Coalesce Research Group

Joint Event

6th International Conference on

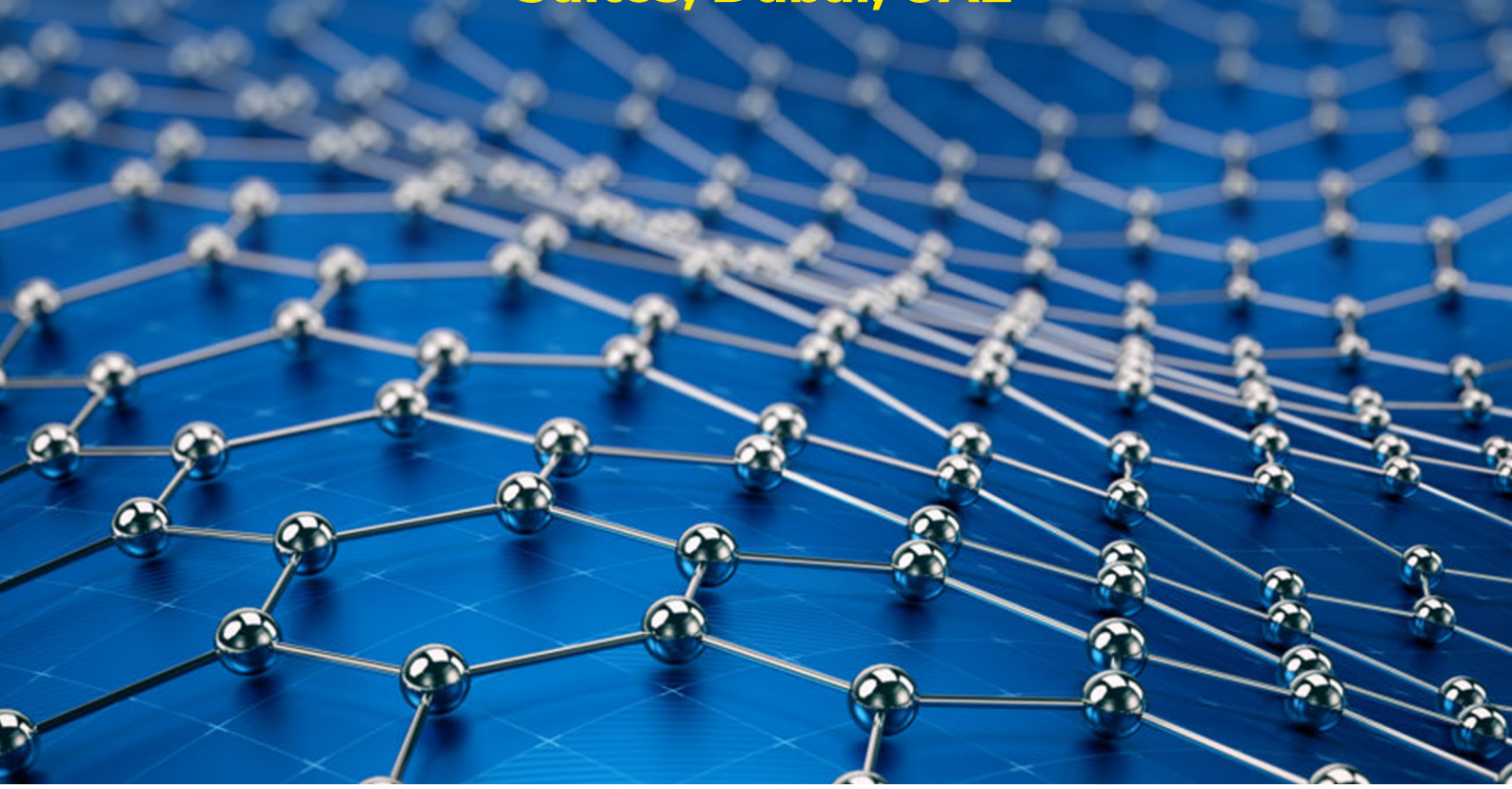
# MATERIALS SCIENCE & ENGINEERING

&

3rd International Conference on

# FUNCTIONAL MATERIALS AND CHEMICAL ENGINEERING

**November 09-10, 2022 | City Seasons Suites, Dubai, UAE**

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# *Scientific Program*

# Scientific Program

**Wednesday**
**November 09, 2022**

6th International Conference on
# Materials Science & Engineering
&
3rd International Conference on
# Functional Materials and Chemical Engineering

## Day 1 - November 09, 2022

**Hall Name: El Dhiyafa 2**

| | |
|---|---|
| 08:00 - 08:40 | Registrations |
| 08:40 - 09:00 | Introduction |
| | **Keynote Presentations** |
| 09:00 - 09:40 | Title: Rings and Chains: New Functionalized Polymeric Materials from Various Heterocyclic Monomers<br>**Helmut Ritter,** University Duesseldorf, Germany |
| 09:40 - 10:20 | Title: Robust Amphiphobic Property on Polymer Substrate for Electronic Devices<br>**Young-Rae Cho,** Pusan National University, Republic of Korea |
| 10:20 - 11:00 | Title: Advantages of Using Ultra-High-Performance Concrete in Modular Construction<br>**Raafat El-Hacha,** University of Calgary, Canada |
| | **Group Photo (11:00 - 11:10)** |
| | **Refreshments (11.10 - 11.30) @ Outside the hall** |
| | **Oral Presentations** |
| Chair | **Young-Rae Cho,** Pusan National University, Republic of Korea |
| Co - Chair | **Markus Brillinger,** Pro2Future GmbH, Austria |
| Sessions: | Materials Science and Engineering \| Materials Chemistry \| Functional Materials \| Nano Materials and Nanotechnology \| Advanced Energy Materials \| Surface Science and Engineering \| Biomaterials and Medical Devices \| Mechanical and Civil Engineering \| Metallurgical Engineering \| Ferrous and Non-Ferrous Materials |
| 11:30 - 12.00 | Title: Improved Corrosion Resistance of Oxide Sol-Gel Films Deposited on Zinc-Based Substrates<br>**Nikolai Boshkov,** Bulgarian Academy of Sciences, Bulgaria |
| 12.00 - 12.30 | Title: Decellularization of Full Heart—Optimizing the Classical Sodium-Dodecyl-Sulfate-Based Decellularization Protocol<br>**Reem S AL Hejailan,** King Faisal Specialist Hospital and Research Center, Saudi Arabia |
| 12.30 - 13.00 | Title: Comparative Chemico-Physical Analyses of Single GaAs/$Al_{0.3}Ga_{0.7}As$ Quantum Dot Photon Sources Grown by Droplet Epitaxy<br>**Inah Yeo,** Pusan National University, South Korea |
| | **Lunch (13:00 - 14:00) @ New Seasons Restaurant** |
| 14.00 - 14.30 | Title: Crystal Chemistry of Ti-Bearing Hydroxyapatites and Nature of Photocatalytic Activity of Ti-Modified Hydroxyapatite Materials<br>**Anatoliy Korneev,** Saint Petersburg State University, Russia |
| 14.30 - 15.00 | Title: Tree Gum-Based Functional Materials for Advanced Applications<br>**Vinod V.T. Padil,** Technical University of Liberec, Czech Republic |

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|---|---|
| 15.00 - 15.30 | Title: Highly Efficient Coalescence and Separation of Oil-In-Water Emulsion by Polyacrylonitrile Nanofibrous Membrane<br>**Yunpeng YUE,** Nagoya University, Japan |
| 15.30 - 16.00 | Title: Friction Stir Spot Welding of Al 6061 Alloy Synthesized Using Powder Metallurgy Route<br>**Vijay Navaratna Nadakuduru,** Malaviya National Institute of Technology Jaipur, India |
| 16.00 - 16.30 | Title: Nano Vs Macro: Small Size Does Matter<br>**Arkadii Arinstein,** Technion-Israel Institute of Technology, Israel |
| 16.30 - 17.00 | Title: The Microstructure and Mechanical Characterization of The Friction Stir Welded Joints with Respect to a Sampling Direction<br>**Sipokazi Mabuwa,** Cape Peninsula University of Technology, South Africa |
| | Networking & Refreshments (17:00 - 17:30) @ Outside the hall |
| 17.30 - 18.00 | Title: Effect of Standoff Distance on the Splat Formation of Flame Sprayed Polymer onto A Mild Steel Rough Surface<br>**Kadhim Al Amara,** University of Ras Al Khaimah, United Arab Emirates |
| 18.00 - 18.30 | Title: A Lyophilized Ready-To-Use Mix for The Real-Time Polymerase Chain Reaction Diagnosis<br>**Siyu Yang,** The Hong Kong University of Science and Technology, Hongkong |
| 18.30 - 19.00 | Title: Integration of Vision System into Laser Sintering Process<br>**Marcin Korzeniowski,** Wroclaw University of Science and Technology, Poland |
| 19.00 - 19.30 | Title: Application of Nanosecond Green Laser for Iron-Based Metallic Glassed Sintering<br>**Aleksandra Malachowska,** Wroclaw University of Science and Technology, Poland |
| 19.30 - 20.00 | Title: Corrosion Resistance of Virgin and Used Steam Line Pipes Made of Steel Grade MoV6-3<br>**Ljubica Milovic,** University of Belgrade, Serbia |
| 20.00 - 20.30 | Title: Dynamic and Real-Time Biometrics in Clinical Research<br>**Ayouba Diarra,** Data Consulting Group, Mali |
| | Day 1 Concludes |

# Scientific Program

**Thursday**
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| Day 2 - November 10, 2022 | |
|---|---|
| **Hall Name: El Dhiyafa 2** | |
| **Keynote Presentation** | |
| 09:00 - 09:40 | Title: Study of Mechanisms of Could Field Emission in CNT and Creation of CNT-Based Cathodes with the Help of Mechanical Bottom – Up Nano-Integration Base on Shape Memory Nano Tools<br>**Svetlana von Gratowski,** Russian Academy of Sciences, Russia |
| 09:40 - 10:20 | Title: Subcooled Liquid Printing – How to Increase Profitability of Additive Manufacturing by Scales?<br>**Markus Brillinger,** Pro2Future GmbH, Austria |
| **Refreshments (10.20 - 10.40) @ Outside the hall** | |
| 10.40 - 11.10 | Title : Thermal Heat Storage and Dissipating Behaviour of Phosphate Composites with House Decorating Materials<br>**Trilochan Swain,** Fakir Mohan University, India |
| 11.10 - 11.50 | Title: Intelligence: Attempting to Build a Bridge Between Artificial and Biological Domains<br>**Alessandro Chiolerio,** Istituto Italiano di Tecnologia, Italy |
| **Oral Presentations** | |
| Chair: | **Svetlana von Gratowski**, Russian Academy of Sciences, Russia |
| Co - Chair: | **Alessandro Chiolerio**, Istituto Italiano di Tecnologia, Italy |
| Sessions | Functional Materials\|Advanced Energy Materials\|Materials Science and Engineering \|Composite, Coating and Ceramic Materials\|Nano Materials and Nanotechnology\|Surface Science and Engineering\|Environmental and Green Materials\| Ceramics and Composite Materials \| Materials for Computing \|Functional Biomaterials\|Micro or Nano Materials |
| 11.50 - 12.20 | Title: Weldability of Additive Manufactured Components by Laser Powder Bed Fusion Process<br>**Shahram Sheikhi,** HAW Hamburg, Germany |
| 12.20 - 12.50 | Title: Bitter Gourd Pericarp Derived Porous Activated Carbon for High Energy Density Supercapacitor Devices<br>**M L Aparna,** Indian Institute of Technology Madras, India |
| 12.50 - 13.20 | Title: Influence of Heating Mode on Cyclic Temperature Range of An Ni-Ti Shape Memory Alloy During Partial Transformation Cycling<br>**G.Swaminathan,** Indian Institute of Technology Madras, India |
| **Lunch (13:20 - 14:10) @ New Seasons Restaurant** | |
| 14.10 - 14.40 | Title: Optical Studies of Near-Infra Red Emitting Agins and Agins/Zns Quantum Dots for Lateral Flow Assay Applications<br>**Ncediwe Tsolekile,** Cape Peninsula University of Technology, South Africa |

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| | |
|---|---|
| 14:40 - 15.10 | Title: Experimental and Finite Element Analyses of Metallic Materials Used in Marine Applications Subjected to Torsion Loading<br>**Saud Bader Amur Al Radini,** Military Technological College, Oman |
| 15:10 - 15.40 | Title: Photocatalytic Properties of Nanotitania to Inhibit the Growth of Gardnerella Vaginalis (GAVA)<br>**Ahmad Mukifza Harun,** Universiti Malaysia Sabah, Malaysia |
| 15:40 - 16.10 | Title: Degradation of the Mechanical Properties of Carbon/Epoxy Composite Materials Under Hygro-Thermal Aging<br>**Bachir Bouiadjra Bel Abbes,** University of Sidi Bel Abbes, Algeria |
| 16:10 - 16.40 | Title: Strengthening Reinforced Concrete Structures Using Carbon Fibre Reinforced Polymer<br>**Raafat El-Hacha,** University of Calgary, Canada |
| 16:40 - 17.10 | Title: Hydroxypropyl methylcellulose-copper nanoparticle and its nanocomposite hydrogel films for antibacterial application<br>**Radha Devi Pyarasani,** Universidad de Catolica del Maule, Chile |
| | Networking & Refreshments (17:10 - 17:20) @ Outside the hall |
| 17:20 - 17.50 | Title: Generalizing Rosenbluth's Algorithm to Include Along-the-Chain Intramolecular Energies<br>**Ebtisam A. Aldaais,** Imam Abdulrahman Bin Faisal University, Saudi Arabia |
| 17:50 - 18:20 | Title: A simplified technique to evaluate the strength and stiffness of a filament winding CFRP composite propeller hollow drive shaft: Comparison to a conventional high strength stainless steel alloy propeller shaft<br>**Ayman Yousef Saleh,** Military Technological College, Oman |
| 18:20 - 18:50 | Title: rGO Decorated Nanoparticles: An Advanced Catalyst for The Hydrogen Evolution Reaction<br>**Kishor Kumar Sadasivuni,** Qatar University, Qatar |
| 18:50 - 19:20 | Title: structure and Possible magnetic phase in Sn-doped $La_{0.67}Ca_{0.33}MnO_3$<br>**Zohra Ali Gebrel,** University of Sabratha, Libya |
| 19:20 - 19:50 | Title: Carbon Nano Fibre Infused Ultra-High-Performance Fibre Reinforced Concrete: Compressive Strength and Modulus of Elasticity<br>**Raafat El-Hacha,** University of Calgary, Canada |

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| Poster Presentations | |
|---|---|
| Poster 001 | Title: Environmentally Friendly Surface Films for Corrosion Protection of Galvanized Steel<br>**Nelly Boshkova,** Bulgarian Academy of Sciences, Bulgaria |
| Poster 002 | Title: Shaped-Controlled Nanocrystals with Carbon Dots-Based Co-Catalyst for Photocatalytic Hydrogen Production<br>**Hana Kmentová,** Palacký University Olomouc, Czech Republic |
| Poster 003 | Title: Properties of Oxidized Surface Layers Produced by the PDT Method on the $Zr_{48}Cu_{36}Al_8Ag_8$ Bulk Metallic Glass<br>**Piotr Błyskun,** Warsaw University of Technology, Poland |
| Poster 004 | Title: The Amine Plasma Polymer Coatings for Increasing Endothelization of Vascular Stents<br>**Solovieva Anastasiya,** Research Institute of Clinical and Experimental Lymphology , Russia |
| Poster 005 | Title: Electropulse and Furnace Sintering of a Tungsten-Based Powder Composition with Copper, Nickel And Iron Additives for Radiation Protection<br>**Vadzim Savich,** O.V.Roman Powder Metallurgy Institute, Belarus |
| Poster 006 | Title: Microstructure and Properties of Cobalt-Based Composite Powders Reinforced by Inclusions of Titanium Carbide Obtained by VIGA<br>**Aliaksandr Ilyushchanka,** O.V.Roman Powder Metallurgy Institute, Belarus |
| Poster 007 | Title: Surface Modification of the $Zr_{48}Cu_{36}Al_8Ag_8$ Bulk Metallic Glass in Glow Discharge Plasma Nitriding<br>**Krzysztof Kulikowski,** Warsaw University of Technology, Poland |
| Poster 008 | Title: Radiative Energy Transfer in Optically Bound Colloidal Quantum Dot Spheres<br>**Marios Sergides,** University of Cyprus, Cyprus |
| Poster 009 | Title: Flexible Hybrid Nanogenerator for Energy Harvesting and as a Self-Powered NH3 Gas Sensor<br>**Elhassen Cheikh Elhadrami,** Qatar University, Qatar |

Day 2 Concludes

Panel Discussion - Awards & Closing Ceremony followed by Vote of Thanks

# Scientific Program

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## Virtual Presentations

### Day 1 - November 09, 2022 BST

| | |
|---|---|
| 10.00 - 10.10 | Introduction |
| | **Keynote Presentations** |
| 10.10 - 10.40 | Title: Stereolithographic Additive Manufacturing of Functional Geometries<br>**Soshu Kirihara,** Osaka University, Japan |
| | **Oral Presentations** |
| 10.40 - 11.05 | Title: Comparing Different Strategies to Protect and Deliver Vitamin D3 for the Treatment of Psoriasis<br>**Marta Gallo,** Politecnico di Torino, Italy |
| 11.05 - 11.30 | Title: Research and Development of Water Electrolyzers Based on Ion Exchange Membranes<br>**Vladimir Fateev,** National Research Center Kurchatov Institute, Russia |
| 11.30 - 11.55 | Title: The 'Generalized Skettrup Model' and Lattice Thermal Capacity of Polymers<br>**Valeri LIGATCHEV,** Singapore |
| 11.55 - 12.20 | Title: Biopolymer-based Gold Nanoparticles for Wound Healing Applications<br>**Sathish Sundar Dhilip Kumar,** University of Johannesburg, South Africa |
| 12.20 - 12.45 | Title: Biomacromolecules as Matrix for Antimicrobial Nanocomposite Films: A Comparative Study<br>**Paolo Pino,** Politecnico di Torino, Italy |
| 12.45 - 13.10 | Title: Properties and Application of 3d Hybrid Nanomaterials: Polyhedral Oligomeric Silsesquioxanes<br>**Enrico Boccaleri,** DiSSTE-Università del Piemonte Orientale, Italy |
| 13.10 - 13.35 | Title: Kinetic, Isotherm and Thermodynamic Study of Mineral Ions Adsorption Using Strong Cation Exchange Resin for Water Softening<br>**Norhayati Abdullah,** Universiti Malaysia Pahang, Malaysia |
| 13.35 - 14.00 | Title: Materials Auscultation in Heritage Building<br>**Rubén Rodríguez Elizalde,** Universitat Oberta de Catalunya, Spain |
| | **Keynote Presentations** |
| 14.00 - 14.30 | Title: Manufacture Wafer Scale Low Cost and Environmentally Friendly Germanium Nanomembranes<br>**Abderraouf Boucherif,** University of Sherbrooke, Canada |
| | **Day 1 Concludes** |

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| Day 2 - November 10, 2022 | |
|---|---|
| **Keynote Presentation** | |
| 10:00 - 10:30 | Title: Stereolithographic Additive Manufacturing of Fine Ceramic Components<br>**Soshu Kirihara,** Osaka University, Japan |
| **Oral Presentations** | |
| 10.30 - 10.55 | Title: Metal Organic Frameworks Incorporated Ultrafiltration Membrane for Industrial Wastewater Treatment<br>**Norhaniza Yusof,** Universiti Teknologi Malaysia, Malaysia |
| 10.55 - 11.20 | Title: Carbon-Modified-$Tio_2$ in Water Decontamination: Photo-Reforming of Pollutants Using 2D and 3D Graphene-Based $Tio_2$ Nanomaterials<br>**Sin Yuan Lai,** Xiamen University Malaysia, Malaysia |
| 11.20 - 11.45 | Title: Improving the Reliability Design of Mechanical Systems Such as Refrigerator<br>**Seongwoo Woo,** Ethiopian Technical University, Ethiopia |
| **Poster Presentations** | |
| 11.45 - 12.00 | Title: Effects of Electron Beam Irradiation on the Hardness and Wear Resistance of PEEK<br>**Nurlan Almas,** Amanzholov University, Kazakhstan |
| 12.00 - 12.15 | Title: Evaluation the Safety and the Impact of Standard Antiviral Drugs on Kinetic of Antiviral Activity on the Early Stages of Viral Replication Cycle by Surface Plasmon Resonance Method<br>**Evdokiya Hikova,** Bulgarian Academy of Sciences, Bulgaria |
| 12.15 - 12.30 | Title: Computational Analysis of Heterostructures with Transparent Conductive Oxides for the Fabrication of Solar Cells<br>**Ana Cristina Carranza Sanchez,** University of Puebla, Mexico |
| 12.30 - 12.45 | Title: Quantum Kinetic Phenomena in Proton Semiconductors and Dielectrics<br>**Valeriy Kalytka,** Abylkas Saginov Karaganda Technical University, Kazakhstan |
| 12.45 - 13.00 | Title: Environmental Residential Architecture of Northern Kazakhstan<br>**Olga Semenyuk,** Gumilyov Eurasian National University, Kazakhstan |
| **E-Poster Presentations** | |
| 13.00 - 13.15 | Title: Reproduction Quality of Thermochromic Line Prints<br>**Katarina Itrić Ivanda,** University of Zagreb, Croatia |
| **Day 2 Concludes** | |

# *Day-1*
# *Keynote Presentations*

# RINGS AND CHAINS: NEW FUNCTIONALIZED POLYMERIC MATERIALS FROM VARIOUS HETEROCYCLIC MONOMERS

**Helmut Ritter**
*University Duesseldorf, Germany*

## Abstract

The lecture includes the preparation of functionalized materials from heterocyclic rings of different sizes. The synthesis and ring-opening polycondensation of e.g., sulfonamide-based bis-epoxides with alpha-aminocaprolactam are presented. The ring-opening polymerization of bis- and tris-cyclocarbonates with various amines, which are suitable for the production of dental filling materials, is also discussed. The application of lactones to prepare polymers with shape-memory effects is another example of the broad synthetic potential of heterocyclic monomers.

The lecture therefore refers equally to organic polymer chemists and materials scientists.

## Biography

Helmut Ritter born 1948 in Nieder-Roden, Germany. He is professor in Polymer Chemistry and Organic Chemistry for Students of Chemistry and Wored at 1972: Diploma of Chemistry, Philipps-University, Marburg, 1975: Promotion: Dr. rer. nat., Johannes Gutenberg University, Mainz, 1976 - 1981: Reseach and Developement in Industry, Bayer AG Uerdingen, 1982 -1997: C2-Professor "Organische Chemie" Bergische University, Wuppertal, 1989: Habilitation, Wuppertal, 1998-2001: C4-Professur, University Mainz "Organische Chemie", 2001 - Dec. 2014 (retirement): C4-Professur, Heinrich-Heine University, Düsseldorf "Organische Chemie and Makromolekulare Chemie". Research 500 publications and many patents in the area of Organic Chemistry of Polymers

# ROBUST AMPHIPHOBIC PROPERTY ON POLYMER SUBSTRATE FOR ELECTRONIC DEVICES

**Young-Rae Cho and Hyun-Soo Jeon**
*Pusan National University, Republic of Korea*

## Abstract

**Background:** Wettability related to amphiphobic property is one of the most important physicochemical properties of a solid surface. Due to the wide applications in the waterproof surfaces and self-cleaning property, the study on the amphiphobic property has attracted a great attention in both fundamental research and industrial applications.

**Objective:** Although amphiphobic coatings can repel both water and organic liquids, the poor mechanical and chemical stabilities significantly restrict their practical applications. To improve the poor mechanical and chemical stabilities of amphiphobic property on polymer substrate this work was processed.

**Methods:** We fabricated a hierarchical structure consisting a micro-pattern array on polymer substrate and nanostructure on it, which resemble the surface morphology of a lotus leaf. The surface was further modified by a low-surface-energy material. The coating possessed high repellency to different liquid droplets, including water, diiodomethane, ethylene glycol, soybean oil, etc.

**Results:** The coating with fluorination process on micro-pattern array presented an excellent self-cleaning property, and it performed well in a series of mechanical and chemical tests, such as water spraying, sand abrasion, and immersion test in alcohol.

**Conclusion:** Due to the excellent self-cleaning property, the contaminant on the surface was easily cleaned as the water droplet rolled off. These good performances and robust property on polymer substrate made the coating possible to be applied widely in various electronic device applications.

## Biography

Young-Rae Cho received his Ph.D. degree in Metallurgical Engineering from Stuttgart University, Germany, in 1994. He is a professor in the School of Materials Science and Engineering of Pusan National University. Former Dean, College of Engineering, Pusan National University. He is a member of The National Academy of Engineering of Korea. His research interests include surface modification, characterization of thin film, thin film processing, interface engineering, measurement of adhesion strength and surface energy, characterization of clad metals and materials for electronic devices.

# ADVANTAGES OF USING ULTRA-HIGH-PERFORMANCE CONCRETE IN MODULAR CONSTRUCTION

**Raafat El-Hacha and Oumaima Awassa**
*University of Calgary, Canada*

## Abstract

Modular construction is a procedure in which a structure is constructed off-site, under controlled plant conditions, and transported to the intended for assembling. This construction trend is based on using panel elements or full volumetric units. Modular construction has become increasingly popular, particularly in rural regions. In recent years, it gained considerable attention from the construction industry due to its positive impact on project constraints, preventing construction and demolition waste, and its numerous benefits over traditional construction techniques. Several studies have been conducted to quantify the possible advantages of modular construction. It was indicated that modular construction minimizes landfill waste, construction waste, delivery truck trips, noise and disturbance, and reportable accidents. Another comparative environmental study of modular construction concluded that modular construction could reduce resources, heath damage, ecosystem damage, and the consumption of timber and water. Although modular construction has a substantial environmental effect, the major advantage is the fast construction process. Despite the significant advantages, the private sector continues to rely mainly on the traditional on-site construction process that involves timber formwork, scaffolding, and in-situ concreting due to the challenges facing this sector.

Ultra-high-performance concrete is a cementitious composite material with a water-to-binder ratio of 0.25 or below, a compressive strength of 150 MPa or above, and a post-cracking tensile strength of at least 5 MPa. Its high compressive strength results from using a low water-cement ratio, eliminating coarse aggregates from the mix, and using admixtures, mostly high-range water reducers and pozzolansError! Reference source not found.. When fibres (usually made of steel or polypropylene) are added to the concrete, it is called ultra-high-performance fibre-reinforced concrete (*UHPFRC*). In addition to the superior mechanical properties, UHPFRC has a low environmental impact. Therefore, the use of UHPFRC can provide a green and sustainable solution for developing the next generation of bridges and buildings. Research indicated that UHPC has reduced impact on the ozone layer, has less potential to harm the environment, and produces fewer greenhouse gas emissions. The application of UHPFRC has been steadily rising in recent years due to its superior performance and ability to result in slender and lightweight structures. The main principle uses of UHPC are bridges, buildings, strengthening and retrofitting, and some special applications such as bridge overlays, windmills, canopy, and cross arms. However, no research so far has focused on the application of UHPFRC in the modular construction sector. Thus, the research herein aims to highlight the unique challenges and opportunities for implementing UHPFRC modular construction for faster construction and greener environment.

The main challenge facing modular construction is the handling and transporting the full module or the panel elements to the site to be assembled, and the module size might be restricted due to the

transit route and transportation technique, which in some cases makes it difficult and costly. Shipping limits are unquestionably the most significant barrier to the modular construction sector. Dimensional limits, load constraints, and possible delays owing to permit authorizations or customs concerns are among the challenges encountered throughout the shipping process. Size and load limitations will vary globally and across states and provinces. These constraints are especially concerning for the modular prefab business, which transports many of its house packages as preassembled parts. To meet these requirements, modular facilities may standardize product proportions, removing numerous possible design freedoms for architects and purchasers. Another challenge facing modular construction sector is maintaining structural integrity of the connection between the structural elements under optimum loading conditions.

Merging the fast construction technique with new innovative materials will help overcome modular construction challenges. UPFRC will result in slender and lightweight sections, ending with no transportation problem. The superior mechanical properties of UHPFRC will allow for better and more robust connections between structural elements. In addition, UHPFRC modular construction will potentially have lasting social, economical, and environmental benefits to the modular construction sector. socially, it will also solve the housing crisis in some communities, such as Northern Canada. Economically, UHPFRC modular Construction and technique will create direct savings. UHPFRC improves durability and service life, undoubtedly resulting in reduced lifecycle costs for maintenance, repairs, strengthening and replacement. The impacts of which results in lower cost and resources. Environmentally, UHPFRC modular construction will minimize the carbon footprint, landfill waste, and ecosystem damage.

Constructing long-lasting modular houses made with CNF-UHPFRC is considered an innovative and effective way to combine high-performance material with exceptional properties and features for sustainability, fast construction, and practical application. It's time to have the biggest revolution in the construction sector.

## Biography

Raafat El-Hacha, is a Professor of Structural Engineering at the University of Calgary in the Department of Civil Engineering, Canada. Dr. El-Hacha's pioneer research has been recognized as pushing the boundary of knowledge in using innovative and smart advanced materials for strengthening structures and new construction, such as fibre-reinforced polymers, shape memory alloy and ultra-high performance concrete for hybrid structural systems in bridge applications and other structures. He published over 250 journal and conference papers. Supervised and graduated 50 Ph.D. and MSc students. He is a Fellow of the International Institute for FRP in Construction (IIFC), the Canadian Society of Civil Engineers (CSCE), the American Concrete Institute (ACI), and the Engineering Institute of Canada (EIC). He received several awards and fellowships, including the CSCE Casimir Gzowski Gold Medal Award, CSCE Excellence in Innovation in Civil Engineering Award, IIFC President's Award, Killam Professorship Award, Erasmus Mundus International Fellowship and many others for his outstanding academic and professional achievements.

# *Day-1*
# *Oral Presentations*

# IMPROVED CORROSION RESISTANCE OF OXIDE SOL-GEL FILMS DEPOSITED ON ZINC-BASED SUBSTRATES

**Nikolai Boshkov[1], I. Stambolova[2], D. Stoyanova[2] and N. Boshkov[1]**

[1]*Institute of Physical Chemistry, Bulgarian Academy of Sciences, Bulgaria*
[2]*Institute of General and Inorganic Chemistry, Bulgarian Academy of Sciences, Bulgaria*

## Abstract

**Background:** Localized corrosion is very dangerous process which can cause serious economic and financial damage. One way to overcome it and to minimize its influence is the application of different types of protective coatings like hybrid, sol-gel, galvanic etc.

**Objective:** Aim of this investigation is to electrodeposit ordinary zinc and two Zn-based (*Zn-Ni and Zn-Co*) coatings with additional oxide sol-gel film of $TiO_2$ on the surface and to compare their protective electrochemical characteristics in a model medium of 5% NaCl which causes localized corrosion.

**Methods:** Generally, electrochemical methods are applied to evaluate the corrosion resistance and protective ability of the investigated coatings – Potentiodynamic (*PD*) polarization curves, Electrochemical Impedance Spectroscopy (*EIS*), Polarization resistance (*Rp*) measurements for a definite time period. Scanning electron (*SEM*) and Atomic force (*AFM*) microscopy are used for studying of the surface morphology of the coatings.

**Results:** The investigations are carried out in a model corrosive medium of 5% NaCl solution at ambient temperature with PAR 4 VersaStat device. The results show the positive influence of the substrate – zinc alloy Zn-Ni(10 wt.%) or Zn-Co(3 wt%) – on the corrosion resistance and protective ability compared to the case when the substrate is ordinary zinc.

**Conclusion:** The experimental data demonstrate that the application of selected alloying components for the ordinary zinc coating improves the corrosion resistance and protective ability of the system low-carbon steel / galvanic coating / surface $TiO_2$ sol-gel film in the presence of aggressive chloride ions.

## Biography

Nikolai Boshkov is Head of department "Electrochemistry and Corrosion" at the Institute of Physical Chemistry at Bulgarian Academy of Sciences. He has his expertise in the field of electrodeposition of different types of corrosion resistant coatings and multilayer systems etc. as follows: galvanic zinc and zinc-based coatings; hybrid coatings; nanocomposite coatings; conversion environmentally friendly layers; concrete and civil engineering; nanoparticles and nanotechnology.

*Joint Event*

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November 09-10, 2022 | City Seasons Suites, Dubai, UAE

# DECELLULARIZATION OF FULL HEART—OPTIMIZING THE CLASSICAL SODIUM-DODECYL-SULFATE-BASED DECELLULARIZATION PROTOCOL

**Reem S AL Hejailan[1], Futwan Al Mohanna[1], Tobias Weigel[2], Sebastian Schürlein [2] and Constantin Berger[2]**

*[1]King Faisal Specialist Hospital and Research Center, KSA*
*[2]University Hospital Würzburg, Germany*

## Abstract

**Background:** Compared to cell therapy, where cells are injected into a defect region, the treatment of heart infarction with cells seeded in a vascularized scaffold bears advantages, such as an immediate nutrient supply or a controllable and persistent localization of cells. For this purpose, decellularized native tissues are a preferable choice as they provide an *in vivo*-like microenvironment. However, the quality of such scaffolds strongly depends on the decellularization process.

**Objective:** The aim of this study was to identify an optimal decellularization protocol that requires less chemical treatment and process steps, facilitates the generation of a vascularized scaffold with cardiac-specific structures and microenvironment, enables long-term survival of a graft, and thereby paves the way for clinical use.

**Methods:** Two protocols based on sodium dodecyl sulfate or sodium deoxycholate were tailored and optimized for the decellularization of a porcine heart. The obtained scaffolds were tested for their applicability to generate vascularized cardiac patches.

**Results:** Decellularization with sodium dodecyl sulfate was found to be more suitable and resulted in scaffolds with a low amount of DNA, a highly preserved extracellular matrix composition, and structure shown by GAG quantification and immunohistochemistry. After seeding human endothelial cells into the vasculature, a coagulation assay demonstrated the functionality of the endothelial cells to minimize the clotting of blood. Human-induced pluripotent-stem-cell-derived cardiomyocytes in co-culture with fibroblasts and mesenchymal stem cells transferred the scaffold into a vascularized cardiac patch spontaneously contracting with a frequency of 25.61 ± 5.99 beats/min for over 16 weeks.

**Conclusion:** By optimizing the decellularization steps through reducing the exposure time of SDS, it is possible to mitigate negative effects on essential ECM proteins and biochemical cues. Therefore the successful generation of human cardiac tissue that was cultured for weeks as well as the functional vasculature with central access for connecting the tissue to a host's circulatory system will support the survival of the cardiac tissue when considered for clinical applications.

## Biography

Reem S AL Hejailan worked as a pharmacist for two years at King faisal hospital &RC . Then I started my scientific work by joining the research center Cell biology department 2004. I conducted several governmental funded projects of biological researched include; Diabetic research, cardiocvascular, research, and xentransplantation research. At 2010 I expanded my research to include tisshue engeneering. My main area of expertise is in cardiovascular tissue engineering, my PhD involved the establishment of vascularized cardiac tissue using human induced pluripotent stem cell-generated cardiomyocytes. Also, I worked as part of a team on many projects including international funds as 'Oxford Heart Project: Reversible model of Heart Failure'; and governmental Funds as ; 1) 'Myocardial infarct Model/Baboon: autologous Bone Marrow CD34+ Stem Cell Transplantation for Acute Myocardial Infarct in a baboon model'; 2) 'The use of rat embryonic stem cells in decellularized rat hearts' and 3) 'Aberrant sensing of extracellular Ca2+ by cultured ataxia telangiectasia fibroblasts'.

# COMPARATIVE CHEMICO-PHYSICAL ANALYSES 0F SINGLE GaAs/$Al_{0.3}Ga_{0.7}As$ QUANTUM DOT PHOTON SOURCES GROWN BY DROPLET EPITAXY

**Inah Yeo, Doukyun Kim, Kyu-Tae Lee, Jong Su Kim , Jin Dong Song , Chul-Hong Park and Il Ki Han**

*Pusan National University, South Korea*

## Abstract

The recent emergence of strain-free quantum dots (*QDs*) has resulted in a new design paradigm of nanophotonics. The light–matter interaction can be manipulated using the front-edge droplet-epitaxy (*DE*) QDs, helping us to realize QD single-photon source and fully integrated quantum photonics. This study presents precise control of the individual quantum confinement characteristics with respect to the composition profiles and geometrical shape asymmetries of GaAs/$Al_{0.3}Ga_{0.7}As$ DE QDs. By performing comparative analyses of atomic-resolution energy-dispersive X-ray spectroscopy, we have systematically resolved 2D in-depth chemical composition profiles of these individual samples. Using a 3D envelope-function model, we demonstrated precise control of the quantum confinement by capitalizing on the geometrical shape asymmetries in several experimental composition depth-profiles of DE QDs. We evaluated the individual quantum mechanical corrections to QD exciton states and their oscillator strengths using realistic potential profiles for the Al-interdiffused QDs. Additionally, we investigated the influence of anisotropic confining potentials on the quantum confinement properties of DE QDs to precisely control the exciton fine structures and the light–matter interactions precisely. The exciton oscillator strength can be increased to become approximately 7% for axial ratios of 0.25–1 by controlling the shape anisotropy of four types of Al-interdiffused DE QDs. Such precise engineering of strain-free QDs is crucial for their implementation as scalable solid-state qubits on an optical chip.

**Take away items**

- Our comparative atomic-resolution analyses of DE QDs provide a precise chemico-physical understanding and geometrical parameters to engineer defect-free and strain-free QDs.
- Using a 3D envelope-function model for the DE QDs, we elucidated significant quantum mechanical corrections ranging from 20% to 45% due to the different band structures of the Al-interdiffused QDs.
- The control of quantum confinement characteristics with practical QD composition profiles and geometries enable accurate control of the light–matter couplings, which links to the innovations in the nanoscale engineering of quantum materials and devices.

## Biography

Inah Yeo has a unique theoretical and experimental competency in the emerging field of hybrid electro-optomechanics as well as in resource (human and material) management. She performed the first demonstration of a monolithic solid-state hybrid system governed by a material strain in Grenoble, which was a promising new direction for the quantum optics joint team from Grenoble. She has developed strain-tunable QD SPSs using her multidisciplinary expertise consolidated from world-leading groups in the fields of quantum optics and quantum electro-optomechanics. Her hybrid scheme could shed some light on on-chip integrated QD networks for quantum information.

Joint Event
6th International Conference on
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# CRYSTAL CHEMISTRY OF TI-BEARING HYDROXYAPATITES AND NATURE OF PHOTOCATALYTIC ACTIVITY OF TI-MODIFIED HYDROXYAPATITE MATERIALS

**Anatoliy V. Korneev, Frank-Kamenetskaya OV, Kuz'mina MA, Ryabchuk VK and Murzin PD**

*Saint Petersburg State University, Russia*

## Abstract

**Background:** Ti-modified hydroxyapatite and its photocatalytic activity are under close attention of scientific society for more than 20 years. The material with biocompatibility of hydroxyapatite and photocatalytic properties of $TiO_2$ makes great interest from both fundamental and practical point of view. However, the nature of photocatalytic activity of Ti-modified hydroxyapatite is poorly studied.

**Objective:** To reveal patterns of $Ti^{4+}$ ions incorporation into hydroxyapatite crystal structure and clarify the nature of photocatalytic properties of Ti-modified hydroxyapatite.

**Methods:** Three series of hydroxyapatite powders were precipitated under various conditions from Ti-containing solutions, annealed at 700°C and studied by a wide set of methods including powder X-ray diffraction, IR and Raman spectroscopy, scanning electron microscopy and EDX. Photocatalytic properties of synthesized powders were estimated by diffuse reflectance spectroscopy and acetaldehyde decomposition reactions.

**Results:** Peculiarities of phase formation in Ti-containing solutions were studied. Regulations of unit cell parameters variations upon replacement of Ca and P by $Ti^{4+}$ in hydroxyapatite structure were revealed as well as concentration limits. It was shown that despite being single-phase by XRD data all powders contain amorphous or crystalline $TiO_2$ impurities that transform into crystalline state after annealing. Photocatalytic activity manifests only in systems containing anatase or rutile and exceptionally after annealing.

**Conclusion:** The study has refined concentration limits of $Ti^{4+}$ ions in various sites of hydroxyapatite crystal structure. The formation of $TiO_2$ impurities was found to be common and almost impossible to evade. The presence of $TiO_2$ in anatase/rutile modifications was found to be crucial for photocatalytic properties of resulting material.

The research was supported by President School 2022 grant №075-15-2022-831.

## Biography

Anatoliy V. Korneev is a PhD student of Department of Crystallography, St.Petersburg State University. Anatoliy V. Korneev is enthusiastic on biomineralization and biomedicine generally and on hydroxyapatite crystal chemistry and properties particularly. His PhD research, which he does under the guidance of Professor Olga V. Frank-Kamenetskaya, is devoted to crystal chemical design of hydroxyapatite-based materials. Using complexed crystal chemical approach and wide set of instrumental methods he is aiming to directionally vary the physical properties of hydroxyapatite by incorporation of various ions into its structure Anatoliy V. Korneev has a rich experience in powder diffraction techniques and vibrational spectroscopy and is aiming to master new methods of materials studies.

# TREE GUM-BASED FUNCTIONAL MATERIALS FOR ADVANCED APPLICATIONS

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## Abstract

Green and sustainable chemistry involves the strategy, progress, and execution of chemical products and processes to diminish and eradicate the use and generation of substances hazardous to human health and the environment. In this context, biopolymers or polysaccharides accomplish these conditions as a renewable source of materials possessing exclusive combinations of functionalities with proven potential usefulness to fabricating bio- based products (sponges, films, or fibers) for many potential applications1. Carbohydrate gum sourced from biogum tress is an important food additive and cradles potential non-food commercial products. The current paper exemplified their prospective commercial produces such as sponges, fibers, and films via various fabrication techniques such as self-assembly freezing drying methods, electrospinning, and solution casting. Furthermore, this article has comprehensively deliberated by exploiting the biogum-based sustainable products for environmental remediation (adsorption/catalysis/or filtration), shopping carrier bags, food packaging films, and rewritable noting pads. The improvement of the gum-based materials' physicochemical, mechanical, and barrier properties with other inorganic, organic, or nanoparticles as additives have also been discussed. The sustainable gum-based products and their morphological, structural, and mechanical attributes were embodied by scanning electron microscopy (*SEM*), transmission electron microscopy (*TEM*), nuclear magnetic spectroscopy (*NMR*), Fourier transform infrared spectroscopy (*FTIR*), Raman spectroscopy, X-ray diffraction techniques (*XRD*), and UV-vis spectroscopy.

A comparison of an assortment of films was prepared based on pristine gums, DDSA (dodecenyl succinic anhydride)-modified gums, and clay-coated and protein incorportated gum. Their physicochemical, mechanical, thermal, and barrier properties were assessed. The introduction of a spray-coated waterborne large-aspect ratio sodium-hectorite thin coating on tree-gum films ensured very high barrier properties even at high relative humidity conditions (OTR = ≈1.7 $cm^3$ $m^{-2}$ $day^{-1}$ $bar^{-1}$ at 75% relative humidity). The oxygen barrier property of the clay-coated nanocomposite films was superior to the several commercials, conventional plastics and was comparable to the high-performance packaging films. A highly porous, lightweight composite sponge was fabricated using tree gum with sodium alginate[2].The surface modification of the material was accomplished via a feasible chemical vapor deposition method using *TCMS* (trichloromethylsilane), which endowed the sponge with hydrophobic and oleophilic properties without altering microporous structure and porosity. The modified bio- sponge exhibited appreciable oil/water selectivity and high absorption capacity for a wide variety of oils and organic solvents (up to 43 g/g) compared to the absorption capacities reported for many other biomass-derived sponges. Subsequently, it shows good mechanical integrity and excellent reusability up to 10 cycles with diesel absorption retention of 91% compared to the first cycle. Thus, these bio-based sponges are highly promising as absorbent materials for oil spill control and environmental safeguard.

Finally, the recyclability, regeneration, and biodegradability of the developed gum-based functional products have also been demonstrated. The present research inclusively encompasses their strategic non-food applications comprising emerging topics of research interest such as environmental bioreme-

diation, energy storage/harvesting, and food packaging with a commentary on their prospects for this burgeoning field. The research aimed to develop economic, biodegradable, and recyclable gum-based 'green' products for a sustainable way to help our society.

**Acknowledgement:** The authors would like to acknowledge the assistance provided the "Inter Excellence Action Programme" within the framework of the project "Bio-based Porous 2D Membranes and 3D Sponges Based on Functionalized Tree Gum Polysaccharides and their Environmental Application" (registration number LTAUSA19091) – TUL internal No.: 18309/136, supported by the Ministry of Education, Youth and Sports of the Czech Republic. This work was also supported by the project- Hybrid Materials for Hierarchical Structures (HyHi, Reg. No. CZ.02.1.01/0.0/0.0/16_019/0000843) financed by the Ministry of Education, Youth and Sports of the Czech Republic, and the European Union-European Structural and Investment Funds in the framework of the Operational Programme Research, Development and Education

## Biography

Vinod V.T.Padil is a Senior Scientist and woring at Institute for Nanomaterials, Advanced Technologies and Innovation (C(I), Technical University of Liberec (TUL), Czech Republic

# HIGHLY EFFICIENT COALESCENCE AND SEPARATION OF OIL-IN-WATER EMULSION BY POLYACRYLONITRILE NANOFIBROUS MEMBRANE

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*Nagoya University, Japan*

## Abstract

**Background:** Oil-in-water (*O/W*) emulsions are widely found in industrial wastewater, and oil separation is essential to meet environmental standards. Coalescence separation is an energy-saving method to separate and reuse oil from *O/W* emulsions. However, traditional coalescers are generally considered unsuitable for separating emulsions containing fine oil droplets smaller than 10 μm.

**Objective:** To find out the continuous separation performance of nanofibrous membrane coalescer for the minute oil droplets of 10 μm or less.

**Methods:** Dodecane with high dispersion stability was selected as the oil model and an *O/W* emulsion was prepared using an ultrasonic homogenizer. The polyacrylonitrile (*PAN*) nanofibrous membrane with a fiber diameter of 400 nm and a porosity of 83% was used as the coalescer. The surfactant-free and surfactant-stabilized emulsions were passed through the coalescer at different flow rates. The pressure drop, the oil concentration, and the droplet size distribution were analyzed at set intervals.

**Results:** A decrease in turbidity was visually observed as the emulsion flowed through the coalescer and oil droplets of several millimeters were obtained from the outlet liquid. Moreover, the separation ratio improved with the rise in flow rate, achieving a separation ratio of about 99.9% at 30 to 80 mL/min. Additionally, the separation ratio maintained more than 99.9% even for long-term experiments with a steady pressure drop smaller than 25 kPa.

**Conclusion:** The *PAN* nanofibrous membrane could coalesce and separate emulsions consisting of fine oil droplets smaller than 10 μm for continuous separation.

## Biography

Yunpeng Yue is a 2nd year Ph.D. student at the Graduate School of Engineering, Nagoya University and he is also an Interdisciplinary Frontier Next Generation Researcher of Nagoya University. He received his Master's and Bachelor's Degrees from Donghua University. In his master thesis, he developed a portable in-situ electrospinning device that is aiming for the fabrication of wound dressing material directly on the human skin surface. And by which, he developed waterproof, breathable, and antibacterial ethanol-soluble polyurethane fibrous membranes. Now, he is focusing on the fabrication and functionalization of nanofibrous membranes and the coalescence separation of oil-water emulsion by nanofibrous membranes.

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# FRICTION STIR SPOT WELDING OF Al 6061 ALLOY SYNTHESIZED USING POWDER METALLURGY ROUTE

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*Malaviya National Institute of Technology Jaipur, India*

## Abstract

**Background:** Powder metallurgically processed components are becoming increasingly attractive as substitutes for wrought and cast materials in various applications. However, it is possible to increase further the use of powder metallurgy (*PM*) by enhancing the ability to manufacture complex geometrical configuration by joining *PM* parts to one another or to other cast/wrought products. The welding of metal parts synthesized using *PM* route is a bit challenging as compared welding of as cast, rolled and forged parts due to the presence of low inter particle bonding in some cases and also porosity in their microstructure. The amount of the porosity is expected to be controlled by several processing variables such as type of powder particles with respect to their size, shape and also green density of the compact. On the other hand, the type of consolidation technique used to produce the bulk material also plays an important role in improving the quality of the material.

**Objective:** To study the feasibility of friction stir spot welding of Al 6061 alloy discs synthesized using powder metallurgy route

**Methods:** In the present study friction stir spot welding (*FSSW*) has been used to join two Al 6061 circular discs of 2 mm thickness and 30 mm in diameter synthesized using an innovative method via powder metallurgy route. The spot welding of aluminium alloy 6061 discs was done at tool rotation speed of 700 RPM.

**Results:** The load bearing capacity of friction stir spot welded Aluminum 6061 alloy 490 N. Finer grain-size was observed in samples produced by PM route compared to that of as-cast alloy of same composition. Grain refinement is also expected to impart higher hardness to the spot-welded samples. In comparison to as-cast alloys, a reduction in the width of thermomechanical affected zone (*TMAZ*) was also observed in the *FSSW PM* processed Al 6061 alloy. Higher hardness values observed in the *FSSW PM* processed Al 6061 indicates that superior quality of joint as compared to that of *FSSW* welded section of sheets produced by conventional route.

**Conclusion:** The study demonstrates feasibility of welding Al 6061 alloy using friction stir spot welding, Friction stir spot welding can be advantageous as they involve compression, which tends to close pores in the weldment, this process can be promising especially in those applications which involve *PM* parts.

## Biography

Vijay Navaratna Nadakuduru is presently working as an Assistant Professor in the Department of Metallurgical and Materials Engineering, Malaviya National Institute of Technology Jaipur, India. Over the years he has been involved in the Development of Advanced Materials using Powder Metallurgical Processing, Standardizing the Laboratory Practices, Teaching as well as Documentation & Peer Reviewed Publications. He is resourceful in deploying methodologies to analyze various material processing techniques and their characterization which include microstructural analysis and mechanical testing. An academician having the distinction of being associated with numerous Scientific Seminars, Presentations, Workshops, Conferences as well as publishing of a plethora of Articles & Papers. His areas of expertise include Mechanical working of metals, Powder metallurgy mainly powder processing and consolidation, Synthesis and characterization of Ultrafine and Nanostructured materials, Shape Memory Alloys, Light Alloy Materials, Friction Stir Welding of Automobile Materials

# NANO *vs* MACRO: SMALL SIZE DOES MATTER

## Arkadii Arinstein

*Technion-Israel Institute of Technology, Israel*

## Abstract

Some open problems concerning polymer materials of reduced sizes and dimensions, are discussed. Such objects exhibit exceptional physical properties when compared with their macroscopic counterparts. The lecture will focus on the mechanical and thermodynamic properties of polymer nanofibers fabricated through electrospinning which have attracted much attention recently because of their unique features. More specifically, electrospun polymer nanofibers demonstrate so-called "size-dependent behavior" when thermo-mechanical proper-ties of material start to depend on fibers diameter, if their diameters are enough small. For example, abrupt increases in polymer nanofiber elastic modulus have been observed when diameters drop below a certain value. The thermodynamics properties of polymer nanofibers also demonstrate size-dependent behavior. For example, the temperature dependence of elastic modulus is highly influenced by fiber diameter, a shift in the glass transition and melting temperatures is observed, etc. Mechanical (macroscopic) analyses have failed to provide satisfactory explanations for the mechanisms ruling such features, calling for detailed microscopic examination of the systems in question. A hypothesis bridging the current knowledge gaps is presented. The key point of the proposed speculations is based on confinement concept: it is assumed that size-dependent behavior is related to confinement of non-equilibrium supermolecular micro-structure of electrospun polymer nanofibers which is being formed during their fabrication.

Finally, a brief review devoted to the history of the electrospinning method elaboration and development is presented.

## Biography

Arkadii Arinstein received his MSc in Theoretical Physics from Tomsk State University in 1977 and PhD degree in Theoretical and Mathematical Physics from the Landau Institute for Theoretical Physics of the USSR Academy of Sciences in 1982. For many years he worked in the Semenov Institute for Chemical Physics of the Russian Academy of Sciences in Moscow where received DSc (habilitation) degree in Chemical Physics in 1995. In parallel, A. Arinstein was teaching in Moscow State Technological University "STANKIN" where he got in 1999 the Full Professor's rank with government certificate. From 2006 A. Arinstein is the Research-Professor Associate at the Technion - Israel Institute of Technology. A. Arinstein was awarded a few honors, such as: the state grant for outstanding scientists of Russia (1995); the annual Vinogradov Prize awarded by the Vinogradov Society of Rheology (2019); the Fellow of International Association of Advanced Materials (2020).

# THE MICROSTRUCTURE AND MECHANICAL CHARACTERIZATION OF THE FRICTION STIR WELDED JOINTS WITH RESPECT TO A SAMPLING DIRECTION

**Sipokazi Mabuwa, Velaphi Msomi and Ncediwe Ndube – Tsolekile**
*Cape Peninsula University of Technology, South Africa*

## Abstract

**Background:** The friction stir processing technique has been successfully used as a joint property modifying technique for both fusion and solid-state joints. In this study, the AA8011-H14 and the AA6082-T651 plates were joined together using the friction stir welding (*FSW*) technique at room temperature.

**Objective:** To examine the microstructure and mechanical characterization of the friction stir welded joints with respect to a sampling direction.

**Methods:** The tests conducted included microstructure, microhardness, tensile testing and fractography. The specimens for the mentioned tests were extracted longitudinally and transverse to the welding direction. This was done to identify the best-preferred sampling direction.

**Results:** The results obtained from both sampling directions showed distinctively microstructural patterns, with the transverse illustrating onion ring traditional patterns and the longitudinal showing sandwich-like layers. When it come to average grain sizes, there was a very minimal difference falling within the range of 20.953 to 26.249 μm. The hardness was found to have a similar pattern. However, the tensile strength of the longitudinal joints was found to be approximately 130 MPa, while the transverse joints have a maximum of 84.444 MPa. Regardless of the specimen sampling direction, all the fractography revealed a ductile failure mode.

**Conclusion:** The longitudinally sampled joints showed better results compare to the transverse sampled joints. This therefore means the longitudinal direction is the best preferred sampling direction for the analysis of the friction stir welded joints.

## Biography

Sipokazi Mabuwa working as a lecturer in the mechanical engineering department, Cape Peninsula University of Technology and co-leader of the FSW division research centre within the same institution. My research interest includes Friction stir welding, friction stir processing and material characterization. I am very active in research activities, and I also review manuscripts for various journals in my research field. The journals I have reviewed include Journal of Manufacturing and Materials Processing, Recent Patents on Mechanical Engineering (Bentham Science Publishers), Advanced Materials Processing and Manufacturing Processes, Materials Today: Proceedings and Hindawi. Co-founder of the International Conference on Applied Research and Engineering (*ICARAE*).

# EFFECT OF STANDOFF DISTANCE ON THE SPLAT FORMATION OF FLAME SPRAYED POLYMER ONTO A MILD STEEL ROUGH SURFACE

**Kadhim Al Amara, Nasser Jaber, Mohamad Kharseh**
*American University of Ras Al Khaimah (AURAK), United Arab Emirates*

## Abstract

The oxy-acetylene flame technique with external powder feeding utilized to spray polypropylene (*PP*) powder onto the roughened surface of mild steel substrates at 100, 150, 200, 250, 300, and 350 mm standoff distances. This study investigates the effect of standoff lengths on *PP* splat morphology in order to get a basic knowledge of the effects of processing factors on microstructural features. To investigate the influence of standoff distance on the shapes and morphologies of the *PP* splats, optical microscopy, scanning electron microscopy (*SEM*), 2D profilometry, non-contact optical surface profilometry, and Micro-Raman spectroscopy analysis are conducted.

The standoff distance reflects the length of time a particle remains in the flame, knowing that an immediate flattening and cooling commence upon droplet collision with the substrate. A standoff distance of 150-200 mm recommended to achieve a dense coating having the desired mechanical properties. Increasing the *SOD* to 300 mm produced splats that exhibited significant splash patterns. In comparison to other spray parameters, changing the *SOD* had the most impact on the splat morphology, including the amount of splashing. The basic splat morphologies of polypropylene, however, exhibited no appreciable variations when deposited onto various substrate materials at the same *SOD* as proved in earlier study when employing glass substrates. At the larger *SOD* of 300 mm, overheated completely distributed splats with considerable loss of particle material, suggested to be owing to deterioration and evaporation produced. The *EDX* study findings revealed no significant variations in carbon content along the tested spots over the cross-section of splats. For all *SOD*s, the carbon weight percentage varied between 75% and 95% of the overall weight.

## Biography

Kadhim Al Amara received his PhD, Master and Bachelor Degrees all from Swinburne University of Technology, Hawthorn, VIC; Australia. The PhD is in the area of surface and coating technology using thermal spray process, the Master of Engineering is in Advanced Manufacturing Technologies with (Honours) and his Bachelor Degree is in Mechanical Engineering. Dr. Kadhim Al amara joined the American University of Ras Al Khaimah, UAE in fall 2019 as an assistant professor in the Mechanical and Industrial Engineering Department. Brier to that he was teaching in University of Sharjah in UAE and in Swinburne of Technology in Australia.

# A LYOPHILIZED READY-TO-USE MIX FOR THE REAL-TIME POLYMERASE CHAIN REACTION DIAGNOSIS

**Siyu Yang, Ziyi Zhang and Weijia Wen**

*The Hong Kong University of Science and Technology, Hong Kong SAR*

## Abstract

**Background:** Polymerase chain reaction (*PCR*), invented by Kary Mullis in 1983, opens access to a practical approach for infectious disease diagnosis and laboratory research in molecular biology. Cold chain transportation and storage for the reagents should be seriously considered to carry out *PCR* tests efficiently and accurately. These issues challenge some emergent situations. For example, the diagnosis of the COVID-19 pandemic was hindered by the slow delivery of the test reagent. Although the world is currently in a good position to end this pandemic, new challenges, like cancer and monkeypox, remain to keep us alert. Few studies have been reported on formulations and easy-to- control processes to produce a real-time *PCR* reagent that can be stored and delivered at room temperature.

**Objective:** To develop a reliable, dried real-time *PCR* reagent and its producing process using lyophilization with a high-temperature storage character.

**Methods:** Dried reagent with cryoprotectants was produced with lyophilization. Polyhydroxy compounds were added to protect the function of the lyophilized reagent during the whole manufacture and cold-free storage process. Dried reagents were stored at room temperature and designed higher temperature gradient and tested the function every 30 days with real-time *PCR*. In addition, scanning electron microscope (*SEM*) and thermogravimetric analysis (*TGA*) were used to characterize the morphology and moisture resistance of the reagents.

**Results:** The final products with the most superior protective formulation containing trehalose, Ficoll 400, and gelatin was able to provide the totally same testing result and sensitivity as the freshly making mix after 300-day storage at 45°C and can be deduced to maintain this function and efficiency at room temperature (22.5 ~ 25.5°C) for about two years. We are also developing microfluidic devices that embed the reagent, which has great potential in addressing health emergencies and point-of-care (*POC*) testing methods.

## Biography

Yang Siyu has been the leader of a national scientific research project for three years since 2016, during which he gained a basic understanding of scientific thinking and got his bachelor's degree in Applied Chemistry. To broaden the research scope, he chose interdisciplinary research projects for most of his Ph.D. projects. These highly collaborative Ph.D. projects allowed him to excel at interdisciplinary study, technique practice, and teamwork. He focuses on combining academic theory and practice and applying technology to actual production after he joins Professor Wen Weijia's group at The Hong Kong University of Science and Technology. When the COVID-19 pandemic raged worldwide, he volunteered at Customs for the Covid-19 PCR test and the related research. The nucleic acid detection chips and test materials he designed and reported in papers have been used in many practical tests internationally.

# INTEGRATION OF VISION SYSTEM INTO LASER SINTERING PROCESS

**Marcin Korzeniowski, A. Malachowska, and M. Wiatrzyk**
*Wroclaw University of Science and Technology, Poland*

## Abstract

**Background:** Application of laser beam for manufacturing process is known for ages. Its using for additive technologies is more and more common. The amorphous structures of 3D printings can be obtain with using iron-based powders, so called metallic glasses. For that reason the method to asses the properties and quality of manufactured structures in pre-process stage is desired.

**Objective:** To evaluate the properties of amorphous structures manufactured by laser additive manufacturing (*LAM*), integration of dedicated vision system is necessary and desired.

**Methods:** Completed vision system consist of IMX 4778 12.3Mpx camera coupled with Raspberry pi 4B and Adaptive Vision software. The implemented algorithm includes image processing operation like: binarizing, thresholding, segmentation and allows image parametrization. In consequence, the quality assessment of powder spreading is possible.

**Results:** With the use of the developed system, the presence or absence of powder, the degree of uniformity of the applied powder layer have been assessed. Implementation of complex algorithm with using Adaptive Vision software allows direct visualization of results, potential process deviation and monitoring the iron-based metallic glass powder spreading.

**Conclusion:** Developed and fully integrated vision system allows to asses the quality and properties of amorphous structures manufactured with using iron-based metallic glasses. Application of system allows for fully controlled Fe-based powder spreading on substrate, and finally manufacture 3D flaw–free structures.

## Biography

Marcin Korzeniowski is assistant professor in Department of Metal Forming, Welding and Metrology, Faculty of Mechanical Engineering, Wroclaw University of Science and Technology. He received his PhD degree in 2008 and his PhD thesis concerned real-time monitoring by ultrasonic method the resistance spot welding process. Until now, his research activity are: welding technologies, robotization and automation of processes, PLC programming and integration of vision systems. Dr. Marcin Korzeniowski have been participating in many regional, national and international projects concerning development of automation, welding and quality control.

# APPLICATION OF NANOSECOND GREEN LASER FOR IRON-BASED METALLIC GLASSED SINTERING

**Aleksandra Malachowska, A. Zakrzewski, M. Korzeniowski, and W. Lapa**
*Wroclaw University of Science and Technology, Poland*

## Abstract

**Background:** The Fe-based metallic glasses are unique materials with superior mechanical properties. The two main obstacles to widespread applications include: lack of plastic deformation and element size limitation in case of fabrication with contemporary methods like casting and thermoforming. The solution seems to be additive manufacturing, however, cracking and crystallization remains the problem.

**Objective:** To examine the interaction of pulsed laser with metallic glasses

**Methods:** In case of pulsed laser the heat affected zones are minimal which may hamper the crystallization but their processing window is narrow and requires a tight control on the processing. In order the usability of pulsed laser for metallic glasses the test setup has been developed.

**Results:** The developed system based on a fiber laser in the MOPA VPFL-G-HE-30 from Spectra Physics was selected. It is a laser with a wavelength of 532 nm and a power of 30W operating in pulsed mode. The laser is deviated by a scanhead (HALscan 10X20 - XY3-100) and focused by an f-theta lens.

**Conclusion:** Additive manufacturing for iron based metallic glasses by Selective Laser Melting is still an open challenge and an important topic of research. It is possible to possible to produce iron based metallic glass through *SLM* by using a nanosecond-pulsed laser but more research is needed to achieve better properties.

## Biography

Aleksandra Malachowska received her MSc in Management and Production Engineering in 2011 and PhD degree in Mechanical Engineering in 2016 from Wroclaw University of Science and Technology. Her PhD thesis concerned metallization of polymers with low pressure cold spraying. She did several research internships in Germany and France. Currently she is working at Wroclaw University of Science and Technology. In 2020 she was a recipient of the Outstanding Young Scientist Scholarship awarded by the Polish Ministry of Science and Higher Education. Her research interests include: material science, thermal spraying technologies and metallic glasses.

# CORROSION RESISTANCE OF VIRGIN AND USED STEAM LINE PIPES MADE OF STEEL GRADE 14MOV6-3

**Ljubica Milovic, Bore Jegdic, Bojana Zecevi and Ana Maksimovic**
*University of Belgrade, Serbia*

## Abstract

**Background:** Frequent failures of temperature-loaded equipment components, such as steam pipes, led to the fact that it is necessary to pay special attention to the behavior of materials in exploitation as well as the problems of their maintenance and the power plant safety. The most frequent failures are related to the appearance of cracks, especially pronounced when steel grade 14MoV6-3 is used in production of power plant components. As a special problem, the question of what should be done with steam pipelines made of such steels, which have been in operation for several years, arises. There are several causes that can lead to the premature failure of a highly temperature-loaded steam pipeline, and one of them is the reduced corrosion resistance of the steam pipeline material.

**Objective:** Corrosion resistance of virgin and used material (after 117,000 hours of operation at steam pressure of 4.2 MPa and steam temperature of 540°C) was compared.

**Methods:** The electrochemical behavior of virgin and used steel grade 14MoV6 3 have been analyzed and compared. The analysis included Linear polarization Resistance (*LPR*), Linear sweep voltammetry (*LSV*) and Electrochemical impedance spectroscopy (*EIS*). The experiments were performed at room temperature, in the presence of the atmospheric oxygen.

**Results:** The investigation showed the principal differences in the structure of the virgin and used material on the outer surface of the pipe, and the analysis of the degradation of the material during exploitation is given on the microstructures of the outer surface of the pipe. The microstructure of the virgin material is bainitic characterized by an inhomogeneous grain size. The grains are of irregular shape and complex geometry with a large number of boundaries. On the microstructure of the used material, the grains growth was observed, which was most likely caused by the mechanism of grain joining.

**Conclusion:** All three applied electrochemical methods give approximately the same results of steel grade 14MoV6-3 corrosion rate value. Corrosion rate of virgin material is around 0.76 $mm \cdot y^{-1}$, while in case of used material ranges around 2.29 $mm \cdot y^{-1}$.

## Biography

Ljubica Milovic is full professor at the University of Belgrade, Faculty of Technology and Metallurgy, Serbia. During her professional work she was engaged in designing of hydraulic lift platforms, investigation of cargo lifting and transportation units, optic analysis of stresses and deformations, measurement of residual stresses of welded joints, testing of mechanical properties of welded joints, testing of fracture mechanics of welded joints, investigation of high strength low alloy steels, investigation of high temperature steels, low-cycle fatigue of materials and their welded joints, experimental and analytical analysis of structures in processing industry.

# DYNAMIC AND REAL-TIME BIOMETRICS IN CLINICAL RESEARCH

**Ayouba Diarra, Oumar Guindo and Bintou Mariko**
*Data Consulting Group, Mali*

## Abstract

**Background:** According to a recent survey report from Oracle Health Sciences and Pharma Intelligence, persistent clinical trial data management problems are slowing down trials, sparking U.S. Food and Drug Administration audits and 483s, and putting patients at risk. Many of these problems can be mitigated when a patient attends a clinical research trial for the first time.

**Objective:** To implement a system that allows biometric enrolment and verification of patients during the trial along with visit management and automatic mobile real-time dashboard reporting to ensure patient safety and trial success. Scheduled visits management is a key success factor but can be challenging with numerous participants, several sites, and increased trial duration.

**Methods:** For improved data management and collecting more complete data, a centralized information management solution utilizing biometrics was used to link clinical test subjects with their data at each stage of the study. It enabled scheduled visits management and real-time dashboard reporting for better adherence of participants to scheduled visits. Rescheduling or cancelling visits was controlled by validation rules for rescheduling within a time window, disallowing past rescheduling, different visit-controlled colors for better visual ergonomics, option to send SMS alert to the team.

**Results:** The system provides a dynamic study dashboard and real-time powerful business intelligence tools that streamline trial operations and improve research efficiency, accessible to the study team in compliance with regulations via computers and smartphones. It provides a fantastic report summarizing the number of screened, eligible, non-eligible and waiting participants and gives real-time visit completion reports with scheduled visitor names and details of completed, pending, and missed visits.

**Conclusion:** Our system has many useful management tool components: Workload prediction in different units when planning visits and within the scheduled visits. With more accurate, reliable, and complete data, this innovation will enable more efficient vaccine development and increased confidence in clinical trial findings.

## Biography

Ayouba Diarra has a solid background of working successfully in pharmaceutical and biotechnological roles. With proven leadership abilities and advanced interpersonal, communication, critical thinking, and negotiation skills, he has created over 100 digital databases, scaling to an innovative platform called Study Trax. He is an Oracle Database 11g Administrator Certified Professional and has a deep understanding of an array of database features, functions, and tasks. He has passed a rigorous exam featuring real-world, scenario-based questions that challenge and measure one's ability to think and perform. He has 7+ years of experience operating in an independent capacity. Throughout his career, he has made it his priority to utilize current technologies and new techniques to develop elegant, creative technical solutions for all project phases. Comfortable in collaborative and independent roles, he is a forward-thinking leader with refined analytical skills, and can adapt his strategies to meet evolving priorities, shifting needs, and emergent issues.

# *Day-2*
# *Keynote Presentations*

# STUDY OF MECHANISMS OF COULD FIELD EMISSION IN CNT AND CREATION OF CNT-BASED CATHODES WITH THE HELP OF MECHANICAL BOTTOM – UP NANO-INTEGRATION BASE ON SHAPE MEMORY NANO TOOLS

**Svetlana von Gratowski, Hab. Victor Koledov and Zoja Kosakowskaja**

*Kotel'nikov Institute of Radioengineering and Electronics Russian Academy of Sciences, Russia*

## Abstract

**Background:** CNTs are nanoobjects with outstanding mechanical, electrical, optical and other functional properties. CNTs shows such interesting properties like low field could field emission, ballistic conductivity, etc. CNTs provide one of the most important modern trends - the trend of miniaturization. However, CNTs are individual 1D nanoparticles and nanodevices based on them cannot be created using standard nanolithography methods.

**Objective:** Among such devices are cathodes for cold field emission based on CNTs. For several decades, CNTs have been considered as one of the most promising materials for a new generation of cathodes, the so-called pointed cathodes. The mechanisms of the occurrence of cold field emission in CNTs is widely discussed in the literature, but till now it is controversial. Another bottleneck is the creation of single nano cathodes and arrays of nano cathodes, while standard nanolithography methods do not work.

**Methods:** In the present work we offer the new mechanical bottom-up technology based on shape memory alloy (*SMA*) nano gripper for the pick-up and place operation, nano-manipulation and nano-assembling for both study of mechanisms of cold field emission in CNT and creation of nanocathodes based on CNT.

**Results:** Using this method, the I–V characteristics of individual CNTs were studied, and it was found that they do not obey the Fowler Northeim law.

**Conclusion:** So, the mechanism of cold field emission depends on the type of CNT. We conclude, that the mechanism of anomalously high field emission currents of nanotube emitter in case inhomogeneous CNT is associated with a coherent mechanism of charge transfer along a CNT. Mechanical bottom-up nano´-assembling allow to produce low field could field emission nanocathodes based on CNT.

## Biography

Svetlana von Gratowski has her expertise in research in nanotechnology, nano-manipulation, nano- assembling, shape memory alloys. She has had invented and suggested frontier mechanical bottom-up nano- assembling, nano-manufacturing and nano-fabrication of single nanodevices based on individual nano-objects using the smallest and the fastest shape memory alloy nanogripper. This technology opens up perspective of the creation of single nano/micro and macro devices from individual nanotubes, nanowires and other nano-objects. Mechanical bottom-up nano assembling is going to overcome the presently existing barrier of the integration of variety of nanoobjects and nanodevices with each other and with convectional integrated circuits. Moreover, the novel technology will provide products not only with the next level high quality, but also extremely low cost. This breakthrough nanotechnology will be affordable for small groups with small modest budget in science, education and SME.

# SUBCOOLED LIQUID PRINTING – HOW TO INCREASE PROFITABILITY OF ADDITIVE MANUFACTURING BY SCALES?

**Markus Brillinger**
*Pro2Future GmbH, Austria*

## Abstract

**Background:** 3D printing is undoubtedly the future of manufacturing in quite a few industries. This is also reflected in the steadily growing number of patents filed. According to the European Patent Office (*EPO*), German companies and inventors filed 155 patent applications in the field of additive manufacturing between 2010 and 2018. In a European comparison, this is 40% of total European 3D printing patent applications, and 19% worldwide. Worldwide, Germany ranks second, directly behind the USA, the country with the highest number of applications. In the USA, 747 applications were received during this period, which corresponds to 35%.

**Objective:** The objective of one of Markus Brillinger's research activities is to increase the economic and ecological sustainability of 3D printing technology by orders of scale.

**Methods:** The presentation will discuss numerous ways to increase economic and ecological sustainability. A key component is the physical or chemical process of solids synthesis. Using examples and concrete research results, it will be shown how novel approaches can be developed from solid matter synthesis, thus significantly expanding the spectrum of possible materials for this technology.

**Results:** Among other things, strong reference is made to 3D printing of sodium acetate trihydrate as a novel material with a previously unused solid synthesis process. Experiments show that an increase in build speed by a factor of up to 1000, perfect recyclability and low energy requirements are promising advantages.

**Conclusion:** Finally, the presentation will focus on the main development and research projects needed to further increase the sustainability of 3D printing and give an outlook on future developments.

## Biography

Markus Brillinger is an expert in production engineering combined with the latest technologies, such as artificial intelligence. In his research area called "Cognitive Production Systems" he thinks and walks the way towards future production systems in the post-digitalization age. On this journey, Brillinger takes both scientific partners and companies with whom he carries out joint research projects. The research topics he is working on with about 15 researchers in his area are (i) AI in production, (ii) collaboration of humans and machines in production, and (iii) sustainable and resource-efficient production. Numerous publications and international lectures show the great interest in the latest developments on these topics. Additionally, Markus Brillinger teaches at 2 universities in Austria

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# THERMAL HEAT STORAGE AND DISSIPATING BEHAVIOR OF PHOSPHATE COMPOSITES WITH HOUSE DECORATING MATERIALS

**Trilochan Swain[1] and Gouri Sankhar Brahma[2]**

[1]*Fakir Mohan University, India*
[2]*IFHE, India*

## Abstract

**Background:** The energy crises throughout the world are increasing day by day due to rapid industrialization, urbanization as well as increase of luxurious life. In order to fulfill this demand, the various carbonaceous fuels are used. The use of these carbonaceous fuels increases the pollution which leads to global warming followed by climate change.

**Objective:** To reduce the energy consumption in household buildings using the energy saving composite materials as coating.

**Methods:** Various mixtures were synthesized using phosphate compounds such as $Ni_3(PO_4)_2$, $Cu_3(PO_4)_2$, $Co_3(PO_4)$ along with their allied chemicals. These mixtures were charged with various household decorating materials such as wall care putty, $CaCO_3$ with polyvinyl acetate, various paints, etc. These composites were synthesized very simple wet method. The thermal properties basically specific heat capacity of these composites was carried out using modular Differential Scanning Calorimetry with sapphire standard in $N_2$ atmosphere as well as normal atmosphere. The mixtures are characterized with different measurement techniques. Some of the composites are applied as coating materials in various prototype households. The temperature difference is studied in prototype houses with and without composite coatings.

**Results:** Some of the composites behave as thermal heat storage and some others as heat dissipating materials. The maximum specific heat capacity of these composites is ~ 2 $Jg^{-1}K^{-1}$.

**Conclusion:** These composites can be used as coating materials in various household buildings for all weather season. The composites with thermal heat storage can be applied in the interior wall of the households. The room heater is basically used in winter season for cold counties. These composites will store this heat energy and will keep the room warmth for a longer period of time even after the room heater shut down. The same thing happens in hot counties using air conditioner. The opposite things are happened for heat dissipating composite materials. In hot countries, these materials can be used in the exterior wall of the households. So, the heat cannot undergo conduction into the interior walls of the house. This will reduce the power consumption which indirectly reduces the use of carbonaceous fuels for harnessing the energy.

## Biography

Trilochan Swain mainly focusses on these thermal heat storage and dissipating behaviors of composite materials; he publishes more than 25 papers. The he built various prototype houses and applied these composite materials in order to study its effect on energy saving in terms of temperature. These composites can be used in all-weather season and in all parts of the world. This application not only reduces power consumption in various households but also indirectly helps to reduce global warming followed by climate change which is inevitable.

# INTELLIGENCE: ATTEMPTING TO BUILD A BRIDGE BETWEEN ARTIFICIAL AND BIOLOGICAL DOMAINS

**Alessandro Chiolerio**

*Istituto Italiano di Tecnologia, Center for Converging Technologies, Soft Bioinspired Robotics, Italy*

## Abstract

Intelligence as a cognitive process can be described using both a symbolic approach, which works well in the digital world and a continuum approach, which is more familiar to biologists. One is known as the cognitive paradigm, which features the brain as a localised centre of intelligence and consciousness. The latter is known as the in *materia* approach, and it is used whenever sentience cannot be justified by a physical brain. We will evaluate which and how many of the features proposed by Artificial Intelligence research in deconstructing human cognitive processes are fundamental, including data completeness, architecture, and causality. Current Artificial Intelligence implementations will be discussed, with a brief mention of holonomic machines, which are expected to restore a link that closes the apparent dichotomy between artificial and biological intelligence. Very recent, unpublished results on liquid state memories, artificial neural networks, and reservoir computers will be presented, as well as perspectives on hybrid synthetic-living colloids.

## Biography

Alessandro Chiolerio received his PhD at the Physics Department of Politecnico di Torino in 2009 with a thesis on spintronic devices, dealing with Giant MagnetoResistance and Magnetic Tunneling Junctions. He obtained a full professor habilitation (Solid State Physics) and associate professor habilitation (Electronics) in 2017. The post-doctoral research period was first held at Politecnico di Torino, Department of Materials Science and Chemical Engineering, in the analysis of transport properties of nanocomposite materials, subsequently at the Center for Space Human Robotics of Istituto Italiano di Tecnologia in Torino, dealing with the development of sensors and materials for space exploration, then at the Center for Sustainable Future Technologies with a pioneering study on the generation of electricity from waste heat using functional liquids, and finally at the Soft Bioinspired Robotics group in Genova with the development of the first ever liquid cybernetic system. During the years Alessandro worked as Visiting Researcher at NASA's Jet Propulsion Laboratory (Pasadena, United States of America) in 2015 and 2016, at the Max Planck Institute for Microstructure Physics (Halle, Germany) in 2017, at the Unconventional Computing Laboratory of the University of the West of England (Bristol, United Kingdom) in 2018 where he is Visiting Professor, as of 2021. His current interest is the study of cybernetic systems, especially those that develop a system of inter-subject relationships that can be described through holographic analogies, such as liquids, through which he is developing autonomous robots capable of perceiving the external environment, generate energy for self-powering, store data and perform rudimentary calculations, and also natural ecosystems.

# *Day-2*
# *Oral Presentations*

# WELDABILITY OF ADDITIVE MANUFACTURED COMPONENTS BY LASER POWDER BED FUSION PROCESS

**Shahram Sheikhi, Felix. Altenhöner and Eduard Mayer**
*HAW Hamburg, Germany*

## Abstract

Laser powder bed fusion (*LPBF*) is a widely used additive manufacturing process for the production of metallic components. However, due to the size of build chambers, the component dimensions of LPBF manufacturing systems are limited, so that joining of several additive manufactured components by means of welding is necessary. The aim of this work was therefore to assess the suitability of the weld by determining mechanical parameters using non-destructive and destructive material testing methods. The investigations therefore included, in terms of production technology, two different layer orientations of the LPBF components as well as a rolled, conventionally produced, sheet as a comparative material. In the first part of this work, the properties and welding of austenitic steels are investigated, the relevant processes such as LPBF and gas metal arc welding (*GMAW*) are presented, and the necessary test procedures were explained. The results show that high-quality and defect-free welds can be achieved on LPBF components using the GMAW welding process, which meet the standards of the highest quality class (B) according to ISO DIN 5817. The strengths and elongations at fracture of the welded LPBF components however were found to be dependent on the direction of built up, with the vertical layer orientation to the weld showing the highest tensile strength and lowest elongation at fracture. Within the weld, a lower hardness was observed compared to the LPBF base material. In the rolled material, on the other hand, uniform hardness measurements were observed, with values below those of the LPBF base material. In the dynamic notched bar impact test, there were only minor differences between the two layer orientations, which were, however, significantly below those of the rolled material. This work has thus shown that components produced by the LPBF process can be joined using GMAW, but that the resulting strength and ductility of the welded structure are lower than those of the base material and must be considered in the design process.

## Biography

Shahram Sheikhi is a professor at Department Mechanical Engineering and Production, Institute for Materials Science and Welding, HAW Hamburg, Germany.

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# BITTER GOURD PERICARP DERIVED POROUS ACTIVATED CARBON FOR HIGH ENERGY DENSITY SUPERCAPACITOR DEVICES

**M L Aparna, G Ranga Rao and Tiju Thomas**

*Indian Institute of Technology Madras, India*

## Abstract

**Background:** Porous structured activated carbon (*AC*) has attracted a great deal of attention for supercapacitor applications because of their viability, sustainability and environmental friendliness. In particular, decentralized and sustainable production of materials related to energy technologies would be enabled through bio-source derived materials. Numerous biomass precursors have been explored to date to obtain activated carbon.

**Objective:** To explore a bio-source (bitter gourd pericarp – *BGP*) not used till date to derive KOH activated porous structured activated carbon towards supercapacitor application.

**Methods:** The microstructural and morphological details of the synthesized AC were evaluated from XRD pattern, FESEM images, BET isotherms, XPS and Raman spectra. The charge storage characteristics and the practical relevance of the AC were studied by conducting 3-electrode measurements and 2-electrode (device-Swagelok cell) measurements respectively.

**Results:** The bio-derived activated carbon shows an excellent surface area of 1125 $m^2g^{-1}$ at an activation temperature of 900°C. It exhibits a specific capacitance of 186 F $g^{-1}$ at 1 A $g^{-1}$. Symmetric supercapacitor device fabricated delivers a power density of 750 W $kg^{-1}$ at an energy density of 8 Wh $kg^{-1}$ with 98% capacitance retention after 5000 cycles in 1M $H_2SO_4$. A further improvement of energy density to a maximum of 23 Wh $kg^{-1}$ and a maximum power density of 6000 W $kg^{-1}$ is achieved using dual redox mediators (KI + HQ) in $H_2SO_4$ due to the redox activity of the I2/I- and Q/HQ redox species at the positive electrode.

**Conclusion:** This work is the first report on the use of bitter gourd pericarp as a biosource for preparing porous AC. The symmetric two-electrode supercapacitor device (BGP900//BGP900) delivers appreciable energy density and power density proving its potential as an electrode material for supercapacitor application is demonstrated.

## Biography

Aparna M L studied B.Tech in Electrical and Electronics Engineering (2010-2014) and M.Tech in Nanotechnology. She worked as Assistant Professor @ Adi Shankara Institute of Engineering & Technology, Kalady, Kerala, India for a duration of 10 months (3rd October 2017 – 24th July 2018). She joined for PhD at IITM, India under Dr. Tiju Thomas and Dr. G. Ranga Rao in 2018. Presently she is a senior research fellow at Department of Metallurgical and Materials Engineering and Department of Chemistry. Her research work focusses on nanomaterials for energy storage applications primarily supercapacitors. She has 6 research publications in Scopus indexed (SCI(E)) journals.

# INFLUENCE OF HEATING MODE ON CYCLIC TEMPERATURE RANGE OF AN Ni-Ti SHAPE MEMORY ALLOY DURING PARTIAL TRANSFORMATION CYCLING

**G.Swaminathan and V.Sampath**
*Indian Institute of Technology Madras, India*

## Abstract

**Background:** Smart actuators based on NiTi-SMAs are much lighter and smaller than conventional actuators since they don't require separate sensors, processors, and actuation systems. However, the smart actuators need to control the working temperature range to ensure shape recovery properties, such as recovery strain, permanent strain, and hysteresis, are maintained during operation.

**Objective:** To understand the role of different modes of heating on the operating temperature variation during cycling.

**Methods:** A binary near-equiatomic Ni-Ti shape memory alloy (*SMA*) under constant stress was experimentally determined to examine the influence of different modes of heating on the operating temperature range during partial transformation cycling. A series of partial thermal cycling (Tmin<Mf to $T_{max}$<Af) tests at a constant stress level of 100 MPa for a duration of 1000 cycles was carried out on an NiTi SMA using a custom-built test setup. An electric current was passed through the sheet samples adopting two different techniques, namely current-controlled mode and temperature-controlled mode. Current-controlled heating involves passing a constant current through the sample (I, t = constant), with the maximum temperature determined by Joule's law of heating. The temperature-controlled mode uses a feedback mechanism to adjust the magnitude of the current based on the target temperature to be achieved at a given time for a fixed maximum temperature.

**Results:** The upper cycle temperature becomes difficult to control as the number of cycles increases due to the generation of defects that affect the material's resistivity during current-controlled heating. However, the temperature-controlled mode of heating prevents variations in upper cycle temperature. During phase transformation, latent heat and hysteresis heat accumulate, resulting in variations in lower cycle temperature.

**Conclusion:** A temperature-controlled heating mode combined with a proper cooling system can provide a controlled working temperature range and stable operation during thermomechanical cycling for *SMA* devices/components.

## Biography

G.Swaminathan is a Ph.D. scholar from the Department of Metallurgical and Materials Engineering, Indian Institute of Technology, Chennai, India. Currently, he is working on improving the functional fatigue resistance of NiTi-based shape memory alloys and developing novel high-temperature shape memory alloys. Recently, he discovered a new phenomenon in shape memory alloys called strain memory effect, which has significant implications for smart actuators. In addition to SMAs, he is interested in advanced manufacturing processes, characterization of materials, and composite materials.

# OPTICAL STUDIES OF NEAR-INFRA RED EMITTING AgInS AND AgInS/ZnS QUANTUM DOTS FOR LATERAL FLOW ASSAY APPLICATIONS

**Ncediwe Tsolekile, Nozikumbuzo Vitshima and Noluvuyo Mngcutsha**
*Cape Peninsula University of Technology, South Africa*

## Abstract

**Background:** Lateral flow assay (*LFA*), commonly known as an immunochromatography test, is a diagnostic strip test that uses paper or membrane-based devices to detect the presence/absence of an analyte. Quantum dots (*QDs*) are ideal fluorescent labels and have been used to improve the detection sensitivity of *LFA* due to their narrow emission spectra, broad excitation range, high signal-to-noise ratio, and high fluorescent quantum yields.

**Objective:** Herein, we report the monowave synthesis of near-infrared, water-dispersible, and highly luminescent AgInS QDs and AgInS/ZnS QDs for LFA application.

**Methods:** The QDs were hydrothermally synthesized at different Ag : In compositions (1:1, 1:2, 1:4, 1:6), temperatures (50, 60, 75 and 95°C) and surface capping ligands. The optical and morphological properties of the synthesized QDs were characterized using various optical and spectrochemical techniques.A lateral flow assay was developed on a phosphate-buffered saline (*PBS*) optimized conjugate pad and nitrocellulose membrane.

**Results:** The optical properties of the AgInS/ZnS QDs proved to be composition and surface capping ligand-dependent. The X-ray diffraction (*XRD*) revealed a tetragonal AgInS2 and cubic ZnS. Transmission electron microscopy (*TEM*) of the QDs showed nearly spherical and mono-dispersed particles. Further characterization of the synthesized QDs' optical and morphological properties was performed using various optical and spectrochemical techniques. The LFA showed concentration- dependent results for cancer antibody detection with highly fluorescent signals on both test and control lines.

**Conclusion:** Electrochemical and LFA sensing of cancer antibodies using AIS/ZnS QDs suggest that the synthesized material has the potential to sense cancer biomarkers.

## Biography

Ncediwe Tsolekile's expertise is in synthesizing and applying nanomaterials for various applications. Her main interest is applying nanomaterials in photodynamic therapy and lateral flow assays. Dr Tsolekile has reported on the in-vitro cytotoxicity, confocal imaging, singlet oxygen generation and photodynamic therapy of ternary and quaternary QDs and their respective drug conjugates. She has grown interested in applying QDs in lateral flow assays to develop fast and cost-effective means for detecting infectious, communicable, and non-communicable diseases.

# EXPERIMENTAL AND FINITE ELEMENT ANALYSES OF METALLIC MATERIALS USED IN MARINE APPLICATIONS SUBJECTED TO TORSION LOADING

**Saud Bader Amur Al Radini, Mayank Anand, Stylianos Markolefas and Bader Ibrahim Al Baroomi**

*Military Technological College, Oman*

## Abstract

Several marine applications such as propulsion system, pumps, rudder and winches include the rotational components such as a metal shaft which is subjected to torsional loading during operation. The quality of materials going into such applications is as significant as the reliability of the manufacturing process. The materials may fail due to numerous reasons including, but not limited to, brittle microstructure, machining marks, excessive loading conditions than recommended, fatigue loading and presence of stress concentration points. Therefore, it is very important to analyse the shear properties of metallic materials used for the manufacturing of rotational components (such as shaft) during their design stage. In the current study, the torsional testing of brass (BS2874), aluminium alloy (2011-T3) and steel (BS 970 230M07) made dog-bone cylindrical specimens (diameter = 6mm and gauge length = 100mm) was performed using HSM40 torsion testing machine at 0.5 rpm test speed and room temperature. The applied torque and resultant angle of twist were measured using sensors and recorded using HSM40 software. Elementary mechanics theory was then used to compute shear modulus, maximum shear stress and maximum shear strain within the elastic limit. In addition, Finite Element analysis of 3D model of torsion test specimen was performed in ANSYS using the appropriate boundary and loading conditions. The unstructured and finer mesh elements were applied to the gauge length section of 3D model as it is the critical segment where the effects of torsional loading is significant. Furthermore, to ensure the accuracy and reliability of FE results, the number of meshing elements was determined by the convergence test. The maximum shear stress and maximum shear strain results obtained from the FE analysis were validated against experimental testing results. The results revealed that the employed steel has the highest ability to resist torsional loading followed by brass and then aluminium alloy.

## Biography

Saud Bader Al Radini is a recent graduate from the Military Technological College Oman (MTC). He has obtained his bachelors degree in Mechanical Engineering and he is currently an assistant lecturer at MTC.

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# PHOTOCATALYTIC PROPERTIES OF NANOTITANIA TO INHIBIT THE GROWTH OF *GARDNERELLA VAGINALIS* (GAVA)

**Ahmad Mukifza Harun[1], Nor Farid Mohd Noor[2], Mohamad Ezany Yusoff[3], Mohd Nadzri Abu Yazid[3], Razif Abas[4], Nor Dalila Nor Affandi[5], Mohd Azizi Abdul Rahman[6], and Mohammad Khursheed Alam[7-9]**

[1]*Universiti Malaysia Sabah, Malaysia*
[2]*Universiti Sultan Zainal Abidin (UniSZA), Malaysia*
[3]*Universiti Sains Malaysia, Malaysia*
[4]*Universiti Putra Malaysia, Malaysia*
[5]*Universiti Teknologi MARA,Malaysia*
[6]*Universiti Teknologi MalaysiaMalaysia*
[7]*Jouf University, Saudi Arabia*
[8]*Saveetha Institute of Medical and Technical Sciences, Saveetha University, India*
[9]*Daffodil International University, Bangladesh*

## Abstract

Nanotitania ($TiO_2$) is a well known substance that has a photocatalytic property. It is considered as a potential in inhibiting the growth of bacteria. *Gardnerella vaginalis (GAVA)* is a common reproductive infection pathogen. *Gardnerella vaginalis (GAVA)* causes various problems in women's sexual behavior. The main aim of this study was to test a material, namely nanotitania extract from modified hydrothermal which was developed at Universiti Malaysia Sabah (*UMS*) and tested against *GAVA.*

The nanoparticles synthesized through above mentioned process, are a combined process with molten salt and proven to have excellent crystallinity, with the bandgap energy falling in the visible light spectrum. The nanoparticle extract was tested using a macro-dilutional method, combining it with 0.03% silver solution during nanoparticle synthesis and then introducing it to the bacteria. A positive control containing the bacteria minus the nanoparticles extract was also prepared. 25 mg/mL, 12.5 mg/mL, and 100 mg/mL concentrations of the samples were produced using the macro dilution method. After adding the bacteria to multiple concentrations of nanoparticle extract, the suspensions were incubated for 24 hours at a temperature of 37°C. The suspensions were then checked for any growth of the bacteria after 24 hours.

Nanoparticle extract in combination with silver at 0.03% could be an antimicrobial substance as it could inhibit *GAVA* at all concentrations. Furthermore, it was also shown to be capable of inhibiting GAVA at concentrations of 12.5 mg/ml-100mg/ml. In conclusion, the nanoparticle extract displayed antimicrobial properties, which were proven effective against the growth of *GAVA*.

## Biography

Ahmad Mukifza is a lecturer at University Malaysia Sabah. His area of expertise is electrical engineering, with experience of more 20 years in both teaching and working. Have been working with Samsung Electronic and Sony Technology Malaysia in the area of automation and EMC research before joining university. Nowadays, actively research for the nanotitania photocatalytic properties under visible light condition.

# DEGRADATION OF THE MECHANICAL PROPERTIES OF CARBON/EPOXY COMPOSITE MATERIALS UNDER HYGRO-THERMAL AGING

**Bachir Bouiadjra Bel Abbes[1], Faraz Ahmed[2], Sohail M.A.K. Mohammed[2,3], Faycal Benyahia[2] and Abdulmohsen Albedah[2]**

*[1]LUniversity of Sidi Bel Abbes, Algeria*
*[2]King Saud University, Riyadh, Saudi Arabia*
*[3]Toronto Metropolitan University, Canada*

## Abstract

Exposure of composite materials to harmful weathering conditions affects their durability. It is important to study the effect of aging on the mechanical properties for long-term application of composites. In this study, the effect of accelerated hygro-thermal aging on the mechanical properties of carbon/epoxy composite materials was analyzed experimentally. Tensile test samples were manufactured from unidirectional eight-layer laminated sheets of this material. Two types of accelerated aging were applied to the tensile test's specimens: the first is the immersion in distilled water during different times and the second type of aging is the exposure to accelerated weathering cycles where the effects of temperature, humidity absorption and UV radiations are highlighted. The aged specimens are subjected to tensile tests along the longitudinal and the transversal directions. The accelerated hygro-thermal aging by means of temperature, UV radiation and humidity absorption deteriorates the mechanical properties of the composites.

## Biography

Bel Abbes Bachir Bouiadjra is full professor at the Djillali Liabes University of Sidi Bel Abbes, Algeria. He has extensive experience in the fields of materials science, computational mechanics and biomechanics. He has been working on carbon composites towards their structural applications. He has published more than 250 papers in international referred journals and conferences and supervised more than 15 Ph.D. dissertations. He received the Scopus award from the major publishing house Elsevier in the specialty of materials science in 2012.

# STRENGTHENING REINFORCED CONCRETE STRUCTURES USING CARBON FIBRE REINFORCED POLYMER

**Raafat El-Hacha, Oumaima Awassa and Kevin Falkenberg**
*University of Calgary, Canada*

## Abstract

**Background:** Most of our infrastructures need substantial and immediate repair, rehabilitation, or replacement because they have degraded or reached the end of their design service lives. Calgary Downtown Core Network comprises approximately 2735 Manholes and 476 Transformer Vaults. Most of these underground, reinforced concrete (*RC*) structures are significantly aged (over 40+ years). Some show signs of degradation and cannot be easily replaced due to their location and continuing usage. Therefore, repairing and strengthening these structures is critical for the safety and livelihoods of Calgarians.

Fibre Reinforced Polymer (*FRP*) systems have been used in different configurations (sheets, strips, plates, bars) using various techniques for strengthening RC structures to restore or increase their capacity. Some *FRP* strengthening techniques could be more effective; however, their cost-effectiveness and applicability are significant and could govern their use due to overall maintenance budget constraints and the structure's location to be repaired. Many researchers reported significant increases in the strength and stiffness of Carbon FRP strengthened RC members. The commonly used technique related in principle to this project to provide additional flexural strength for damaged or deficient RC structures is the Externally Bonded (*EB*) CFRP sheets applied on the tension side of flexural concrete members.

**Objective:** This research aims to evaluate the feasibility and efficiency of the EB-CFRP technique in strengthening RC walls dismantled from deteriorated manholes from the Calgary underground network. In addition, it demonstrates the most appropriate anchorage system for preventing premature failure due to debonding failure.

**Methods:** The experimental program comprised testing under static monotonic loading up to failure four RC walls strengthened in flexure with *EB CFRP* sheets with different anchorage systems. The specimens (400 mm wide × 1950 mm in length) were cut from existing deteriorated walls of manholes and were severely cracked with a major flexural crack about 6 mm in width across the depth of the specimens. All cracked specimens were repaired by epoxy injection of the crack. Ground Penetration Radar scanning revealed the arrangement and location of the main flexural reinforcement disagree with the design drawings. In addition, the reinforcement was found closer to the compression side than the tension side. Thus, the specimens were considered deficient in flexural and required flexural strengthening.

***Strengthening of the Specimens***

The EB CFRP strengthening system was designed to bring the specimens back to their original nominal capacity. Therefore, the area of the CFRP sheets was determined accordingly.

- After testing S1-R-C to failure, it was strengthened with two layers of CFRP sheets with a width of 255mm and a length of 1750mm, and it is labelled as S1-R-C-S.

- S1-R-S was strengthened with three layers of CFRP sheets of width 244 mm and length 1750 mm.
- S2-R-S was strengthened with two layers of CFRP sheets of width 365 mm and length 1750 mm.

***Anchorage System Provided for each Specimen***

Three anchorage systems were used at the ends of the EB CFRP sheets:

#1. S1-R-C-S: Additional 100 mm wide × 255 mm length CFRP sheet was applied at both ends of the longitudinal 1750 mm CFRP sheets

#2. S1-R-S: The following anchorage system was applied:

a. 15 mm×15 mm grooves were cut transversely in the concrete at both ends.

b. Two CFRP sheets were placed in the longitudinal direction and into the grooves at the ends.

c. 10 mm diameter Glass FRP rebar was placed on the top of the CFRP sheets into the groove.

d. Then additional 100mm wide × 244 mm length CFRP sheet was applied at both ends.

#3. S2-R-S: A 100 mm wide × 365 mm length aluminum plate was placed on the top of the CFRP sheets at both ends and anchored to the concrete using four 1.5in. Hilti nails.

**Results:** The following table summarizes the test results.

| Specimen ID# | Specimen Condition | Failure Load (kN) | % increase w.r.t. S1-R-C | Failure Mode |
|---|---|---|---|---|
| S1-R-C | Repaired-Control | 32.7 | | Flexural |
| S1-R-C-S | Repaired-Control-Strengthened | 63.1 | 50% | CFRP rupture |
| S1-R-S | Repaired-Strengthened-Embedded GFRP Bar Anchor System | 122 | 273% | Shear failure in the concrete simultaneously with the anchorage failure |
| S2-R-S | Repaired-Strengthened-End Plate with Hilti Nail Anchor System | 100 | 206% | Anchorage failure due to the inadequate embedded length of the nails in the concrete |

**Conclusion:** A significant increase in flexural capacity was achieved upon strengthening the repaired RC walls with EB CFRP sheets. However, due to the anchorage failure, we could not determine a suitable system. Thus, more tests are undergoing using Hilti nails with longer embedment lengths.

## Biography

Raafat El-Hacha, is a Professor of Structural Engineering at the University of Calgary in the Department of Civil Engineering, Canada. Dr. El-Hacha's pioneer research has been recognized as pushing the boundary of knowledge in using innovative and smart advanced materials for strengthening structures and new construction, such as fibre- reinforced polymers, shape memory alloy and ultra-high performance concrete for hybrid structural systems in bridge applications and other structures. He published over 250 journal and conference papers. Supervised and graduated 50 Ph.D. and MSc students. He is a Fellow of the International Institute for FRP in Construction (IIFC), the Canadian Society of Civil Engineers (CSCE), the American Concrete Institute (ACI), and the Engineering Institute of Canada (EIC). He received several awards and fellowships, including the CSCE Casimir Gzowski Gold Medal Award, CSCE Excellence in Innovation in Civil Engineering Award, IIFC President's Award, Killam Professorship Award, Erasmus Mundus International Fellowship and many others for his outstanding academic and professional achievements.

# HYDROXYPROPYL METHYLCELLULOSE-COPPER NANOPARTICLE AND ITS NANOCOMPOSITE HYDROGEL FILMS FOR ANTIBACTERIAL APPLICATION

**Radha D. Pyarasani, Tippabattini Jayaramudu, Kokkarachedu Varaprasad, K. Koteshwara Reddy, A. Akbari-Fakhrabadi, Veronica Carrasco-Sanchez and John Amalraj**

*Universidad de Catolica del Maule, Chile*

## Abstract

**Background:** The interest in developing copper-based (*Cu*) nanomaterials are intensified due to its high natural abundance and low cost when compared to other metals such as silver and gold. The utilization of Cu has been increasing in diverse fields, including water purification, catalysis, biomedical, environmental, antibacterial and energy conversion and storage. Among them, Cu has gained considerable attention towards antibacterial application due to its special characteristics such as high Surface-to-volume ratio, shape, and size, and potential for treating bacterial infections.

**Objective:** The present work explores the use of non-ionic natural polymer, hydroxypropyl methylcellulose (*HPMC*) as a capping agent to prepare the Cu NPs for antibacterial applications.

**Methods:** Preparation of hydroxypropyl methylcellulose-copper nanoparticles (*HCu NPs*)was done by a simple precipitation method, followed by the preparation of hydroxypropyl methylcellulose hydrogel film (*HPMC HF*) and hydroxypropyl methylcellulose -HCu nanocomposite hydrogel film (*HPMC-HCu NHF*) by solution casting method. The prepared materials were characterized by different instrumentation techniques (*FTIR, XRD, DSC, TGA, SEM* and *TEM*) and examined the antimicrobial activity against both Gram-positive and Gram-negative bacteria.

**Results:** The *XRD* studies confirmed that the formed NPs have a face-centered cubic structure with 42 nm of crystalline size calculated using the Debye–Scherrer equation. The SEM and TEM studies revealed that the formed HCu NPs had a spherical structure with an average size of ~38 ± 2 nm. The NHF SEM image showed rough surface morphology and the cross-section image exhibited a honeycomb structure packed with HCu NPs. DSC studies explained that the Cu NPs enhanced the melting temperature and lowered the decomposition temperature of *HPMC*. Then, TGA results suggested that the HCu NPs had 97.64 % of Cu NPs and the thermal stability of the NHF was improved with the increasing amount of HCu NPs. Antibacterial activity of the resultant NHFs showed the MIC and MBC values of 350 and 1400 µg/mL for *S. aureus*, and 500 and 2000 µg/mL for *E. coli*, respectively.

**Conclusion:** The developed materials (*HCu NPs* and *HPMC-HCu3 NHFs*) exhibited promising antibacterial activity against both *E. coli* and S. aureus due to the increase in surface interactions between NHFs and bacteria. These results successfully demonstrated that the HCu NPs incorporated in HPMC NHFs can be used effectively in antibacterial applications. However, some more experiments need to be performed to corroborate the antibacterial activity of the NPs and NHFs in clinical samples.

## Biography

Radha Devi Pyarasani has obtained her doctorate in Ciencias con mencion y investigacion y desarollo de producto bioactivos From University of Talca, Chile. Her expertise in the synthesis of Metal Nanoparticles and nanocomposite hydrogels, evaluates its biomedical and photocatalytic applications. She has been working for years in this area to develop new materials with improved properties at low cost and environmentally friendly. Her passion is to improve the health care system by developing improved matrials for wound care dressing and to develop smart nanomaterials with improved mechanical and Physico-chemical and thermal properties for water remediation.

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# GENERALIZING ROSENBLUTH'S ALGORITHM TO INCLUDE ALONG-THE-CHAIN INTRAMOLECULAR ENERGIES

**Ebtisam A. Aldaais[1] and Scott Crittenden[2]**

*[1]Imam Abdulrahman Bin Faisal University, Saudi Arabia*
*[2]University of South Carolina, USA*

## Abstract

**Background:** In 1955, Rosenbluth developed a chain-growth technique for Self-Avoiding Random Walk (*SARW*) with a set of weights that allows one to approximate all possible configurations of a real chain in a cubic or square lattice.

**Objective:** To generalize Rosenbluth' theory to model free or extended chains.

**Methods:** We incorporate the Boltzmann factors for intermonomer bending energy into Rosenbluth's algorithm's monomer growth direction choice. This allows for the consideration of compact (bent state lower in energy), free (straight and bent state equal in energy), or extended chains (bent state higher). We validate against, and compare to, various other results, showing very good agreement with known results for short chains.

**Results:** In total, the developed theory is able to model chains with up to 500 segments long, far beyond the length at which the normal Rosenbluth's method becomes unstable for reasonable nonzero bending energies.

**Conclusion:** The approach is easily generalizable both to other energies determinable during chain growth, for example, polymers composed of more than one type of monomer with differing monomer interaction energies, as well as to other chain production algorithms.

## Biography

Ebtisam A. Aldaais has polymer physics and computational biology expertise in healthcare applications. She has 12 years of experience in research and 18 years of teaching and administration in educational institutions. Most of her research interests are modeling polymer-based drug delivery systems, protein structures, and computational image analysis. She has published several papers and participated in conferences in America, Europe, Taiwan, And Brazil. The foundation of this research should improve the Rosenbluth modeling method, which has been used since 1955.

# A SIMPLIFIED TECHNIQUE TO EVALUATE THE STRENGTH AND STIFFNESS OF A FILAMENT WINDING CFRP COMPOSITE PROPELLER HOLLOW DRIVE SHAFT: COMPARISON TO A CONVENTIONAL HIGH STRENGTH STAINLESS STEEL ALLOY PROPELLER SHAFT

**Ayman Yousef Saleh Alhinai, Stylianos Markolefas, Mayank Anand and Bader Ibrahim Al Baroomi**

*Military Technological College, Oman*

## Abstract

Filament Winding (*FW*) is an advanced composite material fabrication technique that is used to construct generally shaped axisymmetric hollowed components. Fiber tows, subjected to tension are passed through a resin bath and wound around a mandrel in a variety of orientations controlled by the relative motion of the delivery eye and the rotating mandrel. An important application of *FW* process in Marine Engineering is the construction of propeller drive shafts. Composite propeller drive shafts have great advantages over their conventional steel alloy counterparts. Owing to their high strength to weight ratio, composite shafts can be made longer, resulting in fewer shaft segments and simpler drive line configurations. On the other hand, conventional steel alloy drive lines are made up of multiple shaft segments, resulting in a large number of supporting bearings and universal joints. The objective of the current work is twofold. Firstly, a simplified methodology based on Classical Lamination theory is developed in order to evaluate the stiffness and strength reserve factor of a hollow composite propeller drive shaft segment, subjected to Torsional, Bending and Thrust (compressive) loading conditions. Equivalent ply properties are employed for the evaluation of the macro-mechanical behavior of the *FW* composite hollow shaft wall laminate. The theoretical developments are applied on a particular drive shaft segment of eight meters long, capable of carrying 33000 KW power at speed 940 RPM with transmitted torque 335 KNm. Composite shaft external diameters of 300, 400 and 500 mm are considered, with thicknesses of 40 mm (200 equivalent plies) and 50 mm (250 equivalent plies). Various FW angles and stacking sequence combinations for the equivalent plies are examined, in order to optimize the shaft shear rigidity (minimize the angle of twist due to torque) and the shaft bending stiffness. The proposed simplified method is verified using a 3D shell finite element model for the composite propeller drive shaft segment. The second objective of the current work is the comparison of the proposed composite shaft analysis to the respective results of the same size high strength stainless steel propeller shaft. The aim of the comparison is to demonstrate and quantify the superiority of the composite drive shaft, in terms of strength to weight performance indices.

## Biography

Ayman Alhinai is currently a mechanical engineer at the Royal Navy of Oman (RNO). Ayman is a member of IMechE and Energy Institute having obtained his Advanced Diploma and Bachelor's degree in Mechanical Engineering from the Military Technological College (MTC). His open and contextual evaluation model is based on designing, analyzing, and comparing a high-strength stainless steel alloy with a CFRP composite propeller drive shaft creating new pathways for improving marine applications. He conducted this research as part of his Bachelor's degree studies at MTC.

# rGO DECORATED NANOPARTICLES: AN ADVANCED CATALYST FOR THE HYDROGEN EVOLUTION REACTION

**Kishor Kumar Sadasivuni[1], Mizaj Shabil Sha[1], Bagmita Bhattacharyya[1], Aboubakr M. Abdullah[1] and Bijandra Kumar[2]**

*[1]Qatar University, Qatar*
*[2]Elizabeth City State University, USA*

## Abstract

Water splitting electrolysis is a promising pathway to achieve the efficient hydrogen production in terms of energy conversion and storage in which catalysis or electrocatalysis plays a critical role. The development of active, stable, and low-cost catalysts or electrocatalysts is an essential prerequisite for achieving the desired electrocatalytic hydrogen production from water splitting for practical use. Herein, we evaluated a graphene modified nanoparticle catalyst for a highly efficient hydrogen evolution reaction. The photocatalytic $H_2$ production rate of rGO/$TiO_2$/NiO/ZnO is high and exceeds that obtained on components alone. This improvement is due to the presence of rGO as an electron collector and transporter. Moreover, a current density was recorded at reduced working potential by 365 mV for nanocomposite. Analysis reveal that the hydrogen evolution reaction catalytic activity of the nanoparticle is induced by the strong electronic coupling effect between the components of nanoparticle at the interface.

## Biography

Kishor Kumar Sadasivuni is currently working as a Research Assistant Professor and the group leader of SmartNanoSolutions at Center for Advanced Materials, Qatar University. Dr. Kishor's research has its roots from the analytical chemistry he mastered during his Master's degree in Andhra University, India. He received his Ph.D. in Materials Science and Engineering from University of South Brittany at Lorient, France in 2012 under the supervision of the Professor Yves Grohens. He was appointed to the Center for Advanced Materials at Qatar University in 2018 as a Research Associate from which he has been promoted to his present designation as Research assistant Professor in June 2021. He has been included in the world's top 2 % scientists according to a list compiled by Stanford University in the year 2019, 2020 and 2021 and for this he was recently honored by the QU. He has enormous knowledge and valuable experience in his field owing to over 12 years of active research experience of 12 years. Dr. Kishor has more than 350 research articles published in international peer reviewed journals with a total citation of 9836 and h-index 53. Dr. Kishor is an expert in the nanomaterials engineering, especially the sensing and flexible electronics. He has a keen interest towards development of different devices based on the smart materials by engineering IoT. Such composites find useful applications in sensors, electro-active lenses, memory devices, energy storage devices and actuators. These devices have their applicability and end-users in security systems, biomedical devices, agriculture sector, waste management, sensors, and other industrial fields. Some of Dr. Kishor's inventions are protected by 3 US patents and 2 Indian patents and presently 5 patent disclosures have been submitted by him. His strong academic background and passion for research is remarkable and reflected in his fast paced career growth.

# STRUCTURE AND POSSIBLE MAGNETIC PHASE IN SN-DOPED $La_{0.67}Ca_{0.33}MnO_3$

**Zohra Ali Gebrel**

*Faculty of Science Sabratha, University of Sabratha, Libya*

## Abstract

In this paper, we report the effect of Sn substitution on the magnetic and transport properties of the colossal magneto resistive compound $La_{0.67}Ca_{0.33}MnO_3$, (referred to as *CMR*) . The X-ray diffraction, resistivity, AC susceptibility and magnetization were studies. The effect of $Sn^{+2}$ substitution for $La^{+2}$ in the ferromagnetic manganite $La_{0.67}Ca_{0.33}MnO_3$ has been studied by preparing a series of$(La_{1-x}\ Sn_x)_{0.67}Ca_{0.33}MnO_3$ (x=0, 0.1, 0.2, 0.3 and 0.4) by Solid state reaction (*SSR*) methods. the XRD patterns for all the samples are of single phase. The patterns could be indexed to orthorhombic symmetry with the space group Pnma. The temperature dependence of resistance showed two maxima in the Sn-doped sample for $x \leq 0.4$, and the peak value of magnetoresistance (*MR*) around insulator–metal transition temperature was decreased with Sn-doping increased . Experimental results show that the ferromagnetism at low temperature is suppressed and the system is driven into a randomly canted ferromagnetic state for x=0.0 and 0.1. hence a cluster spin-glass state for x=0.2, 0.3 and 0.4.

## Biography

Zohra Ali Gebrel is currently working as Assistant Professor in Department of Physics in Faculty of science at the University Sobratha Libya (SAB).

EDUCATION: 2013L Dr - Faculty of Physics, University of Belgrade, (Doctoral dissertation: " Synthesis and Magnetic Properties of Pure and Substituted Yttrium Cuprates and Manganites") worked in Vince instituted as Ph.D student2007-2012

2001 – (MSC) Faculty of Physics, University of putra Malaysia (UPM).

1997. Graduated Physicist - Faculty of Physics, University of Alfatah -Tripoli Libya, (BSC)

FIELD OF ACTIVITY: Synthesis of magnetic materials based on rare earths and transition metals Analysis of crystalline structure of polycrystals by X-ray diffraction. Testing and characterization of magnetic properties using different experimental techniques (SQUID magnetometer, etc.).

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# CARBON NANO FIBRE INFUSED ULTRA-HIGH-PERFORMANCE FIBRE REINFORCED CONCRETE: COMPRESSIVE STRENGTH AND MODULUS OF ELASTICITY

**Raafat El-Hacha[1], Marwa Ibrahim[1], and Vic Perry[2]**

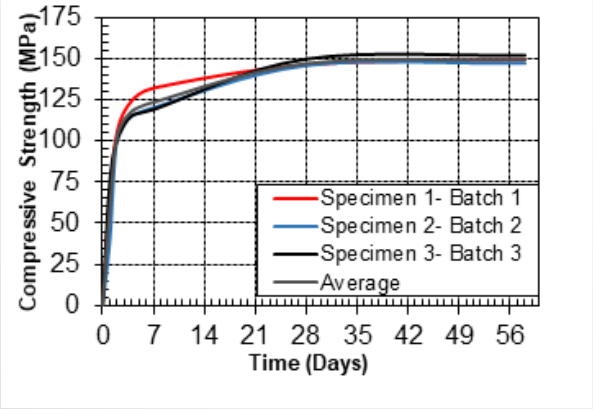
[1]*University of Calgary, Canada*
[2]*ceEntek North America, Canada*

## Abstract

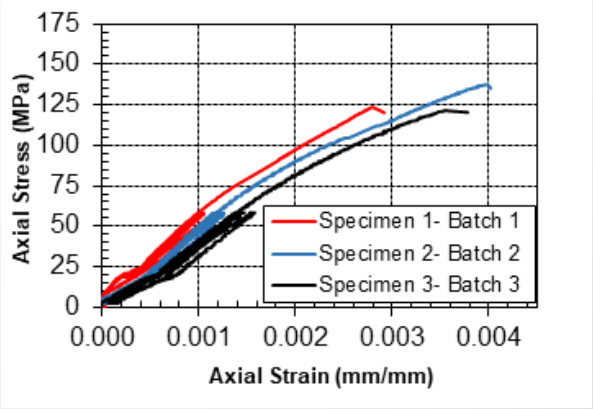
**Background:** The compressive strength ($f_c'$) is one of the most important construction material characteristics that classifies concrete into different strength categories, like Normal Strength Concrete (NSC), High Strength Concrete (HSC) and Ultra-High-Performance Fibre Reinforced Concrete (UHPFRC). Design-wise, the compressive strength is also used to calculate the modulus of elasticity (Ec), which, in turn, dictates the serviceability conditions. This compressive strength-modulus of elasticity (C-M) analytical relationship is of interest in this study using revolutionary Carbon Nano Fibres (CNF) infused UHPFRC. CNF UHPFRC is a special-purpose cementitious mix of enhanced compressive strength, post-cracking tensile strength, and improved durability.

**Objective:** This study aims to assess the accuracy of the C-M analytical relationship of CNF-UHPFRC, as recommended by the design guidelines. The analytical results are verified against experimental ones. It is worth noting the importance of these characteristics as they are key parameters in the structural design of any reinforced concrete element.

**Methods:** For variability reasons, three batches of the same mix design were cast. The batching procedure consisted of first mixing the dry UHPFRC constituents, then introducing the water and CNF suspension, and finally adding the steel fibres. After mixing the final product for a few more minutes, the concrete is poured into the cylinders (75 mm x 150 mm) and manually tapped a few times to eliminate internal voids without affecting the fibres' distribution. Standard curing procedure in the fog room is followed until the testing day. Compressive strength test (ASTM C39 and ASTM C1856) was carried out at the ages of 1, 2, 4, 7, and 56 days using three specimens per age (each from a batch). The ages were selected to intensely record the fast early-age strength gain and the belated long-term representative strength. On the other hand, the modulus of elasticity test (ASTM C496 and ASTM C1856) was carried at the 28th day using three specimens (one specimen per batch).




**Graph 1:** Compressive Strength Gain




**Graph 2:** Modulus of Elasticity Stress-Strain Curve

**Results:** The strength gain shown in Graph 1 can be divided into three portions: sharp and rapid early-age increase with time, followed by a slower strength gain, and finally, a flat slope. CNF-UHPFRC showed an average of 61.3 MPa and 148 MPa compressive strengths at the ages of one and 28 curing days, respectively. Therefore, strength-wise, it roughly conforms to ACI 239's definition of UHPFRC (minimum 28th-day compressive strength of 150 MPa). Graph 2 shows the stress-strain results for three moduli of elasticity samples. These were subjected to three loading-unloading cycles up to 40% of their compressive strength. While the first cycle is mainly used for specimen's seating, the slope of the second and third ones are used to calculate Ec. Russell and Graybeal [1] recommended for UHPFRC Eq. (1) for the analytical determination of $E_c$ (28 MPa $< f_c' <$ 193 MPa). Table 1 summarizes the experimental and analytical results.

$Ec = 46200\sqrt{f_c'}$ (psi) Eq. (1)

| Specimen | Batch | Cycle | $E_c$ (GPa) | Average (GPa) | $f_c'$ (MPa) | Ec (Eq. 1) (GPa) |
|---|---|---|---|---|---|---|
| 1 | 1 | 2 | 47.609 | 49.021 | 146.8 | 46.486 |
| | | 3 | | | | |
| 2 | 2 | 2 | 47.2 | 48.404 | 146.8 | 46.486 |
| | | 3 | | | | |
| 3 | 3 | 2 | 41.273 | 42.633 | 150.6 | 47.084 |
| | | 3 | | | | |
| | | | **Average** | **46.686** | **148.067** | **46.685** |
| | | | **St. Dev** | **2.87695** | **1.79134** | **0.2819** |

**Table 1:** Summary of Experimental and Analytical Results.

**Conclusion:** The experimental data has a wider scatter than the analytical one, although both have approximately the same average modulus of elasticity (46.68 GPa). Although the UHPFRC used in this study included CNF, which improves its mechanical properties, while Eq. (1) was reported only for UHPFRC with steel fibres, the presented preliminary results show Eq. (1) can be applied regardless of the type of fibres infused in the concrete mix.

## Biography

Raafat El-Hacha, is a Professor of Structural Engineering at the University of Calgary in the Department of Civil Engineering, Canada. Dr. El-Hacha's pioneer research has been recognized as pushing the boundary of knowledge in using innovative and smart advanced materials for strengthening structures and new construction, such as fibre-reinforced polymers, shape memory alloy and ultra-high performance concrete for hybrid structural systems in bridge applications and other structures. He published over 250 journal and conference papers. Supervised and graduated 50 Ph.D. and MSc students. He is a Fellow of the International Institute for FRP in Construction (IIFC), the Canadian Society of Civil Engineers (CSCE), the distinctions including the CSCE Casimir Gzowski Gold Medal Award, CSCE Excellence in Innovation in Civil Engineering Award, IIFC President's Award, Killam Professorship Award, Erasmus Mundus International Fellowship and many others for his outstanding academic and professional achievements.

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# ENVIRONMENTALLY FRIENDLY SURFACE FILMS FOR CORROSION PROTECTION OF GALVANIZED STEEL

**Nelly Boshkova[1], L. Lutov[2], N. Tabakova[3] and N. Boshkov[1]**

[1]*Institute of Physical Chemistry, Bulgarian Academy of Sciences, Bulgaria*
[2]*Sofia University, Bulgaria*
[3]*Institute of Organic Chemistry with Center of Phytochemistry, Bulgarian Academy of Sciences, Bulgaria*

## Abstract

**Background:** Localized corrosion is a dangerous process causing great economic, health and financial damages. In order to decrease its influence different types of protective coatings are applied some of which are based on environmentally friendly materials like gelatin.

**Objective:** Aim of this investigation is to characterize the influence of chemically deposited surface protective film based on gelatin on the corrosion resistance and electrochemical behavior of galvanized low-carbon steel in a model test medium containing chloride ions as corrosion activators. The latter generally lead to appearance of localized corrosion which impact is needed to be minimized.

**Methods:** Generally, electrochemical methods are applied to evaluate the corrosion resistance and protective ability of the investigated films – Potentiodynamic (*PD*) polarization curves, Electrochemical Impedance Spectroscopy (*EIS*), Polarization resistance (*Rp*) measurements for a definite time period. Scanning electron (*SEM*) microscopy are used for studying of the surface morphology of the coatings before and after corrosion treatment.

**Results:** The investigations are carried out in a model corrosive medium of 5% NaCl solution at ambient temperature. The results show the positive influence of the newly developed films on the corrosion resistance and protective ability of the galvanized low-carbon steel.

**Conclusion:** The experimental data demonstrate that the application of environmentally friendly films on galvanized low-carbon steel improves the corrosion resistance and protective ability of the material in the presence of aggressive chloride ions.

## Biography

Nelly Boshkova is working at "Electrochemistry and Corrosion" Department at the Institute of Physical Chemistry at Bulgarian Academy of Sciences. She has his expertise in the field of electrodeposition of different types of corrosion resistant coatings and multilayer systems etc. as follows: galvanic zinc and zinc-based coatings; hybrid coatings; nanocomposite coatings; conversion environmentally friendly layers; concrete and civil engineering; nanoparticles and nanotechnology.

# SHAPED-CONTROLLED NANOCRYSTALS WITH CARBON DOTS-BASED COCATALYST FOR PHOTOCATALYTIC HYDROGEN PRODUCTION

**Hana Kmentová, Mahdi Shahrezaei, Lukáš Zdražil and Štěpán Kment**
*CATRIN-RCPTM, Palacký University Olomouc, Czech Republic*

## Abstract

**Background:** The development of highly efficient energy conversion/storage devices has attracted great attention from scientific and technological researchers due to the increasing concerns for the environment and the depletion of fossil fuels. In this context, the development of cost-competitive materials capable of producing fuels or electricity directly from the energy harvested from sunlight offers a desirable approach towards fulfilling the need for clean, sustainable, and secure energy.

**Objective:** The preparation of high-quality different shaped nanocrystals of the $TiO_2$ photocatalysts. The incorporation of defects via highly controllable defect engineering. The incorporation of CDs as a co-catalyst for surface photocatalytic redox reactions and for photocatalytic hydrogen production measurements.

**Methods:** In our lab we can prepare $TiO_2$ nanotubes by anodization technique and highly pure brookite $TiO_2$ nanorods (NRs) via a facile hydrothermal method. Preparation of carbon dots is based on dissolution of aspartic acid in appropriate solvent and the transfer of solution into a 23 mL Teflon-lined stainless-steel autoclave and place into a furnace heated at 210°C for 8 hours. Then the samples will be the subject of measuring the real hydrogen evolution due to photocatalytic water splitting. The amount of hydrogen produced under irradiation and accumulating in the photoreactor will be determined online by Gas Chromatograph coupled to a Mass Spectrometer (*GC–MS*).

**Results:** We successfully prepared the different shape $TiO_2$ nanocrystals, decorated them with carbon dots and we efficiently drove hydrogen production under solar light. We systematically investigated the properties of pure $TiO_2$ and $TiO_2$/CDs composites through material characterization using different spectroscopic techniques (*SEM, HRTEM, EPR, XPS, AFM*).

**Conclusion:** Our results show ability to anchor the carbon dots to the surface of $TiO_2$ nanorods through defects caused by thermal treatment in hydrogen atmosphere and the data from GC-MS measurements show nearly 30 times higher efficiency in terms of photocatalytic hydrogen generation.

## Biography

Hana Kmentová graduated from University of Chemistry, Prague in 2006. Then I earned my Ph.D. degree from the Institute of Chemical Process Fundamentals of the Academy of Sciences of the Czech Republic (*ICPF, CAS*) where I completed work in the spring of 2009. I was a Postdoc at the University of Nebraska – Lincoln in 2010-2011 at the Department of Electrical Engineering. Currently, I work at the Czech Advanced Technology and Research Institute-RCPTM, Palacký University Olomouc, Czech Republic. My research is focused on Advanced Hybrid Nanostructures for Solar Water Splitting Applications.

Research Interest: My research interests are focused on chemical preparation of different semiconductors ($TiO_2$, $Fe_2O_3$, $FeS_2$, CdS, $BiVO_4$) by different methods (sol-gel route, chemical bath deposition, hydrothermal methods, electrodeposition). Together with preparation of semiconductors goes their physical characterization by Raman spectroscopy, X-ray diffraction, XPS, UV/Vis spectrophotometry, FTIR, AFM, SEM, TEM. I also study the functional properties of semiconductors, such as Hall effect, photoelectrochemical (*LSV, CV*, amperometry), advanced photoelectrochemical (*IPCE, EIS, IMPS, IMVS*) measurements and detection of hydrogen concentration by *GC/MS* system.

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# PROPERTIES OF OXIDIZED SURFACE LAYERS PRODUCED BY THE PDT METHOD ON THE $Zr_{48}Cu_{36}Al_8Ag_8$ BULK METALLIC GLASS

**Piotr Błyskun, Krzysztof Kulikowski, Karol Wunsch and Tadeusz Kulik**

*Warsaw University of Technology, Poland*

## Abstract

**Background:** Among many bulk metallic glasses, the Zr-based ones are distinguished by their unique combination of high glass forming ability with good mechanical properties. The $Zr_{48}Cu_{36}Al_8Ag_8$ alloy was selected to perform pioneering oxidizing treatments below its glass transition temperature in low- temperature plasma to study the properties of such a surface treated material.

**Objective:** The aim of this work was to investigate the possibility of the $Zr_{48}Cu_{36}Al_8Ag_8$ bulk metallic glass oxidation in low-temperature plasma in order to improve their micromechanical properties without the substrate crystallization.

**Methods:** The $Zr_{48}Cu_{36}Al_8Ag_8$ bulk glassy samples were subjected to plasma oxidation processes in low-temperature plasma. The influence of the process time (30-180 min) and the ions accelerating voltage on the surface structure and its microhardness were determined. After the process, the phase analysis (*XRD*) and Vickers microhardness measurements were performed.

**Results:** As a result of the conducted research, the relationship between process duration, applied accelerating voltage and the obtained surface microhardness was demonstrated. During the process of plasma oxidation, the tetragonal zirconium oxide $ZrO_2$ formed on the surface, leading to an increase in the surface microhardness. Extending the process time and increasing the kinetic energy of ions allowed for obtaining layers with higher surface microhardness.

**Conclusion:** The oxidation process in low-temperature plasma, below the glass transition temperature, is a viable method of the $Zr_{48}Cu_{36}Al_8Ag_8$ bulk metallic glass microhardness improvement. The increase in hardness occurs as a result of the zirconium oxide $ZrO_2$ formation.

## Biography

Piotr Błyskun is a young but passionate scientist who specializes in the area of bulk metallic glasses preparation and characterization. He is particularly focused on preparation conditions and their influence on the glass forming ability of Zr-based bulk metallic glasses. His recent interest lies in metallic glasses' properties improvement by various surface treatments.

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# THE AMINE PLASMA POLYMER COATINGS FOR INCREASING ENDOTHELIZATION OF VASCULAR STENTS

**Solovieva Anastasiya O.[1], Sitnikova Natnalia[1], Manakhov Anton M.[1], Lenka Zají˘cková[2] and Lucie Blahova[2]**

*[1]Research Institute of Clinical and Experimental Lymphology, Russian Federation*
*[2]Laboratory of Biomaterials and Tissue Engineering, Institute of Physiology of the Czech Academy of Sciences, Czech Republic*

## Abstract

**Background:** Cardiovascular disease is the leading cause of death worldwide. One of the effective therapeutic approaches to the treatment of vascular occlusions that cause critical ischemia is vascular stents. However, one of the significant problems of vascular implants is late thrombosis, which leads to recurrence of occlusion.

**Objective:** To examine the influence of amine plasma polymer (PP) coatings to endothelization of polycaprolactone nanofibers.

**Methods:** The amine-PP films were deposited on nanofibrous PCL membranes in a stainless-steel parallel plate reactor. The modes of deposition of thin plasma polymers containing NH2 groups were worked out depending on the voltage (from 30 to 60 W) and the deposition mode (a pulsed wave or in a continuous wave). Human endothelial cells were planted on samples of nanofibers; as a control, cells were seeded on culture plastic coated with collagen IV. After 3 days of cultivation, the total number of cells (by staining of nuclei with a fluorescent dye Hoechst33342), their proliferative activity (by Click-iT™ EdU Cell Proliferation Kit) and mitochondrial potential (by TMRM Assay Kit) were assessed.

**Results:** As a result, it was demonstrated that the modification of the surface of polycaprolactone with amine plasma polymer coatings significantly increases the colonization of the scaffold with endothelial cells. Moreover, the pulse mode of applying the polymer makes it possible to form a polymer layer that significantly more stimulates proliferation and the formation of a full-fledged layer of endothelial cells.

**Conclusion:** Thus, the modification of the surface of inert synthetic fibers with amino groups presented in the work can significantly increase the rate of their seeding with autologic endothelial cells, thereby improving the quality of the implant, reducing thrombosis risk and increasing the success of stenosis treatment.

**Acknowledgment:** The reported study was funded by Russian Foundation for Basic Research RFBR (project number 20-52-26020).

## Biography

Solovieva Anastasiya has Academic background from 9/1999 – 6/2007 as graduate student, Novosibirsk State University; 10/2007-9/2010 as PhD student; 12.11.2014 -PhD in cell biology, cytology and histology. From 2017 Head of laboratory of pharmaceutical active compounds in Research Institute of Clinical and Experimental Lymphology – branch of ICG SB RAS. The main areas of work: regenerative medicine, stem cells, screening of synthesized compounds, determination of their cytotoxicity, studies of mechanism and kinetics of intracellular penetration and excretion, intracellular distribution. Determination of the specific activity of synthesized compounds, acute and chronic toxicity in vivo. Pathomorphological studies.

# ELECTROPULSE AND FURNACE SINTERING OF A TUNGSTEN-BASED POWDER COMPOSITION WITH COPPER, NICKEL AND IRON ADDITIVES FOR RADIATION PROTECTION

**Vadzim Savich, Ilyushchanka A., Tarajkovich A.M., Kuznechik O.O., Tarusov I.N. and Golodok R.P.**

*O.V.Roman Powder Metallurgy Institute, Belarus*

## Abstract

Composite materials based on tungsten powder with additions of copper, nickel and iron, having a density of at least 16.5 g/cm$^3$, are promising not only for use in mechanical engineering and energy, but also for radioactive protection radiation in radiation therapy devices, X-ray devices and MRI. A comparative study of such materials production using traditional sintering in high-temperature furnaces and the method of electric pulse sintering (*EIS*) has been carried out. The results showed that high-speed EIS processes ensure the consolidation of a multi component charge, but generate residual stresses that reduce strength by an average of 20% compared to similar materials obtained after furnace sintering. The subsequent heat treatment of materials obtained with the help of EIS provides strength by 10-15% than with traditional furnace sintering technology.

## Biography

Vadzim Savich is co-author of 110 inventions, has more than 300 published papers. Research interests - powder metallurgy of titanium and titanium alloys. With his contribution, the Institute developed a technology and created industrial production of porous disk aerators sintered from titanium powder, widely used in the technology of drinking water purification, process water purification, wastewater treatment in more than 10 cities and 6 large industrial enterprises of the CIS countries. He created a new work direction on the porous and composite orthopedic implants from spongy titanium powder with optimal biomechanical and other operational properties production. Research is being conducted and methods and equipment for monitoring the properties of porous powder materials are being developed.

# MICROSTRUCTURE AND PROPERTIES OF COBALT-BASED COMPOSITE POWDERS REINFORCED BY INCLUSIONS OF TITANIUM CARBIDE OBTAINED BY VIGA

**Aliaksandr Ilyushchanka, Letsko A.I., Reutsionak Y.A., Machnev V.S. and Parnitski N.M.**

*O.V.Roman Powder Metallurgy Institute, Belarus*

## Abstract

The vacuum induction melting and sputtering in an inert gas medium method (*VIGA*) is used to obtain powders of a heat-resistant composite material based on cobalt, reinforced with titanium carbide inclusions. The resulting powders phase composition and structure have been studied. The size decrease of carbide inclusions to a size of less than 2 μm after remelting and spraying by the VIGA method compared with the original alloy obtained by SHS metallurgy has been established. Technological properties (bulk density, fluidity) of the obtained powders were studied depending on the fractional composition. The developed composite materials based on cobalt are characterized by high resistance to thermal fatigue and satisfactory manufacturability and are an alternative to nickel alloys.

## Biography

Aliaksandr Ilyushchanka has main direction in scientific activity which is connected with the materials science tasks of developing composite powders, protective powder coatings, special and high-energy materials, theoretical foundations and processes for their production, which served as the basis for the technologies and equipment for their implementation creation. Under the leadership of A. Ilyushchanka, new production facilities for powder coatings, composite powders, structural and friction products from metal, cermet and ceramic powders, carbon-carbon composite materials, materials for metallurgical 3D printing, and utilization of high-powered ammunition were organized. A. Ilyushchanka is doing a lot of scientific, organizational and pedagogical work. He has more than 1170 published articles and inventions, including 29 books, 17 copyright certificates and 163 patents. He is an Academician of the National Academy of Sciences of Belarus, Professor, Doctor of Technical Sciences, Director General of the State Research and Production Association of Powder Metallurgy - Director of the O.V. Roman Powder Metallurgy Institute.

# SURFACE MODIFICATION OF THE $Zr_{48}Cu_{36}Al_8Ag_8$ BULK METALLIC GLASS IN GLOW DISCHARGE PLASMA NITRIDING

**Krzysztof Kulikowski, Piotr Błyskun and Tadeusz Kulik**
*Warsaw University of Technology, Poland*

## Abstract

**Background:** Bulk metallic glasses are modern engineering materials with unique functional properties. Zr-based alloys are particularly attractive as they exhibit high glass forming ability as well as good mechanical properties. Due to their relatively high thermal stability, reaching as much as 300 °C, they can be surface treated in low-temperature plasma in order to further improve their mechanical properties.

**Objective:** The subject of this work was to determine the influence of technological parameters of surface treatments in low-temperature plasma on the structure and mechanical properties of the $Zr_{48}Cu_{36}Al_8Ag_8$ bulk metallic glass.

**Methods:** The $Zr_{48}Cu_{36}Al_8Ag_8$ bulk metallic glass has been subjected to glow discharge nitriding processes in low-temperature plasma. The surface treatments were carried out at 300°C for 30 min. In the course of the work, the influence of the ions accelerating voltage on the structure and micromechanical properties of massive metallic glass was analyzed. The produced samples were characterized in terms of microhardness, nanohardness and Young's modulus of the surface layer. Moreover, the adhesion of the produced layer was determined using the scratch-test method.

**Results:** As a result of the low-temperature plasma nitriding, an increase in the surface hardness of the $Zr_{48}Cu_{36}Al_8Ag_8$ bulk metallic glass was obtained. The obtained results show a relationship between the voltage and the hardness of the surface layers. As the accelerating voltage increased from 400 to 1000 V, the nanohardness of the surface zone increased from 8.18 GPa to 14.30 GPa. The produced layers are characterized by high adhesion to the substrate as well as high cohesion.

**Conclusion:** The conducted research indicates the possibility of modifying the surface properties of bulk metallic glasses in diffusion processes in low-temperature plasma, within their thermodynamic stability range.

## Biography

Krzysztof Kulikowski is a specialist in the field of materials modifications by surface engineering methods. He is also an experienced researcher in the prepared layers analysis. His expertise covers the design and implementation of surface treatments (i.a. PDT, PACVD), including hybrid treatments design and implementation of PDT processes (glow discharge nitriding, carbonitriding, oxygen carbonitriding) combined with chemical and electrochemical coating production as well as PVD and CVD techniques.

# RADIATIVE ENERGY TRANSFER IN OPTICALLY BOUND COLLOIDAL QUANTUM DOT SPHERES

**Marios Sergides[1], Modestos Athanasiou[2], Pedro Alves[2], Charlotte Eling[2], Nicolas Laurand[2], Grigorios Itskos[2] and A. Othonos[1]**

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[2]*Institute of Photonics, University of Strathclyde, United Kingdom*

## Abstract

Evanescent fields find applications in a plethora of areas due to their positive features such as near- surface interactions free from the diffraction limit, plasmon resonance excitation, low laser power requirements and on- chip integration. They are widely used for the manipulation and transport of particles sized from the micro- to the atomic scale, as well as to improve signal-to-noise ratio in fluorescence microscopy. The use of these exponentially decaying fields to manipulate light-emitting material can prove advantageous. Material such as colloidal quantum dots, which offer high emission quantum yield, tunability and solution processability make a great candidate for this purpose. We present experimental work combing evanescent field optical binding and total internal reflection microscopy of spherical supraparticles made of $CdS_xSe_{1-x}$/ZnS quantum dots emitting at 540 nm and 630 nm. The optical binding force allows for the synchronized control of multiple particles with high precision creating ordered structures such as one-dimensional particle chains, while total internal reflection excitation provides high signal-to-noise ratio. Evanescent fields in this configuration are generated on a glass-water interface by two different laser sources: one for particle manipulation (1064 nm) and another for photoluminescence excitation (405 nm). Combination of video microscopy and emission spectrometry revealed photoluminescence enhancement when the spherical particles were in one-dimensional bound states, in contrast to cases were the particles allowed to relax. This can be attributed to radiative energy transfer mediated via the formation of whispering gallery modes when the confined particles are in close proximity. The results demonstrate that this experimental configuration can potentially be an alternative for self- assembling light-emitting micro and nanomaterial while optimizing their interactions. The successful confinement and creation of dynamically configurable ordered structures of nanoparticles, such as quantum dots which are commercially used, can be of great importance to the scientific community and could possibly lead to novel applications.

## Biography

Marios Sergides has attained a versatile research background in experimental physics and in particular in photonics and optoelectronic devices. He is an expert in optical manipulation of "small" scale particles and specifically in optical binding and the self-assembly of photonic lattices through light-mediated interactions. His work also involved the design and realization of highly tunable plasmonic nano-arrays aiming to confine and detect nanoscale objects. His experience also extends to biophysics with his work on the conversion of mechanical forces into biochemical signals by combining optical tweezers and fluorescence microcopy on living cells, as well as on the interactions between mechanosensitive proteins, under various conditions of mechanical load using ultra-fast optical traps. He is currently interested in the study of dynamics of interactions on ultrashort time scale, and in optical characterization techniques of novel semiconductor materials.

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# FLEXIBLE HYBRID NANOGENERATOR FOR ENERGY HARVESTING AND AS A SELF-POWERED $NH_3$ GAS SENSOR

**Elhassen Cheikh Elhadrami, D. Alsoudi, N. S. Almoftah, Z. Elsayed, E. Alijumili, S. Almannai, E. C. Elhadrami, H. Parangusan, J. Bhadra, D. Ponnamma and N. Al-Thani**

*Qatar University Young Scientists Center, Qatar University, Qatar*

## Abstract

**Background:** Applications for wearable technology in the future would require for smart sensors with outstanding durability and self-powered features. There has been significant concern over the detection of gas in many industries. Conventional gas sensors, however, require an external power source, which limits their usage as a portable device and does not meet the low power and self-powered criteria of today's internet of things. As a result, a reliable and simple self-powered gas sensor is needed to detect gas at room temperature.

**Objective:** To examine the $NH_3$ gas sensing properties of the fabricated gas sensor.

**Methods:** In this work, we have investigated the Poly(vinylidene fluoride)/$BaTiO_3$-$MoS_2$ composites for the fabrication of self-powered $NH_3$ gas sensors applications. The nanocomposite $BaTiO_3$-$MoS_2$ have been synthesized by hydrothermal method. The spin coating technique has been used to deposit the composite film on the ITO glass electrode.

**Results:** The structural, thermal stability and surface morphology of the Poly(vinylidene fluoride)/$MoS_2$-$BaTiO_3$ composites film were investigated by X-ray diffraction analysis (*XRD*), Thermal gravimetric analysis (*TGA*) and Atomic force microscopy (*AFM*). The *XRD* patterns indicate that pure *PVDF* and its nanocomposites have been successfully synthesized. It's been observed that Poly(vinylidene fluoride)/$BaTiO_3$-$MoS_2$ composites has higher thermal stability as compared to the pure *PVDF*. The morphology of the film indicates that, with the addition of $BaTiO_3$, $MoS_2$ and $BaTiO_3$-$MoS_2$ composite, the average roughness values are increased (6.227 nm, 4.300 nm and 6.555 nm).

**Conclusion:** Poly(vinylidene fluoride)/$BaTiO_3$-$MoS_2$ composite based gas sensors show high thermal stability, fast response time and high sensitivity as compared to the pure *PVDF*.

## Biography

Elhassen Cheikh Elhadrami is an undergraduate student in the Department of Chemical Engineering with focused minors in Engineering Projects Management and Business at Qatar University. He always strives to exploit every research work opportunity to acquire new knowledge. His area of research interest in materials science and engineering field includes nanocomposites, energy harvest, gas sensors, piezoelectricity polymers, nanomaterials for lithium-ion batteries, smart coatings for corrosion protection, and water and air quality characterization. As a matter of principle and life philosophy, honesty, diligence, creativity, and openness are essential values that Al-Hassan believes are integral to any individual's professional and personal success.

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# STEREOLITHOGRAPHIC ADDITIVE MANUFACTURING OF FUNCTIONAL GEOMETRIES

## Soshu Kirihara

*Osaka University, Japan*

## Abstract

In stereolithographic additive manufacturing (*STL-AM*), 2-D cross sections were created through photo polymerization by UV laser drawing on spread resin paste including nanoparticles, and 3-D models were sterically printed by layer lamination. The lithography system has been developed to obtain bulky ceramic components with functional geometries. An automatic collimeter was newly equipped with the laser scanner to adjust the beam diameter. Fine or coarse beams could realize high resolution or wide area drawings, respectively. As the row material of the 3-D printing, nanometer sized metal and ceramic particles were dispersed into acrylic liquid resins at about 60 % in volume fraction. These materials were mixed and deformed to obtain thixotropic slurry. The resin paste was spread on a glass substrate with 50 μm in layer thickness by a mechanically moved knife edge. An ultraviolet laser beam of 355 nm in wavelength was adjusted to 50 μm in variable diameter and scanned on the spread resin surface. Irradiation power was automatically changed for an adequate solidification depth for layer bonding. The composite precursors including nanoparticles were dewaxed and sintered in the air atmosphere. In recent investigations, ultraviolet laser lithographic additive manufacturing (UVL-AM) was newly developed as a direct forming process of fine metal or ceramic components. As an additive manufacturing technique, 2-D cross sections were created through dewaxing and sintering by UV laser drawing, and 3-D components were sterically printed by layer laminations with interlayer joining. Through computer-aided smart manufacturing, design, and evaluation (Smart MADE), practical material components were fabricated to modulate energy and material transfers in potential fields between human societies and natural environments as active contributions to Sustainable Development Goals (SDGs).

## Biography

Soshu Kirihara is a doctor of engineering and a professor of Joining and Welding Research Institute (JWRI), Osaka University, Japan. In his main investigation "Materials Tectonics as Sustainable Geoengineering" for environmental modifications and resource circulations, multi-dimensional structures were successfully fabricated to modulate energy and materials flows effectively. Ceramic and metal components were fabricated directly by smart additive manufacturing, design and evaluation (Smart MADE) using high power ultraviolet laser lithography. Original stereolithography systems were developed, and new start-up company "SK-Fine" was established through academic-industrial collaboration.

# IN-SITU TEM INVESTIGATION OF OSWALD RIPENING IN GERMANIUM GROWTH ON FREESTANDING GRAPHENE AND ITS APPLICATION TO WAFER SCALE LAYER TRANSFER PROCESS (PEELER)

## Abderraouf Boucherif

*Université de Sherbrooke, Canada*

## Abstract

In-situ High resolution transmission electron microscopy (*HR-TEM*) dynamic investigation of the nucleation of germanium islands on free standing graphene allow direct observation of basic phenomenon such as island nucleation, growth and coalescence. The experimental observations demonstrate that nucleation is enhanced by low temperature deposition, and that the coarsening process is dominated by Oswald ripening, this latter phenomenon leads to monocrystalline coalescence when it occurs below a certain critical size.These basic observations have been applied to mesoporous germanium in order to design and fabricate detachable monocrystalline nanomembranes. We have demonstrated the first waferscale detachable and flexible germanium nanomembrane through the new so-called *PEELER* process, the substrate can be re-used to produce more nanomembranes in the same fashion as the remote epitaxy process enabling layer separation and transfer for non-polar group IV-IV materials. It is shown that this substrate is compatible with *MOCVD* growth of device quality materials.

## Biography

Abderraouf Boucherif is an assistant professor of mechanical engineering at Université de Sherbrooke since 2018. He is the 2020 winner of the Tremplin Prize in Natural science and Engineering. His research is focused on semiconductor nanomaterials for green energy. Leading a multidisciplinary team of more than 20 scientists and students, he is the principal investigator of largescale research project in partnership with industry to create new nanomaterial for solar energy applications. Among his major achievements is the demonstration of a process for semiconductor layer transfer and substrate recycling as well as defect free III-V virtual substrate on silicon. He has published more than 70 papers in international peer reviewed journals and received several awards for his outstanding applied research contributions

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# COMPARING DIFFERENT STRATEGIES TO PROTECT AND DELIVER VITAMIN $D_3$ FOR THE TREATMENT OF PSORIASIS

**Marta Gallo, Mauro Banchero, Silvia Ronchetti, Luigi Manna and Barbara Onida**

*Politecnico di Torino, Italy*

## Abstract

**Background:** Psoriasis is a widely diffused dermatological disorder which can have a strong negative impact on the quality of life of patients. Vitamin D3 is known for its efficacy in treating the symptoms of psoriasis. However, because of its highly susceptibility to oxygen, UV light and heat degradation and its low water solubility, Vitamin D3 presents limited bioavailability.

**Objective:** To develop drug carriers suitable to protect and topical deliver Vitamin D3.

**Methods:** Different routes were followed. Vitamin D3 was: i) embedded in a mesostructured silica- surfactant-vitamin hybrid obtained by a one-pot synthesis, ii) loaded on commercial SBA-15 mesoporous silica by solvent impregnation or supercritical $CO_2$ impregnation, iii) incorporated in cyclodextrine and silica-cyclodextrine hybrids.

**Results:** Vitamin D3 was successfully incorporated on mesoporous SBA-15 silica (by solvent and supercritical $CO_2$ impregnation) and in mesostructured silica-surfactant-vitamin hybrids. The structure (ranging from hexagonal to lamellar, as proved by X-ray diffraction) and the release capacity of the hybrids in a solution mimicking the topical environment were affected by the presence and the amount of Vitamin D3. Although the loaded amount of vitamin on SBA-15 appeared promising (20-25 wt.% according to thermogravimetry), this carrier was not able to shield Vitamin D3 form degradation (as shown by UV-Vis spectroscopy). On the contrary, the vitamin was preserved for up to 17 months when hosted in the silica-surfactant-vitamin hybrids. Incorporation of Vitamin D3 in cyclodextrine and silica-cyclodextrine hybrids appears to be feasible, but tests are still ongoing.

**Conclusion:** Different strategies for the protection and topical deliver of Vitamin D3 were investigated. At present, the most promising route consists in a silica-surfactant-vitamin hybrid which results to be apt to preserve the vitamin from degradation for several months (thanks to the presence of the surfactant) and to release it intact in a pseudo-topical environment.

## Biography

Marta Gallo is a biomedical engineer holding a Ph.D. in material science. Her first research interests were focused on ceramics for bone replacement. In the last years, however, she broadened her expertise and got involved in the field of drug delivery with a particular focus on mesoporous/mesostructured silica. Her know- how encompasses both the synthesis of materials and their physico-chemical, microstructural and mechanical characterization. Marta Gallo carried out her Ph.D. and worked as a post-doc in France at INSA de Lyon and in Germany at FAU University of Erlangen; now she works in Italy at Politecnico di Torino.

# RESEARCH AND DEVELOPMENT OF WATER ELECTROLYZERS BASED ON ION EXCHANGE MEMBRANES

**Vladimir N. Fateev, A.S. Pushkarev, I.V. Pushkareva and M.A. Solovyev**
*NRC "Kurchatov Institute", Russia*

## Abstract

Recently, water electrolysis has gained much attention, since it allows the relatively quick and convenient production of "green" hydrogen only from water and electricity. In particular, membrane electrolysis offers a sustainable solution to produce hydrogen, which may be coupled with widespread intermittent renewable energy sources (e.g. wind and solar) as well as with nuclear power allowing effective grid balancing. There are two main technologies according to which the membrane electrolyzer could be designed: proton exchange (*PEM*) and anion exchange membrane (*AEM*) technology. Both technologies have its own advantages, but still require further improvement to increase their market access.

The main focus of the research is the development of critical components of both *PEM* and *AEM* water electrolyzers – porous transport electrodes coated with electrocatalytic layers.

The research and development of protective/microporous sublayer of anode porous transport layer (*PTL*) (electrode) is suggested. This concept is applicable for both PEM and AEM water electrolyzer, and allows improving the utilization of catalyst and the active layer/membrane binding. Harsh operational conditions of anode in PEM water electrolyzer (acidic media, high anodic overpotential) force to protect the titanium-based PTL from passivation, and even more stable and conductive materials is necessary.

To optimize the electrode structure and to maximize the water electrolyzer performance, a methodology allowing deep understanding of faradaic and non-faradaic processes yield to an overall cell voltage is necessary. The use of Electrochemical Impedance Spectroscopy which provides non-invasive "in-situ" measurement of electrochemical system's impedance, and includes certain data preprocessing to avoid misleading in obtained data, is proposed.

Acknowledgements: the study of PEM water electrolysis is supported by NRC "Kurchatov institute"; AEM water electrolysis study is supported by the Russian Federation President grants for young scientists support: МК-4476.2022.1.3 (*MEA* fabrication and testing at different operational conditions) and МК-407.2021.1.3 (Electrochemical Impedance Spectroscopy study).

## Biography

Vladimir N. Fateev is well-known expert in the research and development of PEM water electrolysis and fuel cells, currently holding a position of Head of the Division of Electrochemical and Hydrogen Technologies, National Research Centre" Kurchatov institute". Having in-depth experience in R&D, project managing and Laboratory/Division leading, Vladimir N. Fateev is among the leading Russian scientists in the field.

# THE 'GENERALIZED SKETTRUP MODEL' AND LATTICE THERMAL CAPACITY OF POLYMERS

**Valeri Ligatchev**
*Singapore*

## Abstract

Intensive experimental and theoretical studies on features of thermal capacity of polymers emerged as an important brunch of material science and engineering since 1945. Later it also becomes very attractive research field in medical and biological sciences. Atomic structure(s) of polymers often comprise of structural fragments of different (1D, 2D, 3D) spatial dimensionalities, as well as include both amorphous (glassy) and crystalline segments. Therefore, vibrational spectrum of polymers customarily exhibit profound gaps between the (quasi-continuous) 'bands' and narrow peaks corresponding to 'skeletal vibrations' and 'group vibrations' (respectively) of different structural segments of the polymers. This specific vibrational spectrum routinely yields a *linear* temperature dependence of the isobaric thermal capacity of polymers, $C_p(T)$, even at elevated (i.e., well compared with Debye's one) temperatures. Moreover, the low-temperature $C_p(T)$ function of linear macromolecules apparently does not follow the Debye's law, $C_p(T) \cdot T^3$, which is well established for bulk crystalline and amorphous solids.

One of the most significant oversimplifications of existing approaches to quantitative analysis on features of the vibrational spectra and $C_p(T)$ function of polymers comprises of neglecting of the 'discreetness' of their vibrational (phonon) spectra even within the aforementioned vibrational 'bands'; this 'discreetness' is eventually caused by the *finite spatial extents* (sizes) of the structural segments of real polymers. Furthermore, both experimental and theoretical quantitative evaluations on the anharmonic fraction of their lattice thermal capacity often require implementation of sophisticated techniques, though elevated room-temperature thermal expansion coefficients for majority of polymers indicate unambiguously significance of anharmonic effects in their atomic structures.

In contrast, basic equations of so-called 'Generalised Skettrup Models' (GSMs) of different (1D, 2D, 3D) spatial dimensionalities allow one to analyse straightforwardly consequences of the spatial *confinement effects*(s) on spectrum of *acoustic* and *optical* phonon modes with the *static plane wave basis* in such materials. Furthermore, the *anharmonic* fraction(s) of the lattice capacity of the 1D, 2D and 3D segments of atomic structures of real polymers might be approximated realistically using appropriate *many-particle counterparts* of their conventional (single-particle) vibrational density-of-states functions of fundamental states of acoustic phonons confined within the (rectangular) volume of the given dimensionality. Results of the GSM simulations on the temperature-dependent harmonic and anharmonic fractions of the lattice thermal capacity of some real polymers with dominant atomic structures of different spatial dimensionalities are discussed in comparison with their well-known experimental counterparts.

## Biography

Valeri Ligatchev was born in Russia in 1959. He had obtained his MS, PhD and Doctor of Science (equivalent of Habilitation) degrees in Moscow Power Engineering Institute (MPEI, Russia) in 1982, 1988 and 1998, respectively. In MPEI he worked as a researcher (senior researcher) and lecturer from 1988 till 1999. Since 1999 till 2014 he is working (and living) in Singapore: in Nanyang Technological University, (1999 – 2005), NanoScience Innovation Pte. Ltd. (2005 – 2006), and Institute of High Performance Computing, A*STAR, (2006 – 2014). He became an author (co-author) of 81 journal articles, 102 conference abstracts and proceeding articles as well as of 7 books and book chapters. His name had been included in 2011 Edition of Marquis Who's Who in the World. His main areas of scientific interest and expertise comprise of experimental, computational and theoretical investigations on thermal, vibrational, electronic, optical, relaxation time and defect states spectra of various semiconductors, insulators and even superconductors, including nominally undoped and heavily doped polycrystalline and nano-crystalline diamond(s), silicon-germanium 'quantum dots', silicon nano-wires and 'molecular wires', amorphous hydrogenated silicon-based semiconductor films, porous 'low-k' organic and inorganic insulating layers, graphene flakes as well as ceramic insulators with 'gigantic dielectric response' (GDR). He also substantiated condensed phases of Fröhlich polarons as the essence of the GDR phenomenon, as well as implemented (abbreviated) Fock space formalism at interpretation on the physical essences of the exponential (Urbach) tail in optical and electronic spectra of polycrystalline and spatially non-homogeneous semiconductors and insulators as well as of their anharmonic lattice thermal capacity. These key innovations were implemented at interpretation of experimentally validated effects of morphology (i.e., shape, size(s) and crystalline orientation – if any) on near-band-gap and intra-gap electronic spectra of polycrystalline and spatially non-homogeneous amorphous semiconductors, insulators and diamond-based superconductors, as well as of their lattice thermal capacity. Furthermore, he had prompted advanced mathematical methods at interpretation of data of several well-established techniques of defect states spectroscopy, employed at actual experimental investigations of defects states of various semiconductors and insulators.

# BIOPOLYMER-BASED GOLD NANOPARTICLES FOR WOUND HEALING APPLICATIONS

**Sathish Sundar Dhilip Kumar, Nicolette Houreld and Heidi Abrahamse**
*University of Johannesburg, South Africa*

## Abstract

**Background:** Gold nanoparticles (*GNPs*) are classified as metal-based nanomaterials and have gained considerable attention amongst researchers for their applications in nanomedicine such as drug delivery, cellular imaging, diagnostic purposes, tissue engineering, wound healing, and photobiomodulation (*PBM*). The effectiveness of GNPs tested in vitro has been well documented in the literature, it has potent antibacterial properties against both Gram-positive and Gram-negative bacterial strains and possesses strong antioxidant activity which plays a key role in wound healing.

**Objective:** To synthesize, characterize and evaluate the potential of synthesized gum tragacanth-based GNPs (*GT-GNPs*) against pathogenic bacteria and their in vitro PBM cellular responses in WS1 normal wounded cells.

**Methods:** Physicochemical characterization of synthesized *GT-GNPs* were studied using the following methods such as particle size and zeta potential analysis (Dynamic laser scattering method), Surface morphology (High-resolution transmission electron microscopy) surface chemistry studies (Fourier transform infrared spectroscopy and X-Ray diffraction) and thermal stability (Thermogravimetric analysis). Bacterial strains *Pseudomonas aeruginosa* ATCC 27853 (Gram-negative) and *Staphylococcus aureus* ATCC BAA-1026 (Gram-positive) were used in the antibacterial disk diffusion study. *GT-GNPs* and PBM treated WS1 cellular morphology was studied in different hours (0, 24, and 48 h).

**Results:** GT-GNPs possessed good antibacterial activity against both Gram-positive and Gram-negative bacterial strains. *In vitro* wound healing studies investigated in WS1 cells suggested that the use of GT-GNPs and PBM shows great potential to heal wounds in in vitro, and this combined therapy did not show any toxicity to the cells.

**Conclusion:** Thus, the present study reveals that the synthesized *GT-GNPs* demonstrated effective antibacterial properties and the use of *GT-GNPs* along with *PBM* showed excellent wound healing properties in *WS1* cells.

## Biography

Sathish Sundar Dhilip Kumar is a Nanobiotechnology Researcher and currently working as a Lecturer at Laser Research Centre, Faculty of Health Sciences, University of Johannesburg. His research work focuses on research projects related to the functional applications of nanoparticles in Photodynamic therapy and Photobiomodulation. His research interests are multidisciplinary in nature with a theme of using nanomaterials/biomaterials for biological applications (Drug delivery, Tumor targeting, cellular Imaging, Wound healing, Photobiomodulation therapy, and Photodynamic therapy). He is a certified "Professional Natural Scientist" in the field of practice "Biological Science" from the South African Council for Natural Scientific Professions (SACNASP). He is a member of the Faculty of Health Sciences Research Ethics Committee at the University of Johannesburg. He has more than 30 publications including peer-reviewed research articles, review articles, book chapters, and conference proceedings. He has an h-index of 13, an i10 index of 16, and >950 citations.

# BIOMACROMOLECULES AS MATRIX FOR ANTIMICROBIAL NANOCOMPOSITE FILMS: A COMPARATIVE STUDY

**Paolo Pino, Silvia Ronchetti, Chiara Mollea, Barbara Onida and Francesca Bosco**

*Politecnico di Torino, Italy*

## Abstract

**Background:** Advanced wound dressings are essential to respond to the increasing incidence of chronic wounds. Biomacromolecules have great potential to serve as innovative dressing materials thanks to their biocompatibility and bioactivity, that can promote cellular regeneration and lead to faster healing. Current research is also investigating the combination of different biomacromolecules with antimicrobial nanostructured materials, such as nano-zinc oxide, in order to prevent or contrast wound infections and to obtain more effective wound care solutions.

**Objective:** Understanding the interactions between biomacromolecules and nanomaterials to identify the best possible combination.

**Methods:** Three different biomacromolecules are used to fabricate flexible bionanocomposite films filled with nanostructured zinc oxide, namely whey proteins, betaglucans and poly(3-hydroxybutyrate-co-3-hydroxyvalerate) (PHBV), originating from animals, yeast and bacteria respectively. Films have been obtained through solvent casting techniques and have been characterized through Fourier-transform infrared spectroscopy, X-Ray diffraction and water absorption tests. Finally, films have been tested against *Staphylococcus epidermidis* and *Escherichia coli* to assess and compare their antimicrobial properties.

**Results:** All three bionanocomposites exhibited antimicrobial properties, depending on the content of nano-ZnO. The antimicrobial action was more marked against *S.epidermidis* then on *E.coli*. Among the three alternatives, betaglucan-based films showed the best results.

**Conclusion:** Whey proteins, betaglucans and PHBV can all be used to successfully fabricate bionanocomposite films containing nanostructured zinc oxide. Matrix water uptake properties and interactions between biomolecules and nanoparticles are among the factors that can influence antibacterial action. Although betaglucans were the most effective in that sense, other properties such as transparency and degradability shall be taken into account in the design of advanced wound dressings.

## Biography

Paolo Pino obtained a Master's Degree in Materials Engineering at Politecnico di Torino, where he is now a PhD Student in Chemical Engineering. His research revolves around the synthesis and characterization of nanostructured antimicrobial materials and their incorporation in biomacromolecule-based films and hydrogels for the obtainment of bionanomaterials for advanced applications in healthcare and food packaging.

# PROPERTIES AND APPLICATION OF 3D HYBRID NANOMATERIALS: POLYHEDRAL OLIGOMERIC SILSESQUIOXANES

**Enrico Boccaleri[1], Stefano Marchesi[2], Luca Palin[2,3] and Fabio Carniato[2]**

[1]*Dipartimento per la Sviluppo Sostenibile e la Transizione Ecologica (DiSSTE), Italy*
[2]*University of Eastern Piedmont, Italy*
[3]*Research institute in Novara, Italy*

## Abstract

**Background:** Polyhedral oligomeric silsesquioxanes (*POSS*) are a class of condensed three dimensional oligomeric organosiliceous compounds with the cage framework having different geometries and symmetries. As a general feature, the molecular structure of these compounds consists of silicon atoms bonded to one- and-a-half oxygen (''sesqui-'') and hydrocarbon (''-ane'') moieties (herein denoted as R), leading to ($RSiO_{1.5}$) bond units.

They are called smart hybrid materials, with features of both inorganic and organic compounds, giving a relevant perspective, for nanoscience, to design and reproducibly tailor specific functional features.

**Objective:** Besides fully condensed polyhedral silsesquioxanes, with a cubic $R_8Si_8O_{12}$ structure, open-corner POSS compounds, where a Si vertex missing giving a general formula $R_7Si_7O_9(OH)_3$, show the capability to link different functionalities through the reaction with specific organosilanes and heteroelement precursors allowing the preparation and use of multifunctional nanomaterials.

**Methods:** M-POSS can be prepared using corner capping reaction in solution, employing mild conditions and short times of reactions. This allows to control of the final structure of the M-POSS, sincemonomer-dimer equilibria can occur. Lanthanide-containing POSS (*Ln-POSS*) can also be prepared, bridging luminescent features of this ion with a high thermal and mechanical stability.

**Results:** A synthetic method led to obtain Ti, V, Al, Eu-POSS derivatives, explored for their properties for fire retardancy of polymers and catalysis.

As Lanthanides, $Eu^{3+}$ was successfully included: the metal ion caps the POSS unit via the open corner and expands its coordination with solvent molecules.

Eu(III)-POSS has proved a quantum efficiency of ca. 14%, and high photostability to photobleaching.

**Conclusion:** Thanks to their molecular and hybrid nature, POSS and M-POSS are suitable for the dispersion in organic environment as polymers.

Application of these materials in polymer-based nanocomposites highlight their potential as functional additives operating at nanoscale level. Examples on the application of POSS in PVC systems, and M-POSS in PP matrices will be given.

## Biography

Enrico Boccaleri is Associated Professor at the University of Eastern Piedmont, at the Department of Science and Innovation Technology (DiSIT). His main research activities are related to synthesis and characterisation of inorganic and hybrid materials with one to three nanoscaled dimensions. He investigated the role of nanomaterials as functional additives for challenging features as modifying properties of common polymers, improving the thermal and mechanical behaviour as well as functional properties. His current research context is focused on matching interactions at nanometric level with macroscopic features with the scope of designing efficient materials for sustainable performances. He's co-author of more than 70 papers on international journals and of 5 national and international patents.

# KINETIC, ISOTHERM AND THERMODYNAMIC STUDY OF MINERAL IONS ADSORPTION USING STRONG CATION EXCHANGE RESIN FOR WATER SOFTENING

**Norhayati Abdullah, Aimi Abu, Syarifah Ab Rahim and Bhinitha Chandrasagaran**

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## Abstract

**Background:** Hard water is well-defined as a water body that contains high concentration of specific mineral ion such as magnesium and calcium ion. water softening process was practically proposed to avoid hard water problem by reducing the concentrated hard ions in water through selected methods.

**Objective:** To study the feasibility of strong cation exchange resin (Diaion PK228LH) for water softening.

**Methods:** The feasibility of strong cation exchange resin (Diaion PK228LH) for water softening was evaluated by conducting the effect of the single-binary system, resin dosage, and influent concentration toward calcium ($Ca^{2+}$) and magnesium ($Mg^{2+}$) ion removal through Solid Phase Extraction (SPE) method.

**Results:** Diaion resin promoted the highest removal of $Ca^{2+}$ and $Mg^{2+}$ at 99.2 and 91 % (0.005 mol/L initial ions concentration, 10 g resin, 26°C), respectively. The ions' sorption mechanism fitted well within three isotherms, Temkin, Freundlich, and Langmuir, where the correlation ($R^2$) achieved more than 0.9. Besides, the adsorption favourability (RL) obtained below than 1; means the adsorption was favored during the experiment. Kinetic study of $Ca^{2+}$ ($R^2$ = 0.9995) and $Mg^{2+}$ ($R^2$ = 0.9996) correlated well with the pseudo-second-order model compared to pseudo-first indicating the chemical adsorption has taken place vigorously.

**Conclusion:** The adsorption process of $Ca^{2+}$ and $Mg^{2+}$ thermodynamically experienced exothermic reaction as the enthalpy ($\Delta H^{\circ}$) showed negative values at -81.13 and -14.01 kJ/mol.K. As the temperature increased, the Gibbs energy ($\Delta G^{\circ}$) values proportionately negatived and increased, signifying the sorption process's spontaneity and feasibility in nature.

## Biography

Norhayati Abdullah is an Associate Professor in Universiti Malaysia Pahang of Chemical and Process Engineering Technology Faculty and also has industrial experience. Her research interests in advanced polymeric material particular in hypercrosslinked polymer, ion exchange resin and chelating agent for separation and catalyst applications. She was filing a few numbers of patents related with ion exchange resin project. While doing research in polymeric materials, she is also in charge in the consultation works with oil and gas company at Malaysia.

# MATERIALS AUSCULTATION IN HERITAGE BUILDING

**Rubén Rodríguez Elizalde**
*Universitat Oberta de Catalunya, Spain*

## Abstract

**Background:** Heritage monuments and ancient constructions are complex and delicate. Its conservation is vital for its subsistence and durability; its conservation is a challenge from a technical point of view. An early and adequate diagnosis of any pathological lesion in a monument is key to its maintenance and preservation. For this reason, auscultation techniques are necessary to allow a quick and effective diagnosis, but above all, it is not harmful to its constituent materials. With this premise, from the author's experience, this oral presentation exposes the most accessible and recommended immediate and instrumental techniques to be used directly on a monument. With them, an adequate pathological diagnosis of the monument can be made, locating possible lesions before they manifest or develop too much, and their removal becomes complicated.

**Objective:** This oral presentation exposes the most accessible and recommended immediate and instrumental techniques to be used directly over the monument to diagnose it.

**Methods:** The data comes from the author's experience, in his work as ancient constructions researcher and conservator. All the techniques analyzed have been effective.

**Conclusion:** Throughout this oral presentation, the immediate and instrumental techniques most used by the author and many other experts in the pathological diagnosis of heritage constructions will be analyzed. All the techniques analyzed have demonstrated their effectiveness in making an adequate diagnosis. Many monuments have been saved in time using these techniques harmless with the monument. However, there are many other techniques that we will not analyze here. These techniques, together with laboratory techniques, can give a much more complete diagnosis, although not as fast as the one provided by the techniques analyzed. In addition, laboratory techniques always involve the extraction of samples, and this always implies a punishment, however small, for the monument.

## Biography

Rubén Rodríguez Elizalde is Geologist and Civil Engineer, PhD in Architecture and Heritage and Senior Occupational Health and Safety Degree. On professional level, he is specialized in pathology and structural rehabilitation. In addition, he has carried out preventive management tasks, fundamentally in construction, metal and entertainment sectors for the last fifteen years: he has worked as execution director, health and safety coordinator on project phase and health and safety coordinator on execution phase. In this sense, he has been health and safety coordinator of great renown works in Spain. Currently, he is a professor at various university centers, such as Universitat Oberta de Catalunya (UOC). In addition, he is Member of the National Association of the Technical Inspection of Structures in Spain, member of the Geology Applied to Engineering Spanish Association and member of the International Association for Engineering Geology and the Environment. In addition, he is Technical Director at EIP, company specializing in structural rehabilitation and prevention management in the construction sector. As a final anecdote, it should be noted that Rubén is a Remote Piloted Aircraft (RAP) Pilot and a Pilot Instructor and Examiner.

# *Virtual Day-2*
# *Keynote Presentations*

# STEREOLITHOGRAPHIC ADDITIVE MANUFACTURING OF FINE CERAMIC COMPONENTS

**Soshu Kirihara**
*JWRI, Osaka University, Japan*

## Abstract

In stereolithographic additive manufacturing (*STL-AM*), 2-D cross sections were created through photo polymerization by UV laser drawing on spread resin paste including nanoparticles, and 3-D models were sterically printed by layer lamination. The lithography system has been developed to obtain bulky ceramic components with functional geometries. An automatic collimeter was newly equipped with the laser scanner to adjust the beam diameter. Fine or coarse beams could realize high resolution or wide area drawings, respectively. As the row material of the 3-D printing, nanometer sized metal and ceramic particles were dispersed into acrylic liquid resins at about 60 % in volume fraction. These materials were mixed and deformed to obtain thixotropic slurry. The resin paste was spread on a glass substrate with 50 μm in layer thickness by a mechanically moved knife edge. An ultraviolet laser beam of 355 nm in wavelength was adjusted to 50 μm in variable diameter and scanned on the spread resin surface. Irradiation power was automatically changed for an adequate solidification depth for layer bonding. The composite precursors including nanoparticles were dewaxed and sintered in the air atmosphere. In recent investigations, ultraviolet laser lithographic additive manufacturing (*UVL-AM*) was newly developed as a direct forming process of fine metal or ceramic components. As an additive manufacturing technique, 2-D cross sections were created through dewaxing and sintering by UV laser drawing, and 3-D components were sterically printed by layer laminations with interlayer joining. Through computer-aided smart manufacturing, design, and evaluation (Smart MADE), practical material components were fabricated to modulate energy and material transfers in potential fields between human societies and natural environments as active contributions to Sustainable Development Goals (*SDGs*).

## Biography

Soshu Kirihara is a Doctor of Engineering and a professor of Joining and Welding Research Institute (JWRI), Osaka University, Japan. In his main investigation "Materials Tectonics as Sustainable Geoengineering" for environmental modifications and resource circulations, multi-dimensional structures were successfully fabricated to modulate energy and materials flows effectively. Ceramic and metal components were fabricated directly by smart additive manufacturing, design and evaluation (Smart MADE) using high power ultraviolet laser lithography. Original stereolithography systems were developed, and new start-up company "SK-Fine" was established through academic-industrial collaboration.

# *Virtual Day-2*
# *Oral Presentations*

# METAL ORGANIC FRAMEWORKS INCORPORATED ULTRAFILTRATION MEMBRANE FOR INDUSTRIAL WASTE WATER TREATMENT

**Norhaniza Yusof, Nur Azizah Johari, Wan Norharyati Wan Salleha, Farhana Aziza, Juhana Jaafara and Ahmad Fauzi Ismaila**

*Universiti Teknologi Malaysia, Malaysia*

## Abstract

Existing ultrafiltration membranes for industrial wastewater treatment, typically polymeric in nature, are still restricted by several challenges, including the trade-off relationship between permeability and selectivity, and low resistance to fouling. Mixed matrix membranes (MMMs), fabricated by combining polymeric materials with nanomaterials, are emerging as a promising solution to these challenges. The advanced polymeric membranes could be designed to meet specific water treatment applications by tuning their structure and physicochemical properties (e.g., hydrophilicity, porosity, charge density, and mechanical stability) and introducing unique functionalities (e.g., adsorptive capability). Recently, many researchers have been focused on incorporating a new hybrid nanomaterial, which is metal- organic frameworks (MOFs), due to their high polymer affinity and tuneable properties, which can significantly improve the overall properties of the MMMs. However, a common challenge with MMM fabrication is the agglomeration of filler, which can deteriorate the membrane structure and hinder the full capability of membrane performance. Herein, our project developed an ultrafiltration membrane incorporated with tannin-modified MOF in order to overcome the aforementioned issue. The presence of vast hydroxyl groups from tannin has increased the zeta potential of the MOF surface from -11.37mV to -26.68mV, thus minimizing the agglomeration tendency through electrostatic repulsion between the MOF in the dope solution. Furthermore, the homogeneous dispersion of tannin-MOF results in a more uniform surface roughness of the modified MMM and promotes a high hydration layer of the membrane surface. The incorporation of tannin-MOF has improved membrane hydrophilicity by reducing water contact angle by up to 40.510 and exhibited 2.91 times higher permeability in comparison to the unmodified polymeric membrane. A crossflow ultrafiltration experiment was conducted using raw textile wastewater and discovered that the Tannin-MOF/polymer MMM possessed high flux recovery rate (>90%), with excellent rejection up to ~100% total suspended solid (TSS), 96.46% (COD), 97.04% (color), 97.41% (turbidity) and 89.94% total dissolved solid (TDS).

## Biography

Norhaniza Yusof graduated with B. Eng (Chemical Engineering) from Universiti Teknologi Malaysia (UTM). She started his academic career when she was appointed as a tutor in 2008 in Department of Gas Engineering, Faculty of Petroleum Engineering and Renewable Engineering. At the same time, she was joining Advanced Membrane Technology Research Center to participate more on research and innovation field. Shortly after that, she was granted with a scholarship from Ministry of Higher Education to further his PhD study in Gas Engineering at Universiti Teknologi Malaysia (UTM), focusing her scope on activated carbon fibers for natural gas adsorption. In 2012, she obtained her PhD degree. During her Phd studies, she obtained 5 publications in refereed international journals.

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# CARBON-MODIFIED-$TiO_2$ IN WATER DECONTAMINATION: PHOTO-REFORMING OF POLLUTANTS USING 2D AND 3D GRAPHENE-BASED $TiO_2$ NANOMATERIALS

**Sin Yuan Lai**
*Xiamen University Malaysia, Malaysia*

## Abstract

Solar-driven photocatalytic techniques have been widely studied for the degradation of wastes in water systems because they are sustainable, with low operating cost and low energy consumption. This advanced oxidation process not only transforms organic wastes into non-hazardous $CO_2$ and $H_2O$, but also removes heavy metals and other inorganic substances from wastewater. Among a variety of heterogeneous photocatalysts discovered a few decades ago, $TiO_2$ is unrivalled with its efficiency and stability. Moreover, $TiO_2$ is undeniably good in rapid charge carriers in preventing electron recombination, which is crucial in determining its photocatalytic performance. Up to date, it is well-known that $TiO_2$ prepared with the addition of carbon sources possesses enhanced photocatalytic properties, including 2D and 3D graphene nanomaterials. 2D and 3D graphene nanomaterials facilitate superior charge mobility and prevent charge recombination, contributing to high photochemical quantum yields. Interestingly, 3D graphene could overcome the intrinsic π-π interaction that has caused the structural aggregation or re-stacking of 2D graphene nanosheets. Since 3D graphene could maintain its inter-connecting network with high structural stability and expose more active sites, thus further enhancing the mass electron transfer in the phocatalytic degradation system. Intrigued by those fascinating properties, this review studies the designs of graphene-based $TiO_2$, in conjunction with its fundamental mechanisms, and the application of water purification. By reviewing the state-of-the-art of these photocatalysts, it is important to exploit the effective 2D and 3D graphene-based $TiO_2$ in combating the recalcitrant wastes in water bodies, especially industrial wastewater. The remaining challenges and future perspectives are also included for advancing the practical utilization of graphene-based $TiO_2$ photocatalysts in environmental remediation.

## Biography

Sin Yuan Lai is passionate about preserving environmental sustainability, especially in sustainable photocatalysis, in these recent years. Her investigation currently focuses on water decontamination to mitigate organic pollutants through the photo-reforming process. A review is prepared to highlight the state-of-the-art of 2D and 3D graphene-based TiO2 in the photodegradation of various pollutants. Meanwhile, she is in the progress to fabricate effective nanomaterials for this photocatalytic degradation reaction. She works on the several designs of the carbon-based $TiO_2$ under the energy-efficient light irradiation.

# IMPROVING THE RELIABILITY DESIGN OF MECHANICAL SYSTEMS SUCH AS REFRIGERATOR

## Seongwoo Woo

*Ethiopian Technical University, Ethiopia*

## Abstract

**Background:** To enhance the lifetime of mechanical system such as automobile, new reliability methodology – parametric Accelerated Life Testing (*ALT*) – suggests to produce the reliability quantitative (*RQ*) specifications—mission cycle—for identifying the design defects and modifying them.

**Objective**: To examine the association between household-level variables and under-5 mortality in Nigeria.

**Methods:** It incorporates: (1) a parametric ALT plan formed on system BX lifetime that will be X percent of the cumulated failure, (2) a load examination for ALT, (3) a customized parametric ALTs with the design alternatives, and (4) an assessment if the system design(s) fulfil the objective BX lifetime.

**Results**: So we suggest a BX life concept, life-stress (*LS*) model with a new effort idea, accelerated factor, and sample size equation. This new parametric ALT should help an engineer to discover the missing design parameters of the mechanical system influencing reliability in the design process. As the improper designs are experimentally identified, the mechanical system can recognize the reliability as computed by the growth in lifetime, LB, and the decrease in failure rate. Consequently, companies can escape recalls due to the product failures from the marketplace. As an experiment instance, two cases were investigated: 1) problematic reciprocating compressors in the French-door refrigerators returned from the marketplace and 2) the redesign of hinge kit system (*HKS*) in a domestic refrigerator.

**Conclusion:** After a customized parametric ALT, the mechanical systems such as compressor and *HKS* with design alternatives were anticipated to fulfill the lifetime – B1 life 10.

## Biography

Seongwoo Woo has a BS and MS in Mechanical Engineering, and he has obtained PhD in Mechanical Engineering from Texas A&M. He majors in energy system such as HVAC and its heat transfer, optimal design and control of refrigerator, reliability design of thermal components, and failure Analysis of thermal components in marketplace using the Non-destructive such as SEM & XRAY. In 1992.03–1997 he worked in Agency for Defense Development, Chinhae, South Korea, where he has researcher in charge of Development of Naval weapon System. He was working as a Senior Reliability Engineer in Refrigerator Division, Digital Appliance, SAMSUNG Electronics. Now he is working as associate professor in mechanical department, Ethiopian Technical University.

# *Virtual Day-2*
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# EFFECTS OF ELECTRON BEAM IRRADIATION ON THE HARDNESS AND WEAR RESISTANCE OF PEEK

**Nurlan Almas[1], Bayan Kubanova[1], Baurzhan Rakhadilov[2] and Zhuldyz Sagdoldina[2]**

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## Abstract

Since the Nafion polymer membrane offers a high proton conductivity and a better durability, it has become the industry standard for proton exchange fuel cells. The membrane-electrode assembly based on Nafion is unsatisfactory, nevertheless, when the temperature exceeds 100 °C because of a decline in its proton conductivity, electrochemical stability, and mechanical strength. Numerous prospective low-cost Nafion substitutes for membranes have already been thoroughly investigated. These alternatives to the Nafion membrane include non-fluorinated or partially fluorinated hydrocarbon polymeric membranes with aromatic backbone architectures. In this paper, tribological tests, microhardness and modulus of elasticity measurements, were used to investigate the impact of electron beam irradiation on the hardness and wear resistance of polyetheretherketone (*PEEK*). At the Park of Nuclear Technologies in Kurchatov, Kazakhstan, the ILU-10 industrial electron pulse accelerator equipment was used to irradiate the polymer samples with rapid electrons while maintaining room temperature. The electron beams current, and energy of the accelerator were tuned to 6.87 mA and 2.7 MeV, respectively. The sample surface electron beam diameter and pulse length were both tuned to 10 mm and 0.4–0.5 ms, respectively. The polymer samples were exposed to a total dose of 400 kGy. The friction-sliding tribological test was performed on a TRB3 tribometer using the standard ball-and-disk technique under technical dry friction conditions at constant room temperature. A ball with a diameter of 6.0 mm made of steel - 100Cr6 was used as a countersample. The tests were carried out under the load of 10 N with linear speed of 5 cm/s on the radius of 2 mm. The change in the coefficient of friction was measured over a test distance of 50 m. The tribological characteristics of the samples before and after ELT were characterized by wear intensity. The wear rate of the sample under the influence of the tip was calculated based on the volume of displaced material. The amount of polymer wear after tribological testing was determined using the Profiler 130. Based on the volume of displaced material, the wear rate of the sample under the action of the tip was estimated. Using the Profiler 130, the degree of polymer wear during tribological testing was calculated. In comparison to the pristine sample, the study's findings indicated that PEEK-1 had a high wear intensity (irradiation dose of 50 kGy). High wear resistance was demonstrated by samples PEEK-4 (irradiation dose 200 kGy) and PEEK-7 (irradiation dose 400 kGy). The microhardness was determined using the FISCHERSCOPE HM2000 S measuring system in accordance with the requirements of DIN EN ISO 14577-1. The load setting accuracy was 4 mg, and the displacements were measured with an accuracy of 0.1 nm. The error in determining the microhardness did not exceed 2% of the measured value. The indenter approach speed was 2 μm/s. The load range during testing was 1–2000 mN. The primary processing of the test results was carried out using the WIN-HCU instrument software. A tetrahedral Vickers diamond pyramid with an angle of 136° was used as an indenter. An increase in PEEK hardness has been observed as a result of electron beam processing.

## Biography

Nurlan Almas is International Science Complex Astana (Kazakhstan) leading scientific researcher and Asatana IT University postdoctoral attendee(Kazakhstan). He holds a B.Sc, M.Sc and Ph.D from Al-Farabi Kazakh National University. He has authored about 20 journal articles, and 5 Kazakhstani patents

# EVALUATION THE SAFETY AND THE IMPACT OF STANDARD ANTIVIRAL DRUGS ON KINETIC OF ANTIVIRAL ACTIVITY ON THE EARLY STAGES OF VIRAL REPLICATION CYCLE BY SURFACE PLASMON RESONANCE METHOD

**Evdokiya Hikova[2], Petia Genova-Kalou[1], Radoslav Marinov[1] and Georgi Dyankov[2]**

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[2]*Institute of optical materials and technologies, Bulgarian Academy of Sciences, Bulgaria*

## Abstract

**Background:** The effectiveness of drugs relies on their interaction with specific target and response of a heterogeneous cell population. The application of Surface Plasmon Resonance (*SPR*) biosensor technology has been extensively employed for investigation the binding properties of many drug candidates to the immobilized bio receptor. In the last decade the application of SPR has been successfully extended into a powerful method for sensing large biological objects such as cells.

**Objective:** To show kinetic of antiviral action and effectiveness of a widely used antiviral inhibitors, such as acyclovir (*ACV*), remdesivir (*RDS*) and hydroxychloroquine (*HCQ*).

**Methods:** We evaluate *in vitro* model system, with a particular focus on the applications of tested drugs on the early stages of virus replication using the Surface Plasmon Resonance (SPR) method. For this purpose, Vero E6 and Lep cells were immobilized on the SPR slides and infected with human coronavirus 229E (*HCoV-229E*) and herpes simplex virus type 1 (*HSV-1*) and then treated with RDS, HCQ and ACV.

**Results:** The SPR response was measured at different time intervals within the early stages of corona- (2h-48h) and herpesvirus (2h-32h) infections after treatment with antiviral drugs in maximal non-toxic concentrations (*MNCs*) or close to them. SPR response was evaluated according the reference SPR conditions for non-infected and non-treated cells (cell control) and infected and non-treated cells (viral control). The results were compared with other conventional methods such as *MTT* – assay and microscopic observation of cell morphology (*TEM, AFM* and other).

**Conclusion:** The results showed that cell-based SPR is a reliable tool in evaluating the safety and the impact of standard antiviral drugs on the early stages of viral replication cycle.

## Biography

Evdokiya Hikova has her expertise in plasmonics and sensing devices at the Bulgarian academy of sciences, where she currently works as a chief assistant. In 2019-2020 she joined the Merkoci's group "Nanobioelectronics and Biosensors" at ICN2, UAB, Spain. As an exchange student there, she successfully achieved her first electrochemical sensing device. She graduated with MA in 2017 in Plovdiv University.

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# COMPUTATIONAL ANALYSIS OF HETEROSTRUCTURES WITH TRANSPARENT CONDUCTIVE OXIDES FOR THE FABRICATION OF SOLAR CELLS

**Ana Cristina Carranza Sanchez [1], E. Rosendo[1], E. Camacho-Espinosa[2], C. Morales[1], R. Romano-Trujillo[1], R. Galeazzi[1], G. García[1], A. Coyopol[1] and F. G. Nieto[3]**

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*[3]Facultad de Ciencias Químicas, BUAP, México*

## Abstract

The solar radiation received on average by the earth's surface is of the order of 1017 watts, which, distributed throughout the earth's surface, corresponds to about 1000 Wh/m$^2$, therefore, each square meter receives ~12KWh daily. This radiation can be transformed into electrical energy through direct conversion processes using photovoltaic devices or solar cells.

On the other hand, the fabrication of CdTe-based solar cells using other transparent resistive films has been little explored despite the advantages it represents. Among the resistive films, one that is attractive is the IZO, because it is high variability in resistivity, which is convenient for coupling between layers. In this work, the simulation of the CdTe/IZO, CuO/IZO, CuO/ITO, CuO/IZTO and CuO/AZO heterostructure was carried out in the SCAPS-1D program.

An analysis of thickness variation, carrier concentration, bandgap, temperature and contacts was performed. The results of the first simulations of the CdTe/IZO and CuO/IZO heterostructures are shown. For the CdTe/IZO cell, an efficiency of 22.5% with a fill factor of 73% and a short-circuit current of $J^{sc}$= 27.1 mA/cm$^2$ was obtained. The open-circuit voltage was 1.1 V. In addition, an evaluation of the metal work function (Ni ϕ=5.15 and Al ϕ=4.28), electron and hole capture cross-section, density of donors (ND), and acceptors (NA) was performed (1x10$^{18}$ cm$^{-3}$). Also, for the CuO/IZO cell, a solar cell was obtained with a current density of JSC=38.26 (mA/cm$^2$), an open circuit voltage of VOC= 0.78 V, a fill factor of FF=85.5% and an efficiency of 25.7%.

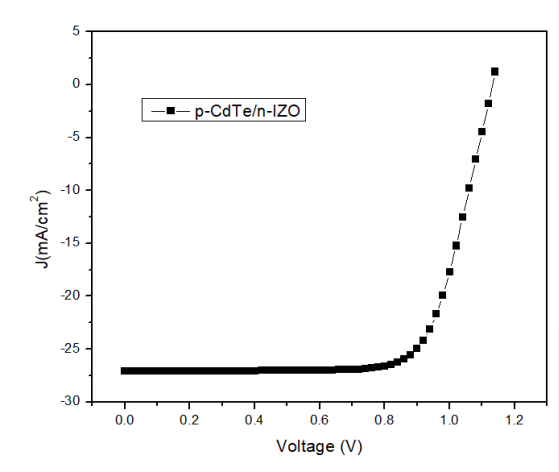


**Figure 1.** J–V characteristics of p-CdTe/n-IZO under AM1.5 G illumination.

Figure 1, shows the current-voltage characteristics of the p-CdTe/n-IZO heterojunction. The use of an IZO layer showed an efficiency of 22.5%, in conclusion, this layer improves the characteristics of the cell by acting as an active layer. On the other hand, this device with a CdTe layer acts as a good absorbent layer in the photoconversion process of solar cells.

**Background:** Currently there is an energy-technological demand with an exponential growth due to the increase in the population. It has been shown that an energy source is not enough to cover the needs demanded by the population worldwide, just as the resources used in the manufacture of optoelectronic devices are no longer sufficient. The vast majority of these devices use semiconductors for their manufacture, unfortunately in recent years there has been a shortage of these materials at the international level; This demand for semiconductors impacted several industries, including technology and the automotive industry. For this reason, it is essential to research new materials that serve as an efficient alternative for its replacement.

**Objective:** Simulate, fabricate and characterize solar cells based CdTe/IZO, CuO/IZO, CuO/ITO, CuO/IZTO and CuO/AZO heterostructure.

**Methods:** The simulation of the solar cells that is being proposed in this work will allow us to study their behavior as a photovoltaic device and will give us a prediction of the efficiency based on the variation of the proposed parameters. For the creation of the modeling of the device, experimental values of the physical parameters of the different layers that constitute the proposed solar cell will be collected, and they will be registered in the SCAPS package.

## Biography

Ana Cristina Carranza Sanchez has experience in synthesis of chemical, inorganic and organic compounds. In his undergraduate thesis he developed a MgNbFe nanocomposite that stored hydrogen at room temperature by high-energy mechanical grinding. She is currently a master's student and is conducting an investigation into the deposit of thin films due to cathode erosion.

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# QUANTUM KINETIC PHENOMENA IN PROTON SEMICONDUCTORS AND DIELECTRICS

**Valeriy Kalytka, Aleksandr Bashirov, Yelena Senina, Yelena Sidorina and Bektas Ospanov**

*Abylkas Saginov Karaganda Technical University, Republic of Kazakhstan*

## Abstract

**Background:** Hydrogen bonded crystals (HBC) mineralogically classified as layered crystals (layered silicates, crystalline hydrates), by electrophysicacal properties determined as proton semiconductors and dielectrics (PSCD). Of considerable scientific and technical interest is the use of thin films of ferroelectrics with hydrogen bonds (KDP, DKDP) in the development of memory elements for non-volatile high-speed memory devices characterized by anomalously high values of residual polarization and relaxation time (up to 10 years) and high thermal and mechanical stability. According to the results of recent studies, of great scientific interest are theoretical studies of nonlinear polarization effects that manifest themselves in dielectrics with an ion-molecular type of chemical bonds (in particular, in HBC) in the ultralow temperature range (1-10 K) in weak fields (100-1000 kV / m) and in the ultrahigh temperature range (550-1500 K) in strong fields (10-100 MV/m).

**Objective:** The purpose of given paper is to develop a rigorous (in terms of the structure of Hamiltonian and its properties) quantum-mechanical model in the form of solutions of the nonlinear quantum kinetic equation that describes, together with the Poisson equation, in order to reveal the effects of tunneling transitions of relaxators (in HBC, protons) to the theoretical temperature spectra of the density of the thermally stimulated depolarization current $J_{TCDP,h}(T)$ and dielectric loss tangent $tg\,\delta_{th}^{(u)}(T)$ in a wide range of field parameters (100 kV/m - 100 MV/m) and temperatures (1-1500 K).

**Methods:** For the ensemble of non-interacting protons, moving in one-dimensional potential image (field of hydrogen bonds in HBC) $W_{(\epsilon[H^+])}(x)$ with a parabolic shape perturbed by external electrical field strength $E(t)$, distributed by quasi-discrete energy levels $E_{n,s}^{(0)}$, the calculating of quantum transparency in the WKB approximation given us $D^{(\pm)}(U_0 \pm |\Delta U|; E_{ns}^{(0)}) = \exp\left(-\frac{\pi\delta_0\sqrt{m}(U_0 \pm |\Delta U| - E_{ns}^{(0)})}{\hbar\sqrt{2U_0}}\right)$. Here $|\Delta U(t)| = \frac{qE(t)a}{2}$ – correction to potential $W_{(\epsilon[H^+])}(x)$; m, proton mass and charge; crystal lattice parameter; $\delta_0$, $U_0$ –, potential barrier width and height (activation energy) for the proton; $E_{n,s}^{(0)} = E_n^{(0)} + \frac{2E_0^{(0)}}{\pi}\sqrt{D(U_0; E_n^{(0)})}\cos\left(\frac{\pi s}{N_W+1}\right)$ – transformed by quantum tunneling into the n-th energy band (zone) with numbers from s=1 to $N_W$, degenerate energy spectrum of the proton, where $N_W$ full number of potential wells in the model; $E_n^{(0)}$ – energy levels of the proton localized in the isolated potential well (nondegenerate energy spectrum);

$D(U_0; E_n^{(0)}) = \exp\left(-\frac{\pi\delta_0\sqrt{m}(U_0 - E_n^{(0)})}{\hbar\sqrt{2U_0}}\right)$ – quantum transparency for the proton with $E_n^{(0)}$ energy levels, where

$E_0^{(0)} = \frac{1}{2}\hbar\omega_0$ $E_{max}^{(0)} = \hbar\omega_0\left(n_{max} + \frac{1}{2}\right) < U_0$; $\omega_0$ – is the circular frequency of proton oscillations in the potential well.

Averaging the stationary quantum transparencies $D(U_0; E_n^{(0)})$, $D(U_0; E_{n\,s}^{(0)})$ over the unperturbed energy levels $E_n^{(0)}$, $E_{n\,s}^{(0)}$ using the quantum canonical Gibbs distribution and introducing an additional dimensionless small parameter $\eta(t) = \Lambda\frac{|\Delta U(t)|}{U_0} < 1$, where $\Lambda = \frac{\pi\delta_0\sqrt{m}}{\hbar\sqrt{2}}\sqrt{U_0}$, we arrive at the temperature dependences for the quantum mechanical diffusion coefficients

$$D_{diff.nonn}^{nondegenerate}(T) = D_0 \times D_{quant;nondegenerate}^{(0)}(T) \times ch(\eta(t)), \quad (1)$$

$$D_{diff.nonn}^{degenerate}(T) = D_0 \times D_{quant;degenerate}^{(0)}(T) \times ch(\eta(t)). \quad (2)$$

Here $D_0 = \frac{\omega_0 a^2}{2}$, $\nu_0$ – natural frequency of oscillations of the proton in potential well, $D_{quant;nondegenerate}^{(0)}(T) = \langle D(U_0; E_n^{(0)})\rangle$, $D_{quant;degenerate}^{(0)}(T) = \langle D(U_0; E_{n\,s}^{(0)})\rangle$.

**Results:** The shift of the theoretical maximum of stationary quantum transparency for the protons from the low-temperature range (T=55 K) with the amplitude of 0,11 (the model of a non-degenerate proton energy spectrum, line no.1 for function $D_{quant;nondegenerate}^{(0)}(T)$ in Figure 1) towards the high temperature range (T=150 K) with an increase in amplitude to 0,14 (the model of a degenerate proton energy spectrum, line no. 2 for function $D_{quant;degenerate}^{(0)}(T)$ in Figure 1) indicates a significant influence even the small changes in numerical values of the parameters of the crystal potential image for the proton and crystal thickness (expressed through a parameter $N_w$) to the proton tunneling probability, the structure and properties of the proton energy spectrum, which is most effective for nanosized HBC layers (d=1-10 нм) in a wide temperature range (50–1550 K).

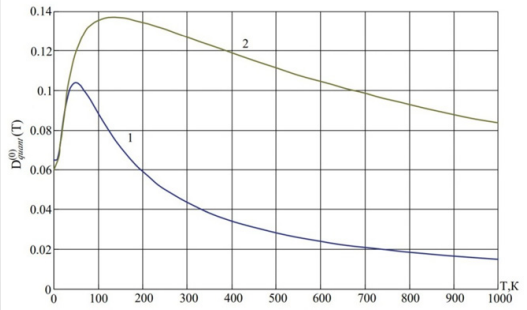


**Figure 1:** Dependences of the stationary quantum-mechanical transparency coefficient $D_{quant}^{(0)}(T)$ on temperature (for a proton) in nanoscale layers of HBC

**Conclusion:** 1. In hydrogen bonded crystals (HBC), quantum tunneling of protons is the mechanism that determines the regularities in the formation of volume-charge polarization in a wide range of field parameters and temperatures. 2. The band (zone) structure of quasi-discrete energy spectrum of relaxators (protons) in nanosized HBC layers (1-10 nm) causes a shift of theoretical maximum of stationary quantum transparency towards the high temperature range (150-550 K) with an increase in the amplitude of the maximum from (0,05-0,1) up to (0,12-0,25), which indicates a significant in the role of quantum effects in HBC in a wide temperature range (50-1550 K)

## Biography

Kalytka Valeriy Aleksandrovich (was born on 14.03.1976 year) – Candidate of Phys. – Math. Sciences (Condensed Matter Physics), Doctor of Philosophy (in Physics), associate professor in Physics, professor at «Power engineering systems» department in Karaganda technical university (KTU) named after Abylkas Saginov, Leading Researcher at Research Institute of Economic and Legal Research in Karaganda University of Kazpotrebsoyuz, Karaganda, Republic of Kazakhstan. Performed by Valeriy A. Kalytka, over the past 20 years, theoretical studies of the electrophysical properties and prospects for practical and scientific applications of proton semiconductors and dielectrics are relevant, primarily from the point of view of numerous analytical and numerical algorithms developed by the author (based on original computer software packages) studies of the physical mechanisms of electric charge transfer in complex crystalline structures of materials with ion-molecular chemical bonds, in an electric (polarizing) field. Developments in this area are being carried out by many other researchers around the World, but they are mainly experimental in nature and contain results closed to the field of electrochemistry and physical chemistry, and are limited in terms of mathematical descriptions and interpretations of rather complex processes of electrical conductivity and polarization in materials. of this class (perovskites, micas, layered minerals, ceramics, etc.). At the same time, received Kalytka V.A. the results are based on the development of generalized physical and mathematical models that allow, using the methods of modern mathematical apparatus, based on the solutions of nonlinear systems of kinetic equations and equations of electrodynamics of continuous media, to investigate the influence of structure parameters and characteristic parameters of various types of relaxers (ions, protons, ionic groups, molecular clusters and associations, etc.) on the theoretical temperature spectra of thermally stimulated depolarization current and dielectric loss tangent in a wide range of field parameters (100 kV / m - 100 MV / m) and temperatures (1-1500 K) in layered dielectrics with different chemical properties crystals and their composites (MDS, MSM structures). The main scientific results relate to theoretical studies of the mechanisms of quantum tunneling of protons in the hydrogen sublattice of hydrogen-bonded crystals (HBC) during the formation of volume-charge polarization in HBC under various experimental conditions. Kalytka V.A. laid the theoretical foundations for further comprehensive studies of quantum-mechanical processes in the hydrogen sublattice under spontaneous polarization in thin films of ferroelectrics with hydrogen bonds (KDP, DKDP, triglycine sulfate, Rochelle salt) in the development of memory elements for energy-independent high-speed memory devices characterized by anomalously high values of residual polarization and relaxation time (up to 10 years) and high thermal and mechanical stability.

# ENVIRONMENTAL RESIDENTIAL ARCHITECTURE OF NORTHERN KAZAKHSTAN

**Olga Semenyuk, Zh. Ashimova and B. Ozganbayeva**
*Gumilyov Eurasian National University, Kazakhstan*

## Abstract

**Background:** The structure of the modern urban environment represented by a combination of two subsystems: anthropogenic and natural. In vast areas of Northern Kazakhstan, they actively consume natural resources. The range of influence of the city is determined by its scale, naturally, the larger the size of the city, the wider the range of its influence, the greater on the territory of the risks under the influence of the city of imbalance in the ecological situation of the second natural subsystem.

**Objective:** To examine the principles of screating eco-architecture in the conditions of Northern Kazakhstan. To development of principles and requirements for the formation of residential buildings using energy-efficient and environmental systems in Northern Kazakhstan. Creation of the methodology for architectural design of residential buildings for the conditions of Northern Kazakhstan

**Methods:** The research methodology provides for the study and generalization of domestic experience in scientific development and design of buildings using energy-efficient systems and the principles of "green" architecture. An analysis of the development and environmental friendliness of residential buildings in Astana carried out. The main ways to save energy and factors affecting the formation of the ecological environment of the city and residential buildings have identified. The regularity and fundamental justification of construction solutions with low, medium and high-energy efficiency in Northern Kazakhstan, and the methods of design.

**Results:** Eco-architecture, like any other direction of architecture, has its own well-defined material and visual features. The implemented architectural eco-projects, of course, favorably affect a person. This expressed in obtaining aesthetic pleasure and unconditional health benefits. These facts are direct evidence that man is part of nature.

**Conclusion:** Eco-architecture forms a love of nature, which consists in the transition to energy and resource-saving alternative sources of energy, building materials of natural origin and an increase in the plant mass.

## Biography

Semenyuk Olga - Architect, Candidate of architecture, professor of Architecture department, Eurasian National University named after Gumilev L.N., Astana, Kazakhstan. Academic degree of the candidate of architecture has awarded in 2004. Academic status professor has awarded in 2008. Semenyuk O. is a Member of the Union of Architects of Kazakhstan since 2008 year. Semenyuk O. is a Member of the Union of town-planners of Kazakhstan since 2009 year. Semenyuk O. has her expertise in evaluation and passion in improving the ecology and energy efficiency of architectural objects. It allows for value-pluralism. This approach is responsive to all stakeholders and has a different way of focusing.

# SYNTHESIS OF NOVEL HYBRID COMPOUNDS CONSISTING OF CARBON QUANTUM DOTS (CQDS), PORPHYRIN AND ZNO/N-DOPED $TIO_2$ WITH PHOTO-INDUCED BIOLOGICAL ACTIVITY

**Manousakis D., Gatou M.-A., Lagopati N., Kotsinas A. and Pavlatou E.A**
*National Technical University of Athens, Greece*

## Abstract

**Background:** Photodynamic therapy is often used against cancer. The photosensitizing agent can be activated upon irradiation with light, in the presence of oxygen. When the photosensitizer is exposed to specific wavelengths, it falls from the "ground state" into the "excited state". Returning to the initial condition the energy is released, in two ways, mediating selective cytotoxicity.

**Objective:** The objective of this research is the synthesis of novel hybrid nanomaterials, with photo-induced biological activity. The structure of these materials consists of three parts: (a) carbon quantum dots (CQDs), (b) a porphyrin and (c) a semiconductor. The semiconductors used in the composite materials are TiO2 doped with nitrogen or ZnO. Carbon quantum dots were used, in order to allow cell imaging. Porphyrin is an organic compound, which is used as a photosensitizer under visible light irradiation. N-doped titanium dioxide and zinc oxide nanoparticles were used for enhancing the photodynamic activity of porphyrin, due to their photocatalytic behavior.

**Methods:** The CQDs were synthesized utilizing a simple one-step electrochemical method. The porphyrin was synthesized using the Lindsey method. The N-doped $TiO_2$ and ZnO nanoparticles were synthesized through the sol-gel and precipitation method, respectively. CQDs solution was then added to a dispersion of N-doped $TiO_2$ or ZnO nanoparticles in ethanol followed by sensitization with porphyrin. The compounds were then thoroughly characterized by XRD, DLS, FE-SEM, TEM, XPS, UV-vis, FTIR and Raman spectroscopy. The biological effect of the novel nanomaterials was investigated on skin normal fibroblasts (CCD-1123Sk), skin/epidermis carcinoma (A-431) and skin malignant melanoma epithelial cells (SK-MEL-31).

**Results:** The synthesis of the hybrid composite material was confirmed. The materials showed improved photo-induced cytotoxicity under visible light.

**Conclusion:** In this research we combined different materials to create a hybrid compound with superior biological activity, that saws great promise for use in photodynamic therapy.

## Biography

Maria-Anna Gatou got her BSc in Geology and Geoenvironment at the National and Kapodistrian University of Athens. She also has MSc in Materials Science and Technology from the National Technical University of Athens and MSc in Resources, Environment and Sustainability from the University of British Columbia (UBC). She is a PhD candidate, Laboratory of General Chemistry, of the School of Chemical Engineering of the National Technical University of Athens.

# *Virtual*
# *E-Poster Presentation*

# REPRODUCTION QUALITY OF THERMOCHROMIC LINE PRINTS

**Katarina Itrić Ivanda, Marina Vukoje, Rahela Kulčar, Tomislav Cigula and Zrinka Jakopčević**

*University of Zagreb Faculty of Graphic Arts, Crotia*

## Abstract

Thermochromic printing inks change their colour under the influence of temperature. Accordingly, their measurement is challenging. So far there were no attempts of measuring the reproduction quality of the thermochromic printed lines, rather the research was directed towards colour characterization and ink stability in terms of exposure to different degradation processes. The use of thermochromic colours adds value to the product, both through its attractiveness and the information it can convey to the consumer. Therefore, it is necessary to quantitatively characterize the prints. The line is the essential object on which any design is based. Accordingly, the quality of the printed line indicates the possibility of printing fine details with thermochromic inks. In this research, novel method of characterizing thermochromic line prints is presented. Prints were made by offset printing, by applying thermochromic UV ink on commercial offset paper. Applied ink is blue below 29°C, and colourless above the specified temperature. The printed line samples were measured at 20°C, and 40°C. Cooling and heating were controlled by placing the samples on the thermostatically controlled cover water block (EK Water Blocks, EKWB d.o.o. Slovenia). Quantitative analysis of the reproduced lines was performed using Personal IAS Imaging Device (Quality Engineering Associates Inc) and ImageJ (Laboratory for Optical and Computational Instrumentation) image processing software.

## Biography

Katarina Itrić Ivanda was born on July 22th 1983 in Dubrovnik. After graduating from high school, she studied Physics at the Faculty of Science University of Zagreb. In 2010 she was employed at the Faculty of Graphic Arts, University of Zagreb as an assistant at the Department of Basic and General Knowledge where she is still working. That same year, she enrolled in the doctoral study of Graphic Technology. During her doctoral studies, she participated in scientific training within the COST network in Spain and the United Kingdom. She defended her PhD on February 25th 2016 entitled "Application of the gradient method in the component separation of dot gain" under the supervision of assoc. prof. Damir Modrić. In collaboration with colleagues from the department, she is engaged in scientific and professional work with the application of physics in graphic technology. Primary areas of interest are examination of the interactions of electromagnetic radiation with different printing surfaces; possibility of separating the mechanical and optical dot gain; influence of printing techniques and different substrates on the appearance and quality of the edge of the raster element; influence of the electromagnetic radiation on the optical properties of printing substrate; FT-IR spectroscopy.

# *Accepted Abstracts*

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# STRENGTHENING DEFICIENT REINFORCED CONCRETE BRIDGE COLUMNS

**Raafat El-Hacha and Adel Al Ekkawi**
*University of Calgary, Canada*

## Abstract

**Background:** Decades ago, several major earthquakes that happened worldwide, such as the 1971 San Fernando Earthquake, the 1994 Northridge Earthquake, and the 1995 Kobe Earthquake, resulted in substantial damage to reinforced concrete (RC) bridge columns. Bridge failures were mainly attributed to their supporting columns' inadequate strength and deformation capacity. Such a deficiency was primarily caused by the inadequate reinforcement design and construction details imposed by codes issued before 1971. This includes insufficient lap splice length, insufficient lateral reinforcements for proper confinement, and the use of materials characterized by low ductility. Therefore, a proper strengthening system must be applied to seismically deficient RC columns to avoid the collapse of bridges, prolong their lifespan, and maintain the sustainability of the transportation infrastructure.

**Objective:** To enhance the seismic performance of deficient RC columns through the utilization of smart and composite materials, which are Iron-based shape memory alloy (Fe-SMA), Carbon Fibre Reinforced Polymer (CFRP), and Ultra-High-Performance Fibre-Reinforced Concrete (UHPFRC).

**Methods:** Five RC circular columns of diameter 300mm and height 1600mm, supported on RC foundations, are constructed following CSA A23.3-2019. However, the amount of lateral reinforcements is selected to be low to induce an improper confinement effect. The concrete compressive strength of the columns is 35 MPa. The steel yield strength is 410 MPa. One column is left in its as-built conditions for comparison purposes, whereas the other four were strengthened. The strengthening systems described herein are applied along the columns' lower half, extending from the columns' base (top of foundation) to the columns' mid-height. All four columns are strengthened in flexure with one pre-strained Fe- SMA strip of 120 mm width and 1.5 mm thickness mounted vertically on both sides of the columns and along their lower half. The top of the strips is anchored to the column through anchor bolts, whereas the bottom is welded to a steel base anchored to the foundation. The second column is kept in a flexural strengthened condition only, whereas the third, fourth, and fifth columns are confined with Fe-SMA strips, CFRP, and UHPFRC, respectively. The confining Fe-SMA strips are wrapped around the column with both ends anchored to it. The CFRP strips are bonded with epoxy adhesive, and finally, the UHPFRC is cast around the column as a jacket. A gas torch is used to heat the Fe-SMA strips above their activation temperature ≈200°C. Since both ends of the strips are restrained, recovery stress of 350 MPa is generated in the strips, effectively prestress the columns vertically. Also, the third column, wrapped with Fe-SMA strips, will be actively confined due to the incompressible nature of concrete and the prestressing effect of the strips. The spacing of the confining Fe-SMA strips, the number of CFRP layers, and the thickness of the UHPFRC jacket are selected to provide a confining pressure of 4 MPa based on the ductility requirements of CSA S6-2014. All columns are loaded laterally in a cyclic manner following FEMA 461 recommendations. Also, an axial load of 110 kN was applied, representing 5% of the column's gross sectional compressive strength, to mimic gravity effects in real bridges. The seismic performance of all columns is assessed in terms of lateral strength, displacement ductility, energy dissipation capacity, and failure mode.

**Results:** The results presented in this paper are based on an analytical approach only, which will be backed up with experimental testing and numerical modelling in the very near future. The analytical study included several constitutive models that best describe the behaviour of confined concrete with SMA, CFRP, and UHPFRC. Non-linear models of concrete were adopted to accurately determine the displacement capacity and ductility of all columns. The as-built column recorded a maximum lateral strength and displacement of 56 kN and 27mm, respectively. After adding two Fe-SMA strips (one strip on each side) to the second column, the strength and displacement capacity increased by 38% and 15%, respectively, recording values of 77 kN and 31mm. This shows that adding Fe-SMA strips as external reinforcements is a viable option to increase the lateral strength of the column, but with a limited increase in displacement capacity. However, confining the column with Fe-SMA strips witnessed a significant increase in strength and displacement, recording 119 kN (112.5%) and 137mm (407%), which was the highest among all columns. The third column, confined with CFRP, recorded similar values of 114 kN strength (104%) and 100.38mm displacement (271%). This clearly shows that the brittle nature of CFRP limits the deformability of the column; meanwhile, the ductile nature of SMAs incredibly favours the column to possess a higher deformation capacity. Finally, the column with the UHPFRC jacket also showed a reliable performance where the strength reached 112 kN, whereas the displacement capacity recorded 74mm (99% and 174% increase, respectively). As for the displacement ductility, adding external Fe-SMA reinforcements recorded a 61% increase and value of 3.8, whereas confining the column with Fe-SMA, CFRP, and UHPFRC, increased the ductility to 11, 8, and 6, respectively.

**Conclusion:** The analytical study focused on investigating the effectiveness of several hybrid strengthening systems in enhancing the seismic performance of deficient RC columns. The results showed that applying both external reinforcements and confinement, referred to as a hybrid system, is the optimum approach to enhancing the seismic performance of RC columns. As a result, the strength and ductility of RC columns were significantly enhanced, especially for the Fe-SMA strengthened column.

## Biography

Raafat El-Hacha, is a Professor of Structural Engineering at the University of Calgary in the Department of Civil Engineering, Canada. Dr. El-Hacha's pioneer research has been recognized as pushing the boundary of knowledge in using innovative and smart advanced materials for strengthening structures and new construction, such as fibre-reinforced polymers, shape memory alloy and ultra-high performance concrete for hybrid structural systems in bridge applications and other structures. He published over 250 journal and conference papers. Supervised and graduated 50 Ph.D. and MSc students. He is a Fellow of the International Institute for FRP in Construction (IIFC), the Canadian Society of Civil Engineers (CSCE), the American Concrete Institute (ACI), and the Engineering Institute of Canada (EIC). He received several awards and fellowships, including the CSCE Casimir Gzowski Gold Medal Award, CSCE Excellence in Innovation in Civil Engineering Award, IIFC President's Award, Killam Professorship Award, Erasmus Mundus International Fellowship and many others for his outstanding academic and professional achievements.

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# POST-TENSIONING IRON-BASED SHAPE MEMORY ALLOY STRIPS TO IMPROVE SERVICE PERFORMANCE OF BRIDGE GIRDERS

**Raafat El-Hacha[1], Benjamin Thorne Forrest[1] and Julien Michels[2]**
[1]*University of Calgary, Canada*
[2]*re-fer AG, Switzerland*

## Abstract

**Background:** The state of the infrastructure in Canada is in peril. A Canadian Infrastructure Report in 2019 stated over 40% of the nation's infrastructure is in poor or worse condition. Structures in this condition will likely require replacement or rehabilitation in the next five to ten years. A novel unbonded post-tensioning system transfers inherent stress recovery developed when it is heated to a beam at the anchors and improves the service performance by reducing deflections and closing cracks. Developing stress recovery by heating with a propane torch, for example, eliminates the need to install heavy jacking and anchoring equipment required for other prestress strengthening systems. The beams are constructed out of Carbon Nano-Fiber Ultra-High-Performance Fiber-Reinforced Concrete (CNF-UHPFRC), a unique product which stands out from other ultra-high-performance concretes as it can be mixed and cast on-site without any rigorous curing regimes, while still maintaining exceptional mechanical properties. The carbon fibres reinforce the microcracks between the matrix and fine aggregates, while the steel fibres reinforce the macrocracks of the beam and offer some resilience and forgiveness in terms of transferring tensile stress when the cracks open and close. Incorporating the Iron-based Shape Memory Alloy (Fe-SMA) post-tensioning system with the remarkable strength and resilience of CNF-UHFPRC provides an interesting solution to improving the service performance of bridge girders which was not possible before this technology was developed.

**Objective:** To quantitatively investigate the flexural performance improvements of CNF-UHPFRC beams post-tensioned with Fe-SMA externally unbonded tendons.

**Methods:** The objective of this investigation is met by investigating three parameters; AT-anchorage type, S-strengthened and PS-post-tension-strengthened. Two series of CNF-UHPFRC beams reinforced with 3-10M were constructed with two types of anchorage. The Fe-SMA strip in series I was anchored to the CNF-UHPFRC beams using eight 22 mm long, powder-actuated fasteners. The strips in series II were welded to embedded steel plates cast into the base of the beams. Each series consisted of an S and PS-beam where the strip of the PS-beam was activated. All the beams were compared to a control beam which was not strengthened with an Fe-SMA strip. The flexural performance was observed by comparing the change in deflection at the characteristic loading points; cracking load, a load of 20 kN (representative of a service load), and Fe-SMA yield load. The ultimate characteristics were also compared by observing the maximum load reached, and the associated deflection and the ductility index were recorded by comparing the load and deflection when Fe-SMA strips yields and the concrete crushes.

**Results:** The failure mode of the control beam was concrete crushing, followed by steel yielding characteristics of an under-reinforced beam using conventional reinforced concrete analogies. The failure mode for the first series of beams was Fe-SMA strip detachment, followed by concrete crushing and steel yielding. The detachment of the strip prior to beam failure did not permit observation at ultimate; however, there was a notable stiffness increase at service levels of the I-PS prior to detachment. For instance,

the deflection of 20 kN of I-S and I-PS was reduced by 29% and 59%, respectively. The cracking strength of I-S and I-PS beams increased by 18% and 118%, respectively. Series II beams showed an obvious improvement even still, attributed to the reinforced anchors. Beam II-PS showed a 56% increase in the cracking load compared to I-PS, which amounts to a 123% increase compared to the control beam. The deflection at 20 kN of II-PS was reduced by 42% compared to I-PS and 76% compared to the control. At ultimate, II-S increased the peak load by 55%, whereas II-PS increased by 39%. The deflection of II-PS at the peak load increased 71% compared to II-S and 126% compared to the control.

**Conclusion:** The experiments in this investigation demonstrate a novel and cost-effective way of improving bridge girders' service performance. A marked improvement in both service performance and ductility was observed. This is significant as there is typically a tradeoff between ductility and prestress strengthening with alternative strengthening systems. Improving the service performance will undoubtedly delay the onset of deterioration and extend the lifespan of the structure which stands to have substantial environmental.

## Biography

Raafat El-Hacha, is a Professor of Structural Engineering at the University of Calgary in the Department of Civil Engineering, Canada. Dr. El-Hacha's pioneer research has been recognized as pushing the boundary of knowledge in using innovative and smart advanced materials for strengthening structures and new construction, such as fibre-reinforced polymers, shape memory alloy and ultra-high performance concrete for hybrid structural systems in bridge applications and other structures. He published over 250 journal and conference papers. Supervised and graduated 50 Ph.D. and MSc students. He is a Fellow of the International Institute for FRP in Construction (IIFC), the Canadian Society of Civil Engineers (CSCE), the American Concrete Institute (ACI), and the Engineering Institute of Canada (EIC). He received several awards and fellowships, including the CSCE Casimir Gzowski Gold Medal Award, CSCE Excellence in Innovation in Civil Engineering Award, IIFC President's Award, Killam Professorship Award, Erasmus Mundus International Fellowship and many others for his outstanding academic and professional achievements.

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## Note

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