Insect-derived proteins are a promising and novel building block for functional coatings. *Hermetia illucens*, commonly known as Black Soldier Fly (BSF), has the ability to convert organic waste into a valuable larval biomass. The latter is rich in proteins of high biological value and has gained attention mainly as animal feed [3]. In this contribution, BSF proteins are proposed as raw material for bioplastics due to their film-forming properties. The preparation of composite films based on BSF protein extract, along with their spectroscopic and mechanical characterization, is presented. Protein extraction was performed on defatted BSF larvae powder, using a modified method basedon Caligiani et al. [4]. A critical step for suitable dry-casted film formation was protein solubilization. The proper combination of sodium dodecyl sulphate (SDS) as surfactant and glycerol as plasticizer was evaluated based on tensile strength and strain tests. Infrared characterization demonstrated good film homogeneity. Preliminary experiments on the incorporation of antimicrobial zinc-based materials [5] for coating preparation were also carried out. In conclusion, our results demonstrate the potential of BSF proteins as a novel source for bio-based film preparations, opening the door to their use for diverse technological applications.

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sciforum-113641: Plasma-Deposited Polymer Coatings for Improved Biocompatibility of Titanium Implants

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The surface modification of titanium implants is essential for improving osteointegration and cellular contact, since untreated surfaces may result in fibrous tissue growth and an elevated risk of infections, hence diminishing implant efficacy. Plasma chemical treatment is an environmentally sustainable technique for applying polymer coatings to various surfaces, enabling meticulous regulation of surface characteristics. The integration of functional groups, including carboxyl and amino groups, enhances hydrophilicity and tissue contact, rendering these coatings particularly advantageous for biomedical applications. This study examines the impact of several plasma chemical treatments on the surface characteristics of titanium implants.

Plasma modification was conducted with the ZP-COVANCE-RFPE-3MP plasma system (13.56 MHz). Three therapy modalities were evaluated, commencing with plasma chemical activation in an Ar/O_2 environment (200 W, 10 minutes). In the initial mode, activated samples were submerged in a 25% collagen solution for one hour. The second approach entailed the deposition of amino groups by cyclopropylamine ($C_3H_5NH_2$) in a CPA/Ar plasma at 50 W. The third mode introduced carboxyl groups via a gas combination of Ar, CO_2, and C_2H_4 at 150 W. Plasma-deposited polymer films were examined utilizing SEM, EDX, XPS, FTIR, and WCA techniques. The adhesion and proliferation of mesenchymal stem cells were quantitatively assessed through fluorescence microscopy.

Plasma deposition yielded homogenous, well-adhered layers devoid of pinholes or fissures, as evidenced by SEM micrographs. Wettability assessments demonstrated a substantial enhancement, with an approximately 100° decrease in the contact angle in the optimal mode alongside notable stability. The coatings facilitated improved adherence and proliferation of mesenchymal stem cells.

Plasma treatment of titanium implants enhanced surface characteristics and biocompatibility. These findings underscore the promise of plasma-deposited polymer coatings for biomedical applications.

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sciforum-114086: Quorum Quenching on Titanium Surfaces: A Strategy to Reduce Virulence in Resistant Bacteria

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Bacterial resistance is a major healthcare challenge caused by the misuse of antibiotics, leading to ineffective treatments for infections. In orthopedics and dentistry, biofilm formation on implants exacerbates the issue. A promising solution is quorum quenching, which disrupts bacterial communication, with lactonase enzymes showing potential to prevent biofilm and combat resistance.

In this work, Ti6Al4V alloy disks were polished, cleaned, and chemically treated with acid etching and oxidation to prepare the surface (Ti6Al4V CT). After UV activation (Ti6Al4V CT+UV) and calcium treatment (Ti6Al4V CT+UV+Ca), surfaces were functionalized with ST1 lactonase enzyme solution using a concentration of 1000 µg/mL, creating a Ti6Al4V CT+UV+Ca+ST1 1000 sample.

The modified titanium alloy is biocompatible[1] and serves as an excellent platform for biological functionalization. Once confirmed that the enzyme functionalization was carried out through a zeta potential analysis, real-time quantitative PCR revealed that neither the enzyme nor the functionalized titanium samples exhibit traditional antibacterial properties. However, they effectively reduce gene expression related to quorum sensing and virulence factor production in *Pseudomonas aeruginosa*. Similar effects were not observed with *E. coli* and *S. aureus*.

This study demonstrates the potential of ST1 lactonase-functionalized Ti6Al4V alloys to combat bacterial resistance. These findings highlight the promise of quorum quenching as a strategy for biofilm prevention, particularly in implant applications.

[1]Surface modification of Ti–6Al–4V alloy for biomineralization and specific biological response: Part I, inorganic modification. (Ferraris et al., 2011)

sciforum-114330: Surface Finishing of As-Printed Additively Manufactured Ti6Al4V Meshes for Biomedical Implants

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Additive manufacturing (AM), especially titanium (Ti) alloys, enables the production of complex-shaped components with minimal material and energy waste, whose design and surface functionalization are critical for biomedical applications. However, as-printed titanium alloys often exhibit inherent defects, such as cracks and unmelted particles, resulting from the heating regimes during printing. These surface irregularities can significantly influence biocompatibility. Their biological impact remains poorly understood, emphasizing the need to address these defects to enhance cell–material interactions on titanium surfaces. In this study, the cytocompatibility of AM Ti meshes was evaluated after applying three surface treatments: chemical etching, electropolishing, and a combination of both. Surface features were characterized using scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS) to assess the removal of unmelted particles and changes in surface roughness. The results showed that chemical etching effectively removed unmelted particles, while electropolishing significantly reduced surface roughness. The combination of both treatments resulted in clean, uniformly smooth surfaces.

The cytocompatibility of the samples was assessed using the Prestoblue assay with the materials in contact with cells after 24 h, 96 h, and 168 h. After 15 days, cells were fixed and labelled for nuclei and actin staining to evaluate adhesion and spreading on the material surfaces. Cell adhesion to the surfaces was also analyzed by SEM/EDS. The findings revealed that all samples were cytocompatible. Nevertheless, the ones treated with the combined etching and electropolishing approach and electropolishing alone favoured the formation of a monolayer on the surfaces. These results confirm the effectiveness of the studied surface treatments in enhancing cell–surface interactions, underscoring their potential for biomedical applications.

sciforum-113659: The Development of Extreme Wettability Coatings to Combat the Spread of Bacterial Infections and their Testing in Hospital Conditions

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The use of materials with extreme wettability [1,2] may become one of the most promising strategies to combat the spreading of bacterial infections through touch surfaces not only in medical facilities but also in public areas, including educational institutions, supermarkets, and fitness centers. The extreme-wettability coatings have both a nonspecific bactericidal effect against various types of bacteria and several more specific mechanisms that work against certain strains depending on the type of metal. At the same time, such coatings are effective against various ways of spreading the bacterial cells, be it through the deposition of an aerosol created when patients cough or sneeze or through contact transfer via patients' hands. In this work, we will briefly summarize the existing strategies for producing materials with extreme wettability by aqueous media and overview their main characteristics. Then, the mechanisms behind the antibacterial effect of these materials will be discussed in detail, along with an analysis of some examples of testing the antibacterial efficacy of extreme-wettability surfaces in hospital settings. We will also discuss the prospects for the wider use of such antibacterial materials not only in medical institutions, but also in shopping centers, educational institutions, in transport, and other places characterized by increased risks of infection-related contact transmission. This will minimize human losses during the spread of future bacterial pandemics. In particular, a 22-week study [2] of extreme-wettability copper-coated high-touch surfaces in a hospital environment showed that the frequency of contamination with various microorganisms was 2.7 times lower than that of control surfaces.

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sciforum-118496: Unlocking the Potential of Flaxseed Oil: Innovative Coating Technologies and Blending Techniques for Enhanced Stability and Health Benefits

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Introduction

Plant-derived oils and fats are estimated to constitute at least 79% of annual global oil production. Flaxseed oil, which is rich in omega-3 fatty acids, has been linked to the prevention and reduction of several serious health conditions, including cancer, diabetes, atherosclerosis, hypertension, eczema, gastrointestinal disorders, and cardiovascular diseases. Despite its numerous health benefits, flaxseed oil is susceptible to oxidation. The process of extracting flaxseed oil from flaxseeds yields an equivalent to 32–45% of the seed mass, with the oil containing 55–57% alpha-linolenic acid (ALA) and 15–18% linolenic acid (n-6). Mixing flaxseed oil with other oils, such as olive and sesame, can create a balanced fatty acid profile while preserving oxidative stability. However, during storage, the peroxide and anisidine values of these oil blends tend to increase.

Methods and Materials

Microencapsulation techniques have been developed to enhance the stability and use of flaxseed oil in food products.

Results

Flaxseed, packed with alpha-linolenic acid, lignans, and fiber, provides multiple health benefits. A regular intake of flaxseed may enhance lipid metabolism, reduce hypertension, regulate blood sugar, and mitigate insulin resistance. Scientific studies focus on protective processing methods like coating milled flaxseed with Arabic gum, ascorbic acid, and hydrogenated fats to minimize its oxidation. Microencapsulation shields oxidation-sensitive compounds in foods, improving their stability. The key methods used in microencapsulation include physical (spray/freeze drying), chemical (interfacial polymerization/cross-linking), and physico-chemical (ionic gelation/coacervation) techniques. Incorporating flaxseed oil into zein films boosts their tensile strength and moisture resistance, while maltodextrin with sodium caseinate demonstrated the optimal encapsulation performance. These strategies enable the effective integration of flaxseed into foods while preserving their nutritional potency and absorption.

Conclusions

As a result, the food industry can develop functional products that harness the health-promoting properties of flaxseed oil while ensuring product stability and quality.

sciforum-117427: Multifunctional Synthesized Flavonoid Complexes for Novel Anticancer Drug Coating Applications

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Flavonoid-based compounds have attracted significant attention in cancer research due to their potent anticancer properties, including their antioxidant, anti-inflammatory, and anti-proliferative effects. However, their application is often hindered by challenges such as their poor solubility, low bioavailability, and instability under physiological conditions. The MET-EFFECT project (EU-funded under HORIZON-MSCA-SE-2021) aims to address these limitations and focuses on the development of novel multifunctional flavonoid complexes based on rhenium and iridium, with the aim of these serving as metallodrugs and homogenous catalysts. Additionally, the project will propose personalized drug design delivery systems using new green methodologies for valorization in order to improve the delivery and bioavailability of active constituents with potential anticancer properties. These coatings will be tailored to provide controlled release mechanisms that enhance the bioavailability of the active compounds and ensure their targeted delivery to cancerous tissues. The ability to immobilize these biofunctional molecules within films and coatings holds significant potential in advancing the field of drug delivery, enhancing therapeutic efficacy, and contributing to the development of next-generation anticancer therapies. Therefore, the MET-EFFECT project will offer a cutting-edge approach to overcoming the current barriers in cancer treatment by harnessing the power of novel flavonoid-based complexes incorporated into functionalized coatings, presenting a promising solution for localized drug delivery and improved therapeutic outcomes.

sciforum-113904: Advancing Sanitary Standards: The Role of Copper in Antimicrobial Materials

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Copper, widely recognized for its antimicrobial properties, has proven to be an essential material for reducing environmental contamination and preventing infections. Its antimicrobial action is based on the release of copper ions (Cu^{+} and Cu^{2+}), which destroy bacterial membranes and alter proteins and nucleic acids, ultimately resulting in cell death. Compared to other metals such as silver and gold, copper stands out for its high efficacy under various environmental conditions, its sustainability and its lower cost.

In the hospital setting, copper compounds have been shown to significantly reduce microbial loads on contact surfaces. Notable examples include waiting-room chairs with embedded copper nanoparticles and intravenous pools coated with paints containing copper-structured zeolite particles. In studies conducted in hospital environments, these interventions achieved reductions in viable microorganisms ranging from 50% to 73%, highlighting their effectiveness in preventing healthcare-associated infections, a critical issue in this sector.

Copper-based antimicrobial coatings have also been implemented in confined environments, such as detention cells. In these spaces, where hygiene conditions are limited, surfaces treated with copper-enriched paints achieved bacterial-load reductions ranging from 68% to 87%, including a notable decrease in airborne bacteria. This innovative approach underscores copper's potential to significantly improve sanitary conditions and reduce the spread of infections in environments with challenging maintenance needs.

Moreover, the integration of copper nanoparticles into polymer matrices represents a disruptive advance in the development of antimicrobial materials. These materials not only retain the mechanical properties of the base polymer but also maximize copper's biocidal effectiveness, providing versatile and durable solutions. In conclusion, copper continues to position itself as a key component in the design of advanced materials. Its applications in coatings, medical devices, and water-treatment systems stand out for their effectiveness and versatility in improving sanitary conditions in critical sectors.

sciforum-112777: Antibacterial Activity of Inorganic and Hybrid COATINGS based on SiO_2, TiO_2 and IrO_x

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Titanium-based materials are commonly used for biomedical applications, especially in the dentistry and orthopedic fields, as they are characterized by a wide spectrum of morphological, compositional, and functional parameters. The intensive development of reliable dental implants relies on certain features such as appropriate mechanical resistance, biocompatibility, and the ability to promote Osseo integration. The aim of the work was the identification of the key parameters for obtaining inorganic and hybrid materials coatings appropriate for biomedical application (i.e. dental implants) with intrinsic antibacterial activity. For this purpose, nanostructured TiO_2 modified with Au/Ag metal nanoparticles and lysozyme, coated on titanium foil was synthesized. Scanning electron microscopy (SEM), atomic force microscopy (AFM), X-ray diffraction (XRD), photoluminescence (PL), and UV–Vis spectroscopies were used to investigate the morphological, structural and functional properties of the resulting coatings. Several paths were studied as follows. Firstly, the singlet oxygen ($^1O_2$) generation by inorganic coatings exposed to visible light irradiation was carried out. Then, the antibacterial activity of the TiO_2/Ti, Au–TiO_2/Ti, and Ag–TiO_2/Ti was assessed. The lysozyme bioactivity for *Micrococcus lysodeicticus*, used as microbial substrate, was evaluated after its adsorption on Lys/TiO_2/Ti, Lys/Au–TiO_2/Ti and Lys/Ag–TiO_2/Ti inorganic surfaces. Finally, the enzymatic activity of the hybrids materials for the hydrolysis reaction of a synthetic organic substrate, 4-Methylumbelliferyl_-D-N,N0,N"-triacetylchitotrioside [4-MU-_- (GlcNAc)3], was emphasized by identifying the presence of a fluorescent reaction product, 7-hydroxy-4-metyl coumarin (4-methylumbelliferone)

sciforum-114270: Copper-Doped Hydroxyapatite-Based Coatings for Medical Applications

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The success of an implant depends on its osseointegration, while its long-term survival is determined by its resistance to bacterial infections. Titanium, commonly used for its mechanical properties and corrosion resistance, has limitations regarding its osteointegration and antibacterial efficiency [1,2]. The present work's aim is to functionalize the Ti surface with hydroxyapatite doped with copper, known for its antibacterial properties and ability to stimulate bone regeneration.

The coatings were obtained by electrochemical deposition of HAp on Ti and subsequent doping by an ion exchange method with a copper solution. The HAp deposition was carried out in pulsed galvanostatic mode at 75°C from two types of electrolytes: Ca nitrate and Ca chlorate salts. The coatings were characterized in terms of morphology, chemical and phase composition, surface roughness, and thickness. SEM images showed that the HAp coating morphology consists of ribbon-like crystals, irrespective of the electrolyte or the presence of Cu. The EDS analysis highlighted the presence of Cu ions and a (Ca+Cu)/P ratio between 1.54 and 1.59. In terms of coating thickness, it was noted that when chloride salts were used, the thickness was smaller than when nitrates were used. Cu addition to HAp resulted in a slight decrease in thickness, regardless of the electrolyte. XRD analysis confirmed the presence of the HAp phase and HAp coatings successfully doped with Cu.

In conclusion, it can be stated that hydroxyapatite-based coatings obtained through electrochemical techniques can be successfully doped with copper by using the ion exchange method.

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sciforum-114279: Eco-Friendly Alginate Films embedding Zinc Oxide Nanostructures: Assessing the Oral Bioaccessibility of Zinc in a Dynamic Mode Using a Fully Automatic flow-Through System

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Novel food packaging films based on biopolymers combined with antimicrobial inorganic nanostructures (NSs) have been developed to replace traditional plastics. However, little is known about their possible toxicity and oral bioaccessibility if accidentally ingested.

In this contribution, we studied the zinc bioaccessibility of ZnO NSs-modified alginate films, setting up a dedicated flow system utilizing sequential injection analysis (SIA) for its automatic evaluation over time through a dynamic approach mimicking human digestion by gastric fluid (GF).

Crosslinked ZnO NSs/alginate films were thus fabricated. NSs were prepared using an electrochemical–thermal method and added directly to the alginate solution. Films were formed by dry casting and crosslinked with Ca^{2+} solution. ICP-OES characterization was carried out to verify the real zinc content in the films before testing, as compared to the nominal mass content. An SIA system was designed to profile the temporal release of zinc ions from nanocomposites. The analysis started by pumping synthetic GF onto film pieces in a flow-through container under fluidized-bed conditions, and then, at fixed times, part of this fluid was automatically retrieved and mixed on-line with borate buffer and Zincon for in-line spectrophotometric detection. A sudden release occurred within the first 3 minutes of extraction followed by a more gradual release.

The proposed approach based on a dynamic extraction method using an automatic SIA system is deemed an interesting solution for the high-throughput assessment of metal ion bioaccessibility in antimicrobial-containing packages without using in vivo or in vitro cell tests. Moreover, it could be applied to other targets (e.g., plasticizers, antioxidant compounds) just by modifying the analytical method.

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sciforum-114272: Effect of Chitosan-Based Coatings with Bioactive Compounds from Tangerines Agricultural Waste on Cherries Shelf Life

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Agricultural waste is an invaluable source of natural compounds with remarkable properties that are often under-exploited while a number of industrial and biotechnological applications could be explored. The potential of citrus waste as a source of bioactive compounds with antioxidant and antifungal properties for the development of edible coatings for fruit preservation has been explored. Indeed, to contribute to the valorization of agricultural waste, the development of sustainable solutions for the management of plant wastes, the transition to a circular economy and to extend the shelf life of fruits, this study focused on the evaluation of bioactive compounds from Citrus agricultural waste, notably leaves and stems, as bioconservatives. Thus, the extracted bioactive compounds were incorporated in the formulation of chitosan-based edible coatings that have being tested on cherry preservation with or without prior fruit washing, and in single- or double-layer form.

Results on the effect of incorporating extracts into the chitosan-based film showed a positive impact on fruit quality during storage at 4°C. The coatings reduced mass loss and total soluble solids, while maintaining a pH around 4.

The encouraging results of this study pave the way for numerous research perspectives to further valorize agricultural waste and improve the performance of edible coatings.

sciforum-114106: Effect of Hybrid Hierarchical PEO/PLA Coatings on Corrosion Performance of Additively Manufactured Ti6Al4V in Simulated Body Fluid

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Plasma electrolytic oxidation (PEO) coatings and biodegradable polymers such as polylactic acid (PLA) present interest as drug-eluting systems for osseointegrated biomedical implants. Given the biodegradable nature of PLA, the coating system may induce crevices at one or more interfaces during degradation. Crevices are known to severely affect the corrosion performance of additively manufactured (AM) Ti alloys. Therefore, understanding the interactions between the PEO/PLA system and titanium alloys is crucial for enhancing the longevity of implants. This study investigates the corrosion of mill-annealed and AM Ti-6Al-4V alloys functionalized with porous hybrid hierarchical coatings comprising a ceramic layer produced by plasma electrolytic oxidation and one or more polylactic acid layers.

PEO coatings were formed using an AC power supply on wrought and DMSL-produced Ti6Al4V. PLA was applied on PEO-coated samples by dip-coating using the “breath figures” technique. Optical profilometry, scanning electron microscopy (SEM), X-ray diffraction (XRD), and energy-dispersive spectroscopy (EDS) were utilized to assess the topography, morphology, phase composition, and elemental distribution in the coated alloys. Corrosion performance was evaluated through DC and AC electrochemical tests, including potentiodynamic polarization and electrochemical impedance spectroscopy (EIS), conducted in a simulated body-fluid at 37 °C to mimic real-world conditions, including the presence of a controlled-size crevice.

The results revealed ~3.5-5.5 µm thick anatase- and rutile-based coatings enriched in several bioactive elements, at.%: 7.6% Ca, 5.76% P, 0.23% Zn, 1.5% Mg, 3.52 %Si. The ~2 µm thick PLA layer featured a 1-6 µm pore size and ~75000 pores mm^{-2}. The PEO coating helped in avoiding the localized corrosion of AM Ti6Al4V. The post-corrosion characterization also elucidates the role of biodegradable sealing layers in crevice formation.

In conclusion, the PEO/PLA system is a viable coating material for enhancing the durability of AM Ti6Al4V. This research provides a foundation for future studies aimed at exploring alternative biodegradable materials as drug-eluting media.

sciforum-114223: Experimental Design-Based Optimization of Bioactive Coatings for Sustainable Antimicrobial Applications

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The uncontrolled spread of infectious diseases has driven the development of innovative materials designed to control microbial transmission and combat harmful pathogens. In this context, inorganic materials have emerged as promising candidates for bioactive coatings, offering intrinsic antimicrobial properties, biocompatibility, and potential eco-friendly applications. However, in accordance with the atom economy and safety criteria outlined by the Green Chemistry Principles, it is essential to ensure the use of the minimal effective dose of antimicrobial agents. This approach minimizes potential toxic effects while optimizing antimicrobial action. Chemometric tools have proven invaluable in designing and refining experimental protocols to achieve these objectives.

This communication proposes innovative strategies for synthesizing and characterizing bioactive coatings based on nanostructured and hybrid inorganic materials. Specifically, two cases of study are presented, focusing on zinc oxide and silver phosphate nanostructures. These materials were synthesized using green electrochemical and precipitation methods and subsequently embedded in polymeric matrices, such as polyvinyl alcohol (PVA), to develop bioactive films via self-standing procedures. Special emphasis was placed on optimizing experimental parameters through chemometric tools.

The chemometric approach enabled the development of materials with reproducible and tuneable properties, ensuring a synthetic yield exceeding 85%. Comprehensive analytical characterization—including electron microscopy, spectroscopy techniques, and solubility studies—was performed to establish correlations between synthesis conditions, material properties, and their potential applications. The antimicrobial structures have nano- and microscale dimensions, and the composite films ensure a controlled release of the metal ions over time.

The findings highlight the potential of these bioactive coatings for industrial-scale production, addressing critical challenges in antimicrobial resistance and promoting sustainable material development.

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sciforum-117359: Gelatin–Chitosan Hydrogels with Encapsulated Essential Oils: A Novel Antibacterial Coating for Biomedical Applications

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Gelatin-based hydrogels incorporating chitosan-encapsulated essential oil microcapsules have emerged as promising antimicrobial materials for biomedical applications. These hydrogels offer a biocompatible and biodegradable platform with enhanced antibacterial efficacy against *Staphylococcus aureus* (Gram-positive) and *Escherichia coli* (Gram-negative) bacteria. Chitosan provides inherent antimicrobial properties while acting as an effective carrier for essential oils, ensuring controlled release and prolonged antibacterial activity. The hydrogel matrix typically consists of 5–15% (w/v) gelatin and 1–5% (w/v) chitosan, and crosslinking agents at 0.1–1% (w/v) are used to enhance mechanical stability. Chitosan acts as both a structural component and an antimicrobial agent while also serving as an effective carrier for essential oils. Essential oils such as peppermint (1–2%), clove (0.5–2%), cinnamon (1–3%), and ginger (1–1.5%) were encapsulated (essential oil-to-chitosan ratio: 1:3 to 1:5), and an encapsulation efficiency of 70–90% was achieved. The antibacterial mechanism is attributed to chitosan's electrostatic interactions with bacterial cell membranes and the sustained controlled release of bioactive compounds. The hydrogels also offer moisture retention, mechanical stability, and barrier protection, making them highly suitable for wound dressings, tissue engineering, and infection prevention. Recent studies have shown that gelatin–chitosan hydrogels incorporating essential oils not only enhance antibacterial efficacy but also support cellular proliferation and tissue regeneration. Therefore, due to their multifaceted advantages, the hydrogels represent a significant advancement in biomedical coatings. Further research is needed to optimize formulation parameters and evaluate long-term biocompatibility for clinical applications.

sciforum-114127: Surface Engineering of Ti6Al4V Alloys by BIOACTIVE coatings

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Surface engineering plays a key role in enhancing the performance of next-generation titanium-based implantable medical devices. Incorporating bioactive agents into protective coating offers a promising strategy to tailor surface properties to improve biological responses after implantation. This study aims to develop PMMA–silica coatings containing calcium and silver phosphates in the surface layer, acting simultaneously as an anticorrosion barrier and a bioactive layer. PMMA–silica coatings were synthesized by combining the sol–gel process of tetraethylorthosilicate (TEOS) with the radical polymerization of methyl methacrylate (MMA) and 3-methacryloxypropyl trimethoxysilane (MPTS). Bioactive agents, including hydroxyapatite (HA), β-tricalcium phosphate (β-TCP), and silver phosphate (Ag_3PO_4), were dispersed in the PMMA–silica solution. The coatings were deposited onto Ti6Al4V substrates by immersion, resulting in uniform layers with thicknesses of up to 17 µm, free of cracks and exhibiting excellent adhesion strength (>14 MPa). The influence of the additives on the structural properties of the nanocomposites was analyzed using infrared spectroscopy, X-ray photoelectron spectroscopy, X-ray diffraction, thermal analysis, and contact angle measurements. Electrochemical impedance spectroscopy conducted in simulated body fluid (SBF, ISO 23317) confirmed the excellent anticorrosion performance of the modified coatings, showing an impedance modulus of up to 70 GΩ cm^2 after 100 days in SBF, which is four orders of magnitude higher than that of uncoated Ti6Al4V. Additionally, apatite crystal deposits observed after 28 days of immersion in SBF are an indicator of the in vivo bone bioactivity of the coatings. Biological evaluations revealed enhanced proliferation of SaOS-2 osteoblasts after 7 days of culture on coatings containing β-TCP or HA combined with Ag_3PO_4. These results highlight the potential of modified PMMA–silica coatings as highly promising materials for improving the bioactive and anticorrosive properties of Ti-based implants.

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sciforum-114198: Surface Modification of Medium Entropy Alloys

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An orthopedic implant is a medical device designed to replace a bone, joint, or cartilage due to damage or deformity. Commonly used implants like Ti (110-120 GPa) and Co-Cr alloys (200-230 GPa) exhibit high elastic moduli, which can lead to 'stress shielding' which is a phenomenon that causes bone to weaken when the implant bears most of the load. In addition, release of certain metallic ions from these materials can provoke adverse tissue reactions. To combat these drawbacks, medium entropy alloys (MEAs) provide a variety of advantages in terms of lower elastic modulus (from single phase body centered cubic structure), improved corrosion resistance and superior biocompatibility. Surface modification of implant surfaces is highly demanding to render bioactive property to bioinert alloy surfaces. Among the various surface engineering approaches, hydrothermal technique is highly advantageous to improve osseointegration. However, reports associated with surface functionalization of MEAs are sparse in literature. The present work explores hydrothermal surface modification of $Nb_{30}Ti_{30}Zr_{30}Cr_5Mo_5$ based MEA for implant application. This talk delves deep into the structural aspects and surface characterization of these MEA with particular emphasis on the X-ray Photoelectron Spectroscopy (XPS) analysis) for pertinent implant application. This work holds promising aspects in understanding MEA surfaces and how the obtained information can be used for developing futuristic bioimplant surfaces.

sciforum-114053: Theoretical Assessment of Antimicrobial Properties of Silver Coating for Medical Applications

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Silver-based biomaterials have excellent antimicrobial properties, as shown by experimental studies on bacterial cultures, viruses, and fungi. The properties of silver nanoparticles have attracted attention around the development of materials that efficiently utilize these characteristics. Thus, silver has been incorporated into many medical products, such as anticancer agents, controlled-release systems, coatings for orthopedic materials and medical devices, as well as bandages, etc.

The aim of this study is to simulate the antimicrobial properties of silver coatings and observe the influence of the morphology and thickness of the silver layer on these properties. To achieve this, the variation in time of the silver concentration and the concentration of bacterial cultures in the selected medium (agar in a Petri dish) were monitored. In this study, the diffusion of silver ions through agar and their interaction with Gram-positive (S. aureus, S. epidermidis) and Gram-negative (E. coli, K. pneumoniae) bacterial cultures was simulated.

According to preliminary data, particles with cubic and spherical morphology exhibit the best antimicrobial properties, with a silver concentration above the minimum inhibitory concentration for both Gram-positive and Gram-negative bacteria. These results indicate the applicability of simulations as a preliminary method for determining the optimal parameters for designing materials with medical applications.

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