ICKEM & MatDes 2024

Mar. 06-08, 2024 | Dubai, UAE

◆ Onsite Venue:

Hilton Garden Inn Dubai Al Muraqabat – Deira
Add.: Abu Baker Al Siddique Road, Dubai, U.A.E
Email：info.almuraqabat@hilton.com
Tel.: +971 4 609 7000

◆ Online Link

Zoom ID: 834 4503 2263
Password: ickem
Link: https://us02web.zoom.us/j/83445032263

◆ Time Zone: GMT+4.00

Please note that all the schedules will be arranged in Dubai standard time.

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WELCOME MESSAGE

It is with great honor and pleasure to extend a warm invitation to you all for attending 2024 the14th International Conference on Key Engineering Materials (ICKEM 2024) & 2024 the 6th International Workshop on Materials and Design (MatDes 2024). This prestigious event will take place Dubai, UAE from March 6-8, 2024. This conference aims to provide a platform for technical and scientific professionals from academia, research and industries in the fields of Key Engineering Materials and Materials and Design. In addition to exchange knowledge and distribute the emerging state-of-the-art technologies.

After several rounds of review procedure, the program committee accepted the papers to be published in conference proceedings. We wish to express our sincere appreciation to all the individuals who have contributed to the conference. Special thanks are extended to our colleagues in program committee for their thorough review of all the submissions, which is vital to the success of the conference, and also to the members in the organizing committee and the volunteers who had dedicated their time and efforts in planning, promoting, organizing and helping the conference.

This year we are honored to welcome our distinguished keynote speakers:

We would like to express our heartfelt thanks to all the units and schools that attended this meeting.

In conclusion, I would like to express our gratitude to all the participants and wish each of you a productive and enjoyable conference experience in the beautiful city of Dubai, UAE.

Conference Chair
Prof. Alexander M. Korsunsky,
Professor and Fellow (em.), Trinity College,
University of Oxford, UK
Editor in Chief, Materials & Design

CONFERENCE AGENDA

*All the arrangements is based on Dubai Time (UTC+4.00)

Day 1—March 06, 2024--Wednesday		
Time	**Activity**	**Location**
10:00-12:00	Zoom Testing	Zoom ID: 83445032263 Password: ickem
13:00-17:00	Onsite Registration & Materials Collection	@ Lobbt
Day 2—March 07, 2024--Thursday		
09:30-12:00	Keynote Speeches & Invited Speech	AI-Rigga
13:30-15:30	Workshop on Materials and Design	AI-Rigga
	Session 1- Composite Materials and Mechanics of Composite Structures	
16:00-17:45	Session 2- Materials Physics and Computational Materials Science	AI-Rigga
	Session 3- Materials Chemistry and Advanced Materials for Engineering Application	
Day 3—March 08, 2024--Friday		
09:30-10:00	Invited Speech	Zoom ID: 83445032263 Password: ickem
10:00-11:45	Session A- Advanced Building Materials and Mechanical Properties of Composite Materials	
13:00-14:45	Session B- Carbon based Materials and Materials Chemistry	

CONFERENCE COMMITTEE

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Prof. Alexander M. Korsunsky, Fellow emeritus, Trinity College, University of Oxford, UK

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Dr. Zacharias Pandermarakis, Region of Attica, ASPETE University, Greece

CONFERENCE VENUE

Hilton Garden Inn Dubai Al Muraqabat – Deira

Address: Address: Abu Baker Al Siddique Road, Dubai, U.A.E
Email Us: info.almuraqabat@hilton.com
Tel.: +971 4 609 7000

Just a 15-minute drive from Al Mamzar Beach, Hilton Garden Inn Al Muraqabat is conveniently located in the heart of Deira. It offers free WiFi in all areas, delicious breakfast, an outdoor pool and 1 restaurant. Free parking is available.

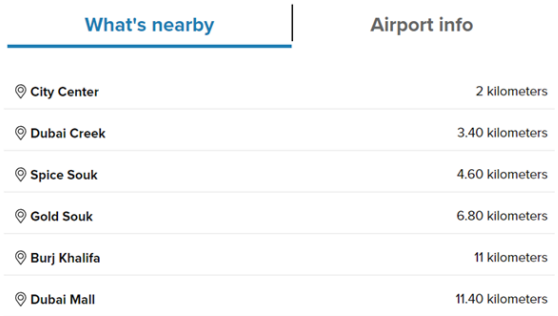
Each room at this hotel feature a modern and warm décor. Each one offers a flat-screen TV, a mini-bar and an electric kettle. The bathroom is fitted with shower and free toiletries.

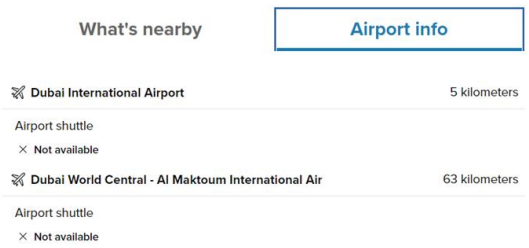
The on-site Garden Grille & Bar serves delicious international and local dishes, including a children's menu. Relax with a cocktail at the bar, or enjoy 24-hour room service if you prefer to eat in.

Events are held in the meeting space, which is flexible enough for large or small functions. Guests can work out in the fitness center or refresh in the temperature-controlled rooftop pool.

There is free shuttle service to the La Mer beach & Dubai Mall. Also a 24-hour Business center, front desk & a gift shop at the property

Hilton Garden Inn Dubai is within a short driving distance from Al Ghurair Shopping Mall and Deira City Center. Dubai International Airport is 10 minutes by car.





Warm Tips

Dubai Standard Time: UTC/GMT+04:00
Temperature: 55F—70F
Currency: AED 1AED= 0.27227 USD

GUIDELINES FOR ONSITE ATTENDANCE

For Oral Presentation

- The duration of a presentation slot is 15 minutes. Please target your lecture for a duration of about 12-13 minutes for the presentation plus about 2-3 minutes for questions from the audience.
- A projector & computer will be available in every session room for regular presentations.
- We suggest you bring a backup PDF-version of your presentation.

Tips

- Your punctual arrival and active involvement in each session will be highly appreciated.
- Get your presentation PPT or PDF files prepared.
- Laptop (with MS-Office & Adobe Reader), projector & screen, laser sticks will be provided by the conference organizer.
- Please keep all your belongings (laptop and camera etc.) with you in public places, buses, subway.

Reminder

- Please remember to take all personal belongings with you whenever you leave a conference room or public area. Do not leave bags or laptops unattended.
- The conference is irresponsible for the loss.
- Please silence your cell phones during presentations or sessions to minimize the disruptions

GUIDELINES FOR VIRTUAL TALKS

Time Zone

- Dubai Standard Time (CST) UTC/GMT+04:00
- Please make sure that both the clock and the time zone on your computer are set to the correct Paris Time

Device

- A computer with an internet connection (wired connection recommended)
- USB plug-in headset with a microphone (recommended for optimal audio quality)
- Webcam (optional): built-in or USB plug-in

Environment

- Quiet Environment
- Stable Internet Connection
- Proper lighting

Platform: Zoom

- For Users from mainland China: www.zoom.com.cn/download
- For General Users: https://zoom.us/support/download
- Zoom Help Center: https://support.zoom.us/hc/en-us/articles/206175806

Sign-in & Join-in

- Join a meeting without signing in: A Zoom account is not required if you join a meeting as a participant, but you cannot change the virtual background or edit the profile picture
- Sign in with a Zoom account: All the functions are available

Voice Control Rules

- The host will mute all participants while entering the meeting.
- Speakers can unmute microphone when it is his or her turn for presentation.
- Q&A goes after each speaker, the participant can raise questions.

Conference Recording

- The whole conference will be recorded. We appreciate your proper behavior and appearance.
- The recording will be used for the conference reports among the committee. It won't be distributed to or shared with anyone else, and it shall not be used for commercial or illegal purpose. It will only be recorded by the staff; the presenters are not allowed to record.

DETAILED PROGRAM

March 6, 2024 | Wednesday		
Online **10:30-12:00**	**Zoom Testing**	**Zoom ID: 83445032263** **Password: ickem**
10:30-11:00	**Prof. Zeki Candan**, Istanbul University, Turkey **Prof. Huirong Le**, Tsinghua University, China **Prof. Geoffrey R. Mitchell**, Polytechnic of Leiria, Marinha Grande, Portugal	
11:00-11:30	**Session A:** KM-037, KM-042, KM-065-A, KM-033, KM-079, KM-051, KM2-012-A	
11:30-12:00	**Session B**: KM-008, KM-010, KM-057, KM-019, KM-031, KM-005, KM-029	
Onsite **13:00-17:00**	**Sign-in & Conference Materials Collection**	**@Lobby of the meeting room**

Onsite Registration Instructions

Hilton Garden Inn Dubai Al Muraqabat - Deira

Abu Baker Al Siddique Road，Dubai, U.A.E

- **Give your Paper ID to the staff (**e.g., KM-001**).**

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- **Sign your name in the attendance list and check meal information.**

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- **Check your conference kit, which includes conference bag, name tag, meal voucher, conference program, the USB.**

March 7, 2023 | Thursday Meeting Room: Al Rigga (M floor) Zoom ID: 83445032263 Password: ickem		
Time	**Activity**	
	Chaired by	
09:00-09:10	**Opening & Remarks** **Prof. Alexander M. Korsunsky**, Fellow emeritus, University of Oxford, UK	
09:10-09:50	**Keynoted Speech 1** **Prof. Alexander M. Korsunsky**, University of Oxford, UK *Speech Title: Rational Experimental-Computational Correlation (RECC) in Structural Engineering and Mechanobiology*	
09:50-10:30	**Keynoted Speech 2** **Prof. Geoffrey Mitchell**, Institute Polytechnic of Leiria, Portugal *Speech Title: The First 30s of an Injection Moulding Cycle – Operando SAXS Measurements*	
10:30-10:50	Group Photo & Coffee Break @ Foyer of AI Rigga	
10:50-11:30 (online)	**Keynoted Speech 3** **Prof. Jian Lu**, City University of Hong Kong, China *Speech Title:*	
11:30-12:00	**Invited Speech 1** **Assoc. Prof. Dmitry Dzhurinskiy**, Skolkovo Institute of Science and Technology, Russia *Speech Title: Surface Modification trough Cold Spray Coating Deposition Method: Theory and Applications*	
12:00-13:30	Lunch Break @ Garden Grille Restaurant	
13:30-15:30	**Workshop on Materials and Design** KM-139-A, KM-132-A, KM-128-A, KM-124-A, KM-121-A, KM-111-A, KM-146-A	AI Rigga (M floor)
	Session 1- Composite Materials and Mechanics of Composite Structures KM-094, KM-090-A, KM2-007, KM-105, KM-109-A, KM-099-A, KM-085, KM-119-A	Al Manzr (M floor)
15:30-16:00	Coffee Break @ Foyer of AI Rigga	
16:00-18:00	**Session 2- Materials Physics and Computational Materials Science** KM-094, KM-090-A, KM2-007, KM-105, KM-109-A, KM-099-A, KM-085, KM-119-A	AI Rigga (M floor)
	Session 3- Materials Chemistry and Advanced Materials for Engineering Application KM-082-A, KM-106, KM-064-A, KM-024-A, KM-103, KM2-013, KM-104, KM-093	Al Manzr (M floor)
18:30	Banquet @ Garden Grille Restaurant	

March 08, 2024 | Friday Zoom ID: 83445032263 Password: ickem	
Time	**Activity**
09:30-10:00	**Invited Speech 2** **Prof. Zeki Candan**, Istanbul University, Turkey *Speech Title: Nanocellulose: Sustainable Material for Advanced Engineering*
10:00-12:00	**Session A- Advanced Building Materials and Mechanical Properties of Composite Materials** KM-037, KM-042, KM-065-A, KM-033. KM-079, KM-051, KM2-012-A
12:00-13:30	Lunch Break
13:30-15:30	**Session B- Carbon based Materials and Materials Chemistry** KM-008, KM-010, KM-057, KM-019, KM-031, KM-005, KM-029

KEYNOTE SPEAKER

Venue Al Rigga (M floor) Time 09:10-09:50, March 7, 2024 (GMT+4)

Prof. Alexander Korsunsky

Alexander Korsunsky received his degree of Doctor of Philosophy (DPhil) from Merton College, Oxford, following undergraduate education in theoretical physics. His current appointment is Professor of Engineering Science at the University of Oxford and Trinity College. He has given keynote plenaries at major international conferences on engineering and materials. He has developed numerous international links, including visiting professorships at Universitá Roma Tre (Italy), ENSICAEN (France) and National University of Singapore.

Prof Korsunsky's research interests concern developing improved understanding of integrity and reliability of engineered and natural structures and systems, from high-performance metallic alloys to polycrystalline ceramics to natural hard tissue such as human dentin and seashell nacre.

Prof Korsunsky co-authored books on fracture mechanics (Springer) and elasticity (CUP), and published over 200 papers in scholarly periodicals on the subjects ranging from neutron and synchrotron X-ray diffraction analysis and the prediction of fatigue strength to micro-cantilever bio-sensors, size effects and scaling transitions in systems and structures.

Speech Title: Rational Experimental-Computational Correlation (RECC) in Structural Engineering and Mechanobiology

Abstract: The exploration and optimisation of the interface between the experimental and computational approaches in the study of materials for functional and structural engineering is a critically important topic for ensuring the predictive and design validity of numerical calculations, machine learning descriptions, artificial intelligence models, etc. Computer-based simulation has become so widely and extensively used that it is often implicitly trusted to deliver conclusive answers. However, the important

step of model validation and refinement may only too frequently become overlooked or brushed aside, as if the ability to obtain "nature-like" simulation automatically guarantees the reliability for design in construction and technology. The situation is, in fact, quite to the contrary: the greater the complexity of the physical processes and mechanisms implemented numerically within the model, the larger is the number of parameters and interdependencies between them that needs to be supplied as input to the model. Insufficient care in assuring the correctness of inputs leads to the problem becoming ill-posed in the sense of non-uniqueness, non-smooth dependence of the results on input data, and the possibility of obtaining similar predictions from multiple parameter combinations. There is a clear need to develop a broadly reaching approach placed at the interface between computational modelling and digital experimentation that can provide a rational basis for model validation, refinement, and extrapolative use. The Rational Experimental-Computational Correlation (RECC) approach presented here must incorporate the following key components:

- Experimental observations fulfil the primary role, whilst numerical simulations must incorporate available information regarding the method of measurement, sources of uncertainty and aberration to match the experiment(s);
- The measure of the goodness of match between the simulation and observation must be formulated mathematically as a functional (expressed digitally within the computational algorithm) to allow the application of the classical and novel means of optimization;

- Numerical simulations must incorporate uncertainty quantification (UQ), i.e. error propagation procedures to deliver predictions equipped with the measures of overall error and result sensitivity with respect to different parameters and assumptions made in the algorithm;
- Algorithms should allow progressive improvement of prediction reliability through the choice of base functions, mesh refinement, and the inclusion of further experimental observations, including those obtained using different additional modes.

Although the proposed approach is somewhat novel in the context of structural engineering and mechanobiology, prominent examples of this paradigm can be found in other scientific and engineering disciplines, e.g., Rietveld refinement. Systematic expansion of the approach is anticipated in the field of aerospace engineering, chemical synthesis and processing, additive manufacturing, and mechanobiology. In the latter case in particular, it is anticipated that RECC will offer pathways to the discovery of novel signalling mechanisms and multi-scale relationships that determine the complex adaptive response of biological living systems (cells and tissues) to their interaction with biomaterials, biological and chemical molecules, substrates, scaffolds, and mechanical actuation.

KEYNOTE SPEAKER

Venue	Al Rigga (M floor)	Time	09:50-10:30, March 7, 2024 (GMT+4)

Prof. Geoffrey Mitchell

Geoffrey Mitchell is a researcher at the Centre for Rapid and Sustainable Product Development at the Polytechnic of Leiria in Portugal and Visiting Medical Physicist Oxford University Hospitals NHS Foundation Trust, Oxford UK. He is also Chief Scientific Officer for a high tech company in Marinha Grande "Visionary Equation Lda". Geoffrey Mitchell carried out his doctoral work at the University of Cambridge in the UK and subsequently held a post-doctoral fellowship at Cambridge and a JSPS Fellowship at Hokkaido University in Japan. Prior to his current position he was Professor of Polymer Physics at the University of Reading, UK and from 2005 the founding Director of the Centre for Advanced Microscopy at Reading. His research work bridges physics, engineering, biology, chemistry and technology and he is passionate about the opportunities afforded by Additive Manufacturing. He has pioneered the use of in-situ x-ray and neutron scattering in the study of polymer processing and has most recently extended this concept to injection moulding. At CDRSP he was responsible for Internationalisation. He is a Fellow of both the Institute of Physics and the Royal Society of Chemistry as well as the Royal Society for the Encouragement of Arts, Manufactures and Commerce and a Member of the Institute for Physics and Engineering of Medicine. He is an enthusiastic supporter of the Green and Digital Transitions and has pioneered research work on gum rosin as a biomaterial and developed the concept of morphology mapping as part of digital materials for additive Manufacturing.

Speech Title: The First 30s of an Injection Moulding Cycle – Operando SAXS Measurements

Abstract: The bright sources of X-rays available at 3rd Generation Synchrotron Light Sources facilitate the development of operando x-ray scattering measurements during polymer processing [1]. Polymer processing involves heating the polymer in to the liquid phase, shaping it in to the product, whether it is a fibre or complex industrial component, which usually involves fluid flow, and then cooling to solidify the polymer either as a glassy polymer or a semicrystalline solid. Intense X-ray sources and fast area detectors facilitate time-resolving measurements which are able to separate the various components or stages of the molecular reorganization which accompanies processing. This has many advantages over rebuilding the time profiles from measurements made post-processing.

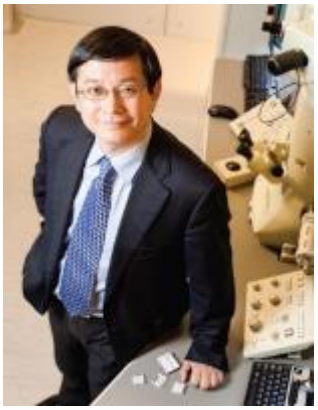
X-Ray scattering is ideal probe for developing a quantitative understanding of the evolution of structure and morphology. It is a quantitative technique, the physics of X-ray scattering is well understood and there are well established

methodologies for extracting structural parameters from X-ray scattering data including crystallinity, preferred orientation, crystal structure and long period [2]. X-ray scattering is able to address multiple scales of structure, through the use of both Wide-angle X-ray scattering and Small-angle X-ray scattering. Data collection cycles of less than 1s are possible.

Injection moulding is the common technology used to manufacture plastic parts as it has a high throughput and can produce many different shapes of variable sizes. It is a deceptively simple technique in which liquid polymer is injected at high pressure in to a metal mould, with a space shaped to be the negative of the desired part. The liquid polymer cools as the mould is at a lower temperature and the part forms a solid and is then ejected from the mould, and so the cycle begins again. Complex parts of more than a 1m in length can be easily prepared. Due to the high cost of the mould, the technology is highly suited to mass production. A mould for the dashboard of a car may cost in excess of $1M, and producing a million significantly reduces the cost. In the current practice for mould design and manufacture, computer aided design is used extensively, and before the mold is manufactured it is fully tested in computer simulations. The high pressure of injection and the rapid cooling rates experienced by the liquid polymer, mean that it is difficult to evaluate the effects of flow and temperature on the crystallization of the polymer during the process using conventional laboratory instruments. As a consequence, we have design and constructed an injection moulding system [3] which can be mounted on the NCD-SWEET Beamline of the ALBA Synchrotron Light Source in Barcelona. We are able to obtained time-resolved small-angle x-ray scattering with a 1s data cycle during the injection moulding cycle [1]. We have used this equipment to explore the changes in molecular organization that occur in the mould for a number of semi-crystalline polymers including isotactic polypropylene [3], polyhydroxyalkonoates and polybutylene succinate [4]. The latter two polymers prepared from biomaterials. We report here quantitative data which relates to the first 30s of an injection moulding and we are using this data to understand the source of the downgrading of properties during the processing cycle in order to move towards a 100% circular economy for plastics and to transform injection moulding for the Digital Transition.

KEYNOTE SPEAKER

Zoom ID	83445032263		
Password	ickem	Time	10:50-11:30, May 9, 2023 (GMT+4)



Prof. Jian Lu

Fellow SEM, Fellow HKAES, Fellow HKIS,

Academician: National Academy of Technologies of France

Chair Professor of Mechanical Engineering, Department of Mechanical Engineering

Director of Hong Kong Branch of National Precious Metal Material Engineering Research Centre

Director of Centre for Advanced Structural Materials

Senior Fellow of Hong Kong Institute for Advanced Study

Speech Title:

Abstract:

INVITED SPEAKER

Venue	Al Rigga (M floor)	Time	11:30-12:00, March 7, 2024 (GMT+4)

Assoc. Prof. Dmitry Dzhurinskiy

Dr. Dmitry Dzhurinskiy is Associate Professor at the Skoltech Center for Materials Technologies. He received combined B.Sc. and M.Sc. degrees in 2000 and earned his Ph.D. in 2006 with a major in Materials Science and Engineering. In 2011, after three years of postdoctoral appointment, he joined same research group at the University of Windsor, Canada as a Research Associate. From 2000 – 2007 he held research engineer and managerial positions at National Research Center and Innovation Department of Arconic (former Alcoa Corporation). Before joining Skoltech in 2020, he held a senior R&D engineer position servicing automotive industry needs in a greater Detroit area, USA.

Dr. Dzhurinskiy's research interests span the study of thermal spray coatings and multidisciplinary subjects of materials/metallurgy, mechanical, and computer-aided engineering. Dr. Dzhurinskiy is author/co-author of more than 30 scientific papers and co-invented for 8 patents in Russia and USA.

Speech Title: Surface Modification trough Cold Spray Coating Deposition Method: Theory and Applications

Abstract: This talk presents an overview of original research results and achievements accomplished by presenter in the area of surface engineering with specific focus on Cold Gas Dynamic Spray Technology (CGDS). CGDS is a unique solid-state materials deposition process whereby metallic or mixtures of metallic and non-metallic particles are forming a coating by means of ballistic impingement upon a substrate.

The overview of methods and technique to determine gas dynamic parameters of supersonic flows and experimental procedures will be presented. The results of numerical simulation using both CFD and explicit structural dynamic along with a correlation study will be discussed in addition to analysis of collected experimental data.

Specific features of CGDS spray will be focused on coating structure formation and its properties evaluation. Application of feedstock powder pre- processing to increase coating deposition efficiency will also be explained on the basis of a strain gradient plasticity model.

Summary of technological developments and results of technology application will be presented.

INVITED SPEAKER

Zoom ID	83445032263		
Password	ickem	Time	09:30-10:00, March 8, 2024 (GMT+4)

Prof. Zeki Candan

He completed his undergraduate, master's, and doctorate studies at Istanbul University. He visited many universities and research institutions in the United States, Canada, Sweden, England, Germany, Spain, Greece, Romania, and China, carrying out scientific research and studies with the world's leading scientists in his area.

These include the University of Maine; Advanced Structures & Composites Center – ASCC in the United States, which is regarded as the world's biggest laboratory in the fields of composite materials, biomaterials, and renewable energy. Candan also worked in the private sector as the General Secretary of the MDF and Particle Board Manufacturers' Association between 2005 and 2006.

Speech Title: Nanocellulose: Sustainable Material for Advanced Engineering

Abstract: Today's world demands the usage of renewable and sustainable technologies in every area of life because of the increased environmental concerns the consumption of fossil resources, climate change, health problems, and the generation of large amounts of waste, etc. Nanotechnology, which is one of these enhanced technologies, has been nowadays widely recognized as one of the most important factors behind a new industrial revolution in different interdisciplinary sectors like the pharmaceutical, food, automotive industries, and so on. Nanocellulose or nano-structured cellulose has been one of the most outstanding and attractive materials since the beginning of the 21st century thanks to nanotechnology. Nanocelluloses, which are classified with different names in terms of their production processes, have many enhanced properties such as low density, large specific surface area, high degree of polymerization, high transparency, high crystallinity, dimensional stability, high stiffness, high tensile strength, improved thermal stability, lightweight, biodegradability, biocompatibility, and non-toxicity. Also, they are achieved from wood, annual plants, agricultural wastes, tunicate, bacteria, seaweed, etc. Thanks to these excellent properties, nanocelluloses are evaluated in different application areas such as automotive, tissue engineering, communication, healthcare, 3D printing inks, drug delivery, dye removal, biomedical, construction, paper, textile, polymer composites, food packaging, optical products, energy, electronics, water treatment, and oilfield servicing fluids. Consequently, nanocelluloses have carved out a niche in every sphere of life, and they have gradually become the most impressive agents for the design of novel bio-based products.

WORKSHOP

Room	Al Rigga (M floor)	Time	13:30-15:15, March 07, 2024

Workshop on Materials and Design

Paper ID	TAIK DETAILS
KM-139-A	Application of nanoindentation technique for mechanical properties characterization of organic-rich shales on the example of the Bazhenov Formation Author(s): Valentina Bobrysheva, Tagir Karamov, Alexey Salimon, Eugene Statnik, Alexander Korsunsky and Mikhail Spasennykh Presenter: Alexander M. Korsunsky University of Oxford, UK Abstract: Source rocks which are characterized by high organic matter content, exhibit complex mechanical properties due to their high degree of heterogeneity, anisotropy, and diverse composition. Traditional methods for studying these properties on macro-level are limited by sample destruction and bulk results, neglecting the relationship between mechanical properties, mineral composition, and structure of the shale intertwined components contributions. A nanoindentation technique was applied to study mechanical properties at the micro-level, analyzing individual rock-forming components such as kerogen, clay, pyrite and mineral matrix. A rock sample of the Bazhenov Formation was tested. Results reveal significant variations in mechanical properties among its components. Kerogen, the primary hydrocarbon source, classified as “soft component” with the lowest Young's modulus range (2.64 to 4.90 GPa), while pyrite and clay components had the highest elastic modulus range (9.07 and 18.97 GPa, respectively). The mineral matrix was divided into two types depending on its dominant composition, resulting that increased amount of organic matter (OM) leads to the reduced Young's modulus. The results provide insights into the mechanical behavior of source rocks and highlight the importance of considering the impact of individual component properties on the overall rock performance. General problem of mechanics of a inhomogeneous material is discussed. This knowledge is crucial for enhanced oil recovery methods (EOR), reservoir modeling, and effective exploration strategies. Further improvements in the nanoindentation methodology are suggested to enhance the accuracy and reliability of the measurements and to create digital models for predicting the rock behavior under different conditions.
KM-132-A	Versatile Characterization of PVA-Agarose Hydrogels for Biomedical Applications Author(s): Eugene Statnik, Elizaveta Cherkasskaya, Danila Sukhomlin, Iuliia Sadykova, Eugene Prokopev, Alexey Salimon, Zhanna Semenova and Alexander Korsunsky Presenter: Alexander M. Korsunsky University of Oxford, UK Abstract: The aim of this study is to investigate the mechanical properties as well as the shrinkage and swelling of PVA-Agarose hydrogels, in order to evaluate their potential for use in various biomedical applications. To examine the different mechanical responses of the hydrogels, specialized add-on devices were designed for the miniature testing machine Deben MT 1 kN, which were used to perform needle piercing resistance, extrusion, and standard tension tests. Furthermore, a long-term operando experiments were conducted inside a fridge to analyze the shrinkage and swelling behaviors of the hydrogels using the digital image

	correlation technique. The results indicate that the PVA-Agarose hydrogels have favorable mechanics and rheology, rendering it appropriate for various medical applications such as fabricating phantoms that mimic human organs, tissue engineering, and wound healing.
KM-128-A	Micropillar mechanical testing techniques in probing irradiated oxide dispersive strengthened (ODS) steels Author(s): Pavel Somov, Eugene Statnik, Ekaterina Korneeva, Vladimir Skuratov, Alexey Salimon and Alexander Korsunsky Presenter: Alexander M. Korsunsky University of Oxford, UK Abstract: Materials inside nuclear reactors (especially of new generations) are always exposed to attacks of numerous aggressive factors: irradiation of diverse high energy particles like light and heavy ions, and neutrons, elevated temperature, water and steam, or liquid metals corrosion, gaseous hydrogen. This motivates materials scientists to develop new classed of materials capable to withstand these impacts for decades and oxide dispersive strengthened (ODS) steels are considered as promising candidates since nano- and submicrometer sized oxide particles are relatively persistent to radiation swelling and coarsening and, therefore, suppressing grain growth, dislocation climbing and other mechanisms of creep. Experimental studies of mechanical performance evolution under irradiation are complex and time consuming, and various computational or empirical models are being developed to accelerate experiments while retaining fidelity and engineering robustness. The irradiation with swift heavy ions is an approach to simulate radiation impact in reactors, however, all expected changes occur within relatively thin surface layers (up to 10 μm) and micromechanical testing becomes only way to assess these changes. We demonstrate the use of world seldom characterization setup – dual FIB-SEM high resolution scanning electron microscope Tescan S9000 Solaris equipped with Alemnis Standard Assembly nanoindentation tester that makes feasible to prepare with FIB gun special micropillars having diameter of 2 μm and height of 4…5 μm and test them in compression in situ. Cr16 ODS, Eurofer ODS and AISI410S steels were irradiated by 48 MeV Ar+ ions and 150 MeV Xe+ ions at room temperature at the IC-100 cyclotron (FLNR, JINR, Dubna). Ion projected ranges, i.e. the depth of material affected by radiation damages were about 6 μm. Digital image correlation allows revealing fine effects of slip initiation, while coarse effects of micropillar segmentation by shear bands are especially noticeable. All studied steels show similar mechanical performance of surface layer both in pristine and irradiated state, the last is, however, characteristic by higher yield strength for about 15%.
KM-124-A	Calculation and cross-validation of the cooling rates during steel sample quenching Author(s): Matvey Merkulov, Eugene Statnik, Alexey Salimon and Alexander Korsunsky Presenter: Alexander M. Korsunsky University of Oxford, UK Abstract: Understanding many important processes in materials science, engineering, and manufacturing requires solving the transient heat equation, since the heat history of a component often determines its microstructure, properties, and performance in the desired application. Especially for metallic parts, the changes in the structure, phase composition, and residual stresses both in the volume and at the surface directly depend on the evolution of temperature, time of exposure and the heat flow rate. In addition, the knowledge of temperature distribution can help optimize the component geometry to prevent cracking and warping, and to reduce the need for post processing and finishing. Heat exposure can also be important for plastic and composite parts apt to degrade rapidly at elevated temperatures. Moreover, the growing interest in additive manufacturing has revived the interest in efficient heat equation solvers for process interpretation and control. Ever since Joseph Fourier published the mathematical equation for heat conduction in 1822, the solutions for many problems were found either analytically or using numerical methods. For the latter, the finite element method (FEM) is often used, along with the finite differences (FD), finite volume and

	spectral methods. Various packages exist for obtaining numerical solutions such as ANSYS©, ABAQUS©, Siemens NX©. However, these commercial programs typically use encrypted code, precluding detailed analysis of the internal implementation of the solution algorithm. In the present study, explicit implementation of the finite difference approach was compared with the results obtained from packages and with analytical solution. To perform it, a simple problem of one-dimensional heat transfer was chosen, and the thermal history at points along the rod cooled at one end was calculated. To correlate the results with real experiment, the problem was solved for the specific case of steel 30KhGSA with its characteristic dependence of the physical parameters (density, heat conductivity and specific heat) on temperature. The results were compared, and the mismatch was assessed in terms of the maximum difference and root mean square error at different points.
KM-121-A	Exploring the Anisotropy of Mechanical Properties of α and β phases in Ti-6Al-4V Alloy Using in Situ Micropillar Compression Tests Author(s): Eugene Statnik, Pavel Somov, Alexey Salimon and Alexander Korsunsky Presenter: Alexander M. Korsunsky University of Oxford, UK Abstract: Magnesium alloys present mechanical qualities similar to natural bone and degrade during a specific time period. As an outcome, they provide unique advantages when implemented as biodegradable implants in medicinal practice. However, their high susceptibility to corrosion has severely limited their use in the orthopedic area. For such applications, new compositions, the addition of particular alloying elements, and surface modification are considered as potential avenues. The current work aimed to investigate the corrosion behavior in aqueous solutions while electrochemically testing a newly developed Mg-Ga-Zn alloy. The degradation behavior of magnesium alloy with different roughness in a Hank's buffered solution and saline as a simulated body fluids has been investigated by using electrochemical impedance spectroscopy tests and corrosion current density using potentiodynamic polarization measurements at 37 °C and scanning electron microscopy observation. After it was compared with AZ31 results, one of the most widely used commercial magnesium alloy. According to measured current density, the corrosion resistance of the new alloy is higher than that of AZ31, making it far more appropriate for practical application. It has been demonstrated that alloys dissolve slower in Hank's solution than in 0.9% NaCl. It could be because of to the phosphate layer generated on the oxide surface during experiments in Hank's solution in combination with fewer chlorine ions than saline solution. Surface roughness also influences the results of electrochemical testing, though the results of various studies on the influence of surface pretreatment may be contradictions. Surface roughness of samples should be adopted in accordance with the real implant condition, and simulated body fluids with similar components to human blood plasma should be used to overcome major constraints in numerous clinical applications.
KM-111-A	"Digital Materials" and the Materials Selection paradigm Author(s): Alexey I. Salimon, Eugene S. Statnik and Alexander M. Korsunsky Presenter: Alexander M. Korsunsky University of Oxford, UK Abstract: Since its introduction by Michel F. Ashby [1] in the beginning of 1990s Materials Selection paradigm has maturated and expanded from purely educational aspects towards scientific, engineering, IT and management applications welcomed by universities and industrial companies. It became a gold standard to justify the motivation of new materials' (NM) developments or research through the positioning of NM on the Ashby charts. The elaboration of Application Selection, Eco-Audit, Hybrid and Composite Synthesizer tools makes possible to explore alternatives in terms of engineering solutions and to consider many real and imaginary materials as actual candidates for these solutions. In recent decades, materials scientists were delighted by the great progress in "digital materials" – mainly in terms of theoretically predicted and calculated model entities, and rarely in the form of

	synthesized and fabricated actual objects – which are envisaged as meaningful forecast prototypes for 21st century materials and hopefully even longer glorious future. Artificial Intelligence (AI) technologies promise the creation of even more "digital materials" facilitating fast estimations of material performance values within a single material class (e.g. low alloyed steels or carbon fiber reinforced polymer matrix composites having somewhat different topology of fiber lay-up) and, potentially, beyond a single material class domain limits. Natural materials having perhaps the most pronounced correlation between non-technological transient driving forces and actual structure and performance present ideal objects for AI and machine learning (ML) technologies for accelerated prediction of materials property profile. Recently, AI entered the scene of materials prediction and governing for 3D printed metal materials [2] that actually bring closer the integration of topological and structure optimization for even better control over the performance of designed parts and systems. Key points of the Materials Selection paradigm (material profile as digital multidimensional vector, Ashby charts, performance indices), capturing the landscape of the real materials world, must be equally valid for "digital materials". A "digital material" having been positioned and coordinated together with real materials proves (or does not prove) its right for existence and justifies the need for further development and research. Therefore, Materials Selection paradigm works as a loyal gate-keeping porter and guider for new generation of materials researchers and their sweet dreams. We exemplify our findings in the field of analysis of "digital materials" and demonstrate how AI and ML are applied for the tasks of clustering and classification of real and "digital" materials.
KM-146-A	On the use of Crystal Plasticity Finite Element Method (CPFEM) simulations in the context of metal Additive Manufacturing optimization Author(s): Marina Klesareva, Egor Nazarov and Alexander Korsunsky Presenter: Alexander M. Korsunsky University of Oxford, UK Abstract: Crystal Plasticity Finite Element Method (CPFEM) has emerged over the last two decades as a powerful and versatile means of simulating the deformation behavior of metallic alloy polycrystals at the geometrical scales spanning micrometers to millimeters. The use of CPFEM allows probing the effects of alloy crystal structure, dislocation slip and twinning modes, grain size and shape, texture (preferred orientation) and deformation history on the hardening behavior, fatigue response and ultimate strength of metallic polycrystals. Typically, CPFEM simulation is performed for a representative volume element (RVE) of material with the assumption that such small-scale computation can provide sufficient insight into the response of larger volumes with similar microstructure. However, rationally validated measures of "microstructure representativity" need to be defined rigorously for specific materials response properties – it is fairly apparent, for example, that formulations differ for stiffness and strength. Further aspect that remains the subject of discussion concerns the choice of boundary conditions appropriate for specific loading cases. Of particular interest is the use of CPFEM in the context of metal Additive Manufacturing, due to the manifest influence of the 3D-printing conditions on the material microstructure and its inhomogeneity within the volume of the produced part. It is also apparent that a degree of control can be exercised during 3D printing over the local microstructure and texture, etc., thus opening up the possibility of optimising the manufacturing route with the express purpose of obtaining components with desired service properties, such as ultimate strength, elongation, or resistance to crack initiation. It should be noted, however, that very considerable computational effort is required to perform CPFEM simulation in support of e.g. LPBF additive manufacturing optimization for real engineering components. As a consequence, direct incorporation of large volume CPFEM into optimization frameworks turns out to be impracticable, and alternative routes need to be sought. In this context, 'lightweight' machine learning and correlation methods appear highly suitable for the task. Examples of CPFEM use for the analysis of microstructure-dependent deformation behavior are drawn from the past and present work.

TECHNICAL SESSION

Room	Al Manzr (M floor)	Time	13:30-15:15, March 07, 2024

SESSION 1. Composite Materials and Mechanics of Composite Structures

Chair: Prof. Rinlee Butch Cervera, University of the Philippines Diliman, Philippines

Paper ID	TAIK DETAILS
13:30-13:45 KM-094	Compressive Strength and Expansion Characteristics of BOFS-Based Geopolymer Mortar under Different Curing Regimes Author(s): Zarina Onopriyenko, Chang-Seon Shon, Dichuan Zhang and Jong Ryeol Kim Presenter: Zarina Onopriyenko Nazarbayev University, Kazakhstan Abstract: Basic oxygen furnace slag (BOFS) is a by-product material from the steel industry, which might be used as a substitute for the natural aggregates in the construction industry. The issue pertaining to the use of BOFS as an aggregate is the volume expansion in the concrete matrix by calcium hydroxide (Ca(OH)2) or magnesium hydroxide (Mg(OH)2) formed by free calcium oxide (f-CaO) and free magnesium oxide (f-MgO) components in BOFS. Mineral sequestration (CO_2 curing) and the geopolymerization technique are potential remedies for the BOFS expansion problem. This research studied the compressive strength and expansion characteristics of BOFS-based geopolymer mortar under different curing regimes and durations. Four different curing regimes were evaluated: air, water, steam, and combined steam and CO_2 curing. Additionally, two different durations of 6 and 12 hours in combined steam and CO_2 curing were compared. The results indicate that steam curing and combined steam and CO_2 curing increase the compressive strength of BOFS-based geopolymer, while the curing regime does not affect the water expansion characteristics. For both steam and CO_2 curing, a 12-hour curing duration is favorable rather than a 6-hour curing in terms of compressive strength development and stabilizing the water expansion curve fluctuation.
13:45-14:00 KM-090-A	Multiaxial tension-compression fatigue behavior of pultruded glass-fiber composites Author(s): Aleksandr Elkin, Oleg Staroverov and Ivan Sergeichev Presenter: Aleksandr Elkin Skolkovo Institute of Science and Technology, Russia Abstract: We studied the influence of multiaxial fatigue of pultruded glass-fiber composites. To initiate multiaxial, complex stress state, cylindrical specimens were used, and they were subjected to simultaneous axial force and torque. The multiaxial and just axial fatigue tests were conducted in tension-compression mode. The S-N curves for all types of loading were determined. The results indicated that addition of torque (shear stress component) to the axial load decreases the fatigue life of pultruded glass-fiber composites. However, the decrease become significant only when the shear component is more than 70% from the maximum shear loading.
14:00-14:15 KM2-007	MECHANICAL PERFORMANCE OF DEFECTIVE FDM MULTI-LAYER MATERIAL PANELS Author(s): Amged Elhassan, Waleed Ahmed, Essam Zaneldin, Presenter: Amged Elhassan

	United Arab Emirates University, UAE Abstract: A finite element model was developed in this research to investigate the impact of defects on the mechanical properties of a 3D-printed composite sandwich panel that could occur during the layer alteration period between the dissimilar materials, affecting the interfacial strength between the layers and causing the 3D-printed panel to fail. Numerous parameters, such as interfacial position, size, material properties, and location of defects along the panel, have been examined that might affect the failure mechanism. This finite element study adopted linear elastic behavior by utilizing ANSYS simulation program. The outcomes showed that the midsection of the composite is under a lot of stress, and as we approach the edges of the composite, the tension concentration falls outward until it reaches zero. In the intact scenario, the deformation was zero at either end of the panel and highest in the composite middle. The shear stress was most significant in the center, and it decreased as we moved closer to the extremities of both sides, it gradually decreased until it was lowest there. The endpoints where we have support responses have significant maximum shear stresses, which could degrade the material overall mechanical properties. This rise in the maximum principle stress at the end support could be due to the reaction of the fixed support, which tries to counteract the applied flexural load and raise the maximum principle stress.
14:15-14:30 **KM-105**	Can geopolymer mixture be a solution for utilizing waste glass and BOFS as aggregates? Author(s): Islambek Manap, Anel Galymzhankyzy, Zhaniya Omarova, Dulat Ualiyev, and Doszhan Temirbekov, and Chang-Seon Shon1, Dichuan Zhang and Jong Ryeol Kim Presenter: Islambek Manap Nazarbayev University, Kazakhstan Abstract: This research studies the influence of aggregate proportions, namely Waste Glass Sand (WGS) and Basic Oxygen Furnace Slag (BOFS), on the expansion and compressive strength characteristics of both geopolymer and Ordinary Portland Cement (OPC) mixtures. The research includes an experimental program in which geopolymer mixtures were prepared with different combinations of WGS and BOFS contents (0/100, 25/75, 50/50, 75/25, 100/0, respectively) alongside reference OPC samples containing only WGS or BOFS. The samples prepared for testing expansion behavior were cured under 2 conditions: water submersion and 1M NaOH solution submersion, both maintained at 80°C. Regardless of different combinations of SWS and BOFS, the 28-day compressive strength results for all geopolymer mixtures exceeded the value of 40 MPa. The geopolymer samples experienced different expansion patterns depending on factors such as aggregate content and curing conditions. Specifically, a mixture with 25% WGS and 75% BOFS showed rapid expansion in water, while others maintained expansion within acceptable limits (0.1% threshold value). This was analyzed via literature review, highlighting the role of the alkali-silica reaction. At the same time, the OPC mortar mixture demonstrated significant expansion values, particularly in the NaOH solution, which is connected to the interaction between cement hydration products and NaOH. Based on compressive strength and expansion results, the geopolymer mixture having the 50/50 combination of WGS and BOFS seems to be the optimum mixture in compressive strength and expansion behavior.
14:30-14:45 **KM-109-A**	Deformation mapping and modelling during bending of metallic and composite beams Author(s): Lucynda T. Lumba, Eugene S. Statnik, Alexey I. Salimon and Alexander M. Korsunsky Presenter: Lucynda T. Lumba Skolkovo Institute of Science and Technology, Russia Abstract: Deformation mapping involves the digital visualization and quantitative analysis of material deformations under loading. The present study investigated the deformation behavior of beam samples made from aluminum alloy D16 and epoxy matrix composite obtained by vacuum infusion of carbon fiber-reinforced laminae with the orientations of 0º

	and 90º with respect to the beam axis. These materials play a pivotal role in the structural engineering for aerospace, automotive, and marine industries. To optimize the result interpretation, the research employs an approach that uses the Rational Experimental-Computational Correlation (RECC). A four-point bending (4PB) experimental setup was employed along with the digital capture of real-time deformation fields by Digital Image Correlation (DIC), while Abaqus finite element analysis (FEA) was used to compute the predicted stress and strain distribution evolution. DIC provides a means of digital deformation mapping that provides insights into the pointwise displacement, strain localization and failure mechanisms. In combination with computational modelling this can aid in the optimization and design of resilient structural components. The use of RECC facilitates correlating computational models with experimental data, enhancing the 'fidelity of predictions. The present considers the comprehensive stress and strain field data for metallic alloy and composite beams, contributing valuable insights into the material behavior characteristics and optimizing future structural components.
14:45-15:00 **KM-099-A**	Evaluation of functional properties of oil composites enriched with salicylic acid Author(s): Anita Staroń, Barbara Pucelik, Agata Barzowska, Jarosław Chwastowski, Jolanta Pulit-Prociak, Magda Kijania-Kontak and Paweł Staroń Presenter: Anita Staroń Politechnika Krakowska, Poland Abstract: Waste cooking oil (WCO) is generated as waste from the frying process for which edible vegetable oil is used. It is obtained on a large scale both in food service outlets, hotels, restaurants and in households. According to estimates, currently about 60% of WCO is disposed of in an inappropriate manner such as discharging it into the sewage system. In the literature, one can find information about the use of waste cooking oil in the production of lubricants, polyurethane foams and fuels. Increasingly, researchers are focusing on the use of WCO for the production of construction materials. In view of the large amount of waste cooking oil and the need to look for an alternative way to use it, this oil was used in this study as a raw material for obtaining functional composites. The scope of the study included the selection of parameters for the process of obtaining salicylic acid-enriched oil composites, their manufacture and examination of their properties (including strength, surface structure, chemical composition, leachability of heavy metals and polycyclic aromatic hydrocarbons,biocidal and deodorizing abilities). The content of heavy metals and PAHs in the filtrates after incubation of the oil composites did not exceed the limits specified in the applicable legislation. The obtained composites had high compressive and flexural strengths (above 5.5 MPa). Selected oil composites enriched with salicylic acid showed 25-35% activity against S. epidermidis in suspension, bacterial inactivation by up to 70% was observed for E. coli. The lethal activity against C. albicans was as high as 50%. Reduction in odor intensity was even more than 70% for rotting meat odor and 58% for malodorous gas.
15:00-15:15 **KM-085**	The effect of fiber hybridization on properties of engineered geopolymer composite containing hollow micro glass bubble Author(s): Zhanbolat Artyk, Islam Yerzhanuly, Yerassyl Kuan, Dichuan Zhang, Chang-Seon Shon and Jong Kim Presenter: Islam Yerzhanuly Nazarbayev University, Kazakhstan Abstract: This paper investigates the potential replacement of Polyvinyl Alcohol (PVA) fibers with cost-effective alternatives, namely Polypropylene (PP) and Steel fibers, in Engineered Geopolymer Composites (EGC) containing lightweight aggregates. The study aims to address the environmental and economic concerns associated with PVA fibers, which require an oil treatment, leading to increased costs and limited use in practical engineering applications. The research explores the use of hollow micro glass bubble (HMGB) in an EGC mix, where Portland cement is replaced by geopolymer made from low calcium fly ash. The

	experimental program involves assessing workability, drying shrinkage, compressive strength, and tensile properties of the developed composites. The results indicate that the hybridization of PVA with PP and Steel fibers improves workability, but also leads to increased drying shrinkage. Compressive strength is enhanced at 7 days due to better workability, while tensile properties are affected by the replacement of PVA, with PP fibers reducing tensile strength and steel fibers showing a mixed effect. Overall, the study provides insights into creating economical and environmentally friendly fiber-reinforced EGC for broader applications in real-world engineering.
15:15-15:30 **KM-119-A**	The analysis of deformation fields in the vicinity of a crack in pipeline steel samples Author(s): Alexander Frantsuzov, Eugene Statnik, Alexey Salimon and Alexander Korsunsky Presenter: Alexander Frantsuzov Skolkovo Institute of Science and Technology, Russia Abstract: The structural integrity of pipelines plays a critical role in ensuring the safe transportation of liquid and gaseous fuels (oil, natural gas, hydrogen), as well as chemicals and energy resources across vast distances. One of the primary challenges faced in maintaining pipeline integrity is the initiation and propagation of cracks that can jeopardize the overall structural integrity. This study focuses on the analysis of the deformation fields in the vicinity of a crack tip in pipeline-grade steel, aiming to enhance the understanding of the mechanical behavior and failure mechanisms. The experiments were performed using specimens of C-110 grade steel after regular heat treatment used in industry. Tensile samples were prepared using electrical discharge machining (EDM), and a fatigue crack was grown in a thin sample. The deformation behavior in the vicinity of the crack tip under applied tension was investigated in situ inside a scanning electron microscope (SEM). During testing, the load-displacement response was recorded whilst a sequence of sample images was acquired continuously. Applying the digital image correlation (DIC) method, the deformation fields near the crack tip were plotted [1]. To observe the individual grain behavior under tension, electron backscatter diffraction (EBSD) maps were obtained before and after the application of the tensile deformation. It is known that the deformation close to the crack tip tends to form slip bands extending diagonally ahead of the growing crack at an angle of ~45° according to the simple slip-line field theory solution [2], or in a more complex 'tulip' pattern reported previously. The present results reveal clearly that the pattern of slip accumulation can be complex, with the slip direction deviating from a straight line [3]. Further crack propagation under monotonic loading may be associated with material separation localization within one of the side 'lobes'. The results of the present study provide useful experimental evidence for the development of improved predictive models of material failure.

TECHNICAL SESSION

Room	Al Rigga (M floor)	Time	16:00-18:00, March 07, 2024

SESSION 2. Materials Physics and Computational Materials Science

Chair: Chair: Dr. Julijana Cvjetinovic, Skolkovo Institute of Science and Technology, Russia

Paper ID	TAIK DETAILS
16:00-16:15 KM-061-A	Revealing diatom frustule vibrations: bridging computational study with atomic force microscopy experimentation Author(s): Julijana Cvjetinovic, Sergey Luchkin, Stanislav Perevoschikov, Nickolai Davidovich, Alexey Salimon, Yekaterina Bedoshvili, Pavel Somov, Pavlos Lagoudakis, Alexander Korsunsky and Dmitry Gorin Presenter: Julijana Cvjetinovic Skolkovo Institute of Science and Technology, Russia Abstract: The remarkable mechanical properties of diatom frustules, intricately structured algal silica exoskeletons, present them as promising candidates for a diverse array of engineering applications. This investigation focuses on delving into the eigenmode resonance vibrations exhibited by the diatom frustules, aligning both in silico computational study and experimental atomic force microscopy techniques [1]. Through the fusion of these methodologies, the study aims to unveil and comprehend the complex vibrational behaviors within these natural structures. The resonance frequencies within the range of 1–8 MHz, deduced through numerical predictions by COMSOL Multiphysics, were verified experimentally utilizing the optical detection system of the atomic force microscope. This verification taps into the potential for applications in vibration-based sensing and the development of diatom-inspired micro-electro-mechanical system devices. Moreover, these findings may lead to the opening of new realms for effective energy absorption, vibration damping, and highly sensitive detection mechanisms, thereby showcasing the transformative potential of diatom frustules in engineering and beyond. The research is supported by Russian Science Foundation (RSF) grant № 22-14-00209.
16:15-16:30 KM-067-A	Relationship between crystal structure and improvement of the piezoelectricity after the [001]-texturing of PZT-PNN piezoceramics Author(s): Jung-Soo Kim, Geun-Soo Lee, Seung-Hyun Kim, San Kwak and Sahn Nahm Presenter: Jung-Soo Kim Korea University, Republic of Korea Abstract: 1.0 mol% CuO-added 0.53Pb(Zr1-xTix)O3-0.47Pb(Ni1/3Nb2/3)O3 [CP(Z1-xTx)-PNN] ceramics (x= 0.57, 0.62, and 0.66) exhibit a rhombohedral-tetragonal (R-T) structure. Specifically, the piezoceramic (x = 0.57) contains a large amount of the R structure (91%), decreasing to 51% in the piezoceramic with x = 0.66. Although the CP(Z1-xTx)-PNN ceramics were densified at 950 oC, they were not textured at low temperatures (< 1250 oC) due to limited grain growth. The CP(Z1-xTx)-PNN ceramics were well textured along the [001] direction at 1250 oC with a large Lotgering factor (> 94%) using 3.0 vol% BaTiO3 templates. They also have the R-T structure, but the R structure considerably reduced after the [001] texturing; the [001]-textured piezoceramic (x = 0.57) has 60% of R structure and the 21% of R structure was observed in the textured piezoceramic (x = 0.66). The study also reveals that the untextured CP(Z0.43T0.57)-PNN ceramic provided low d33 (370 pC/N) and kp (0.49) values, but they were considerably improved to 920 pC/N and 0.65, respectively, after

	[001] texturing, attributed to the high R structure content. Conversely, the untextured CP(Z0.34T0.66)-PNN ceramic has a large d33 of 740 pC/N and kp of 0.63 but they decreased to 480 pC/N and 0.52, respectively, after [001] texturing due to a lower R structure content. Consequently, the study suggests that piezoceramics with a higher R structure content are more favorable for enhancing piezoelectric properties through [001] texturing.
16:30-16:45 **KM-122-A**	Electrochemical Evaluation of the Corrosion Resistance of a Novel Mg-2Ga-2Zn Implant Alloy in Simulated Body Fluids Author(s): Iuliia Sadykova, Eugene Statnik, Alexey Salimon, Viacheslav Bazhenov, Alexander Komissarov, Nikolay Redko and Alexander Korsunsky Presenter: Iuliia Sadykova Skolkovo Institute of Science and Technology, Russia Abstract: Magnesium alloys present mechanical qualities similar to natural bone and degrade during a specific time period. As an outcome, they provide unique advantages when implemented as biodegradable implants in medicinal practice. However, their high susceptibility to corrosion has severely limited their use in the orthopedic area. For such applications, new compositions, the addition of particular alloying elements, and surface modification are considered as potential avenues. The current work aimed to investigate the corrosion behavior in aqueous solutions while electrochemically testing a newly developed Mg-Ga-Zn alloy. The degradation behavior of magnesium alloy with different roughness in a Hank's buffered solution and saline as a simulated body fluids has been investigated by using electrochemical impedance spectroscopy tests and corrosion current density using potentiodynamic polarization measurements at 37 °C and scanning electron microscopy observation. After it was compared with AZ31 results, one of the most widely used commercial magnesium alloy. According to measured current density, the corrosion resistance of the new alloy is higher than that of AZ31, making it far more appropriate for practical application. It has been demonstrated that alloys dissolve slower in Hank's solution than in 0.9% NaCl. It could be because of to the phosphate layer generated on the oxide surface during experiments in Hank's solution in combination with fewer chlorine ions than saline solution. Surface roughness also influences the results of electrochemical testing, though the results of various studies on the influence of surface pretreatment may be contradictions. Surface roughness of samples should be adopted in accordance with the real implant condition, and simulated body fluids with similar components to human blood plasma should be used to overcome major constraints in numerous clinical applications.
16:45-17:00 **KM-069-A**	Hard and soft piezoelectricity of low-temperature sintered (Pb, Sr)[(Zr,Ti)-(Zn, Nb)]O3 ceramics for high power multilayer devices Author(s): Geun-Soo Lee, Jung-Soo Kim, San Kwak, Seung-Hyun Kim and Sahn Nahm Presenter: Geunsoo Lee Korea University, Republic of Korea Abstract: High-power piezoceramics have been utilized in various piezoelectric devices such as transformers, motors, actuators, and ultrasonic transducers. Since these devices generate a significant heat during the operation, the piezoceramics for these devices should have a high Qm value. Additionally, the piezoceramics for high-power applications demand a large d33 value and a high TC. In this study, the (Pb0.94Sr0.06)[(Zr1-xTix)0.75(Zn1/3Nb2/3)0.25]O3 piezoceramics were produced at a low temperature of 950 oC and their structural and piezoelectric properties were investigated. The piezoceramic (x = 0.5) exhibited the excellent hard and soft piezoelectric properties (d33 = 357, kp = 0.53, and Qm = 1511) and a high TC around 250 oC, indicating that it can be applied to the high-power devices. Piezoceramic (x = 0.5) was utilized to produce the multilayers and the 80Ag/20Pd was used as the inner electrodes. The cantilevertype actuators were produced and their actuating properties were investigated to assess their suitability for high-power multilayer devices.

17:00-17:15 **KM-026-A**	Cutting procedure influence on magnetic properties of non-oriented FeSi alloys Author(s): Gheorghe Paltanea, Veronica Manescu (Paltanea), Horia Gavrila, Iosif Vasile Nemoianu, Costel Paun Presenter: Gheorghe Paltanea National University of Science and Technology POLITEHNICA Bucharest, Romania Abstract: Shaping of laminated magnetic cores always implies cutting of the sheets and ensuing degradation, via localized plastic deformation, of their soft magnetic properties. The performances of fully processed non-oriented (NO) Fe-Si laminations can, in particular, be seriously impaired by the cutting operations required to form the slotted stator core of rotating machines. Because of its applicative impact, this problem has been amply treated in the literature, with focus on the specific magnetic properties of the mechanically damaged band at the cut edge [1] and on the phenomenological retrieval of the overall loss behavior, either by numerical methods [2] or analytical formulations [3], employing a suitable high number of parameters, to be found by experiments. These reveal somewhat awkward procedures, often limited to the assessment of the degradation of the quasi-static magnetic behavior of the material. In this work, which provides an extensive set of experimental results on different types of non-oriented Fe-Si sheets, we aim at a simple phenomenological assessment of the degradation of magnetization curve and magnetic losses enforced by cutting. This is based on the idea that, although the induction in a cut strip sample is not uniform, we can nevertheless invoke an equivalent uniform induction for the dynamic magnetic behavior, while providing simple relationships for the evolution of magnetization curve and losses with strip width. Two types of commercial non-oriented Fe-Si sheets of thickness 0.20 mm (Cogent NO20 Hi-Lite) and 0.35 mm (Cogent M300-35A) were cut as strips of different widths (5 mm ≤ w ≤ 60 mm), using both guillotine punching and water-jet method. By using a simple scheme, where the work-hardened region of the strip is identified with two defined bands of width Lc running along the cutting line at the edges, we can express the dependence of the magnetization Jp on the strip width w under an applied field Hp. It turns out that, by measuring the complete normal magnetization curves at two different w values, we can estimate the width of the damaged bands Lc and, for any Hp value, the associated magnetization. The full evolution of the curves with w is then obtained and found to agree with the experimental curves, in spite of the somewhat crude scheme involved.
17:15-17:30 **KM-070-A**	Improvement of piezoelectric properties of [001]-textured (K, Na)NbO3-based ceramics for piezoelectric energy harvester Author(s): Sahn Nahm, Geun-Soo Lee, Jung-Soo Kim and Seung-Hyun Kim Presenter: Sahn Nahm Korea University, Republic of Korea Abstract: The output power of piezoelectric energy harvester (PEH) at the resonance frequency is dependent on the electromechanical coupling factor (kp) of the piezoceramic, which is proportional to d33/(εT33)1/2, where d33 and εT33 are the piezoelectric change and dielectric constants, respectively. Therefore, the piezoceramic for the PEH should have a large d33 and a small εT33. [001]-texturing can be used for developing piezoceramics for PEH because it generally increases d33 without increasing εT33. The 0.96(K0.5Na0.5)(N1-zSz)O3-0.03(Bi0.5Ag0.5)ZrO3-0.01SrZrO3 [KN(N1-zSz)-BAZ-SZ] piezoceramics were textured along the [001] orientation, and the piezoceramic (z=0.01) showed a large kp of 0.77, which is the largest kp for KNN-related piezoceramics reported in the literature. The cantilever-type PEH manufactured using the KN(N0.99S0.01)-BAZ-SZ piezoceramic exhibited a large output power density of 7.86 mW/cm3 at resonance frequency because of its large kp. To date, this is the largest power density for PEHs manufactured utilizing lead-free piezoceramics. Hence, the [001]-textured KN(N0.99S0.01)-BAZ-SZ piezoceramic is an excellent candidate for PEH, and [001]-texturing is a very efficient method for developing piezoceramics for PEH.

17:30-17:45 **KM-060-A**	High-strength and ductile UFG Al-Mg-Zr alloy for low-temperature and cryogenic applications Author(s): Dinislam Sadykov, Tatiana Orlova, Maxim Murashkin, Demid Kirilenko, Aleksandr Levin and Alexey Lihachev Presenter: Sadykov Dinislam ITMO University, Russia Abstract: Nowadays, the development of high-strength and lightweight functional materials for a wide variety of applications at low and cryogenic temperatures is one of the important tasks of materials science. We present our results on the influence of deformation temperature in the range 77–293 K on mechanical properties of ultrafine-grained (UFG) Al-Mg-Zr alloy in various states, before and after special deformation-heat treatment (DHT) consisting of annealing and addition deformation. The UFG structure was obtained by high pressure torsion processing. It has been shown that after DHT, the UFG Al-Mg-Zr alloy demonstrates outstanding combination of high strength (370–490 MPa) and good ductility (7–13%) in the whole temperature range 77–293 K. In the range 243–293 K, an atypical character of changes in mechanical properties (strength-ductility) with temperature is observed for the first time, which is not typical for coarse grained and other UFG Al-based alloys. A possible explanation for such anomalous temperature dependences of strength and ductility is proposed.
17:45-18:00 **KM-114-A**	FIB-DIC Determination of Residual Stresses of Selective Laser Melting Single-Track Ni-based Alloy Author(s): Rustam Kyarimov, Eugene Statnik, Alexey Salimon and Alexander Korsunsky Presenter: Rustam Kyarimov Skolkovo Institute of Science and Technology, Russia Abstract: Selective laser melting (SLM or PBLF) technology is widely explored for nickel-based superalloys in additive manufacturing due to its ability to fabricate complex and high-performance components. However, rapid heating and cooling in the SLM process result in intense temperature gradients, leading to high residual stresses and metallurgical defects in Nibased superalloys. Residual stresses are self-balancing stresses that occur in a material due to non-uniform inelastic deformation. The study focuses on residual stresses in the melt pool region created by a single track of laser emission – a traditional test in SLM 3D printing (fig.1). Ring-core ion beam drill and digital image correlation (FIB-DIC) method [1] has been purposefully developed to determine residual stress at 1 … 50 μm scale level that is very relevant to characteristic dimensions of tracks and layers at SLM. The FIB technique creates ring-shaped trenches for controlled stress relief, and strain is measured using DIC with SEM micrographs. Finite element imulations align with experimental results, making this method effective for accurate assessment at the (sub)micron scale. Results reveal uneven residual stress distribution in the cross-section of a single laser emission path on the metal powder surface throughout the melt pool volume. High-resolution DIC, EBSD analysis, and post-heat treatment investigations indicate the need for further research to understand and mitigate residual stresses in Ni-based superalloys produced by SLM, enabling broader applications of these materials.

TECHNICAL SESSION

Room	Al Manzr (M floor)	Time	16:00-17:45, March 07, 2024

SESSION 3. Materials Chemistry and Advanced Materials for Engineering Application

Chair: Assoc. Prof. Dmitry Dzhurinskiy, Skolkovo Institute of Science and Technology, Russia

Paper ID	TAIK DETAILS
16:00-16:15 KM-082-A	Thin Film Fabrication and Property Investigation of Novel Electrode and Electrolyte Materials for Solid Oxide Fuel Cells and Electrolysis Cell Applications Author(s): Rinlee Butch Cervera Presenter: Rinlee Butch Cervera University of the Philippines Diliman, Philippines Abstract: For the next generation energy conversion and storage systems, the development of fuel cells and electrolysis cells is an important endeavor to achieve a sustainable and clean alternative energy source in support of the global sustainable development goals. Thus, R&D activities in developing green and reliable energy storage and conversion technologies are at the heart of successful incorporation in the power mix and securing global future energy needs. One of the research efforts at our laboratory focuses on developing solid oxide electrochemical cells (SOEC), such as fuel and electrolysis cells, from materials considerations to device fabrication. In this presentation, new material electrode compositions and synthesis methods such as for LSM-ScYSZ, Ni-ScSZ, and highly conducting solid electrolyte material of Sc and Y co-doped ZrO2 were investigated and its electrochemical performance in a solid oxide fuel and electrolysis cell applications will be reported.
16:15-16:30 KM-106	Characterization of phosphogypsum for potential uses in soil stabilization Author(s): Doszhan Temirbekov, Chang-Seon Shon, Anel Galymzhankyzy, Zhaniya Omarova, Islambek Manap, Dulat Ualiyev, Do Kyum Kim, Hong Seop Kim and Jong Ryeol Kim Presenter: Doszhan Temirbekov Nazarbayev University, Kazakhstan Abstract: This research investigated the influence of phosphogypsum (PG) addition to mortar mixture and determined the possibility of utilizing PG in soil stabilization. Originally, the chemical composition and mineralogy of the PG were determined using X-ray fluorescence (XRF) and Xray diffraction (XRD) tests. The principal constituent of PG becomes calcium sulfate hemihydrate with the presence of some impurities. A total of 9 mixtures have been developed: A plain mortar mix is a comparative base, and 4 mixes are with 5, 10, 15, and 20 % cement replacement with PG for each type (fresh and stockpiled PG called PGF and PGS, respectively). The experimental program focuses on analyzing the effects of PG on setting time, hardened density, compressive strength, and water expansion of mortar mixtures before its soil stabilization application. Test results indicate that with higher PG, the setting time of the mortar mix is delayed except for the mixture with 20% PG, which experienced an early false set. The results of the compressive strength tests revealed that the 5% PG mixes exhibited higher values compared to the control mix, starting from the 28-day curing period, regardless of PG type. Although the higher PG content and

	compressive strength lowered, the expansion levels were very low based on the ASTM C 1260 limits for all mixtures, excluding heaving risks.
16:30-16:45 KM-064-A	Low-temperature sintering and piezoelectric properties of [001]-textured (Na, K)Nb-based piezoceramics using Na(Nb0.9Sb0.1)O3 templates Author(s): Seung-Hyun Kim, Geun-Soo Lee, Jung-Soo Kim, San Kwak and Sahn Nahm Presenter: Seung Hyun Kim Korea University, Republic of Korea Abstract: CuO-added 0.96(Na0.5K0.5)(Nb1-xSbx)O3-0.04(Bi0.5Ag0.5)ZrO3 (NKNS-4BAZ) were textured along the [001] direction using 3.0 mol% Na(Nb0.9Sb0.1)O3 (NNS) templates at low temperature of 980 oC. All NKNS-4BAZ piezoceramics were well textured along the [001] direction with a large Lotgering factors (> 96%). CuO used as sintering additive assisted the sintering and [001]-texturing of the NKNS-4BAZ piezoceramics at 980oC. NaNbO3 templates have been generally used to texture the NKN-based piezoceramics along the [001] direction. However, they were melted during the sintering and produced many holes in the piezoceramics leading to the decrease of the mechanical and reliability characteristics. In this study, the NNS templates were used for [001]-texturing of the NKNS-4BAZ piezoceramics at 980oC and they were not melted during the sintering leading to the dense microstructure without pores and the improved mechanical properties. The amount of Sb5+ content was modified to obtain the best piezoelectricity after the [001]-texturing through the control of the crystal structure.
16:45-17:00 KM-024-A	Biodegradation behaviour of magnesium alloys Mg-Zn-Ag coated with hydroxyapatite in simulated body fluid Author(s): Veronica Manescu (Paltanea), Aurora Antoniac, Iulian Antoniac, Gheorghe Paltanea, Alina Robu Presenter: Veronica Manescu (Paltanea) National University of Science and Technology POLITEHNICA Bucharest, Romania Abstract: This study presents the biodegradation behaviour analysis for two types of Mg-Zn-Ag alloys (Alloy 1: Zn - 7.1%, Ag - 1.5%, Mg – balance; Alloy 2: Zn – 6.3%, Ag - 2.5%, Mg – balance), uncoated and coated with hydroxyapatite (HAp) by magnetron sputtering, in simulated body fluid (SBF) at body temperature. The corrosion behaviour was investigated by immersion tests and measurements of sample weight loss using a balance RADWAG. Also, electrochemical characterization was made using a Potentiostat/Galvanostat PARSTAT 4000 model, Princeton Applied Research, Oak Ridge, TN, USA. Surface properties were evaluated with scanning electron microscopy (SEM) coupled with energy dispersive spectroscopy (EDS-SEM-TM3030Plus, Bruker, Belin, Germany), a Dektak 150 surface profilometer (Veeco Instruments, USA), and Krüss DSA30 Drop Shape Analysis System. SEM images of the coated and uncoated samples were used to investigate the surface morphology of the Mg-based substrate and the uniformity and homogeneity of the HAp coatings. It was noticed that the visualization of the grain boundaries was possible, a fact that is directly linked to the existence of a very thin HAp layer. No cracks or other visible defects were present. Based on X-ray spectroscopy, the Ca/P ratio was found to be about 1.7, showing a stoichiometric calcium phosphate coating type. The roughness results (average roughness parameter Ra of about 1000 nm) were correlated with contact angle measurements, showing that the coated alloys exhibited a hydrophilic character with a contact angle value lower than 90°. The electrochemical measurements based on open circuit potential, corrosion current density, and corrosion potential evidenced an improvement in the corrosion behaviour of both coated alloys in comparison with uncoated samples. Parameters such as corrosion rate (CR), polarization resistance, and protective efficiency were analysed to provide a clear image of the corrosion behaviour of the investigated alloys. Similar results were put in evidence through mass immersion tests in SBF and mass loss measurements. The value of the pH was found to be about 9.50, and the hydrogen release rate variated with the Ag content. It was concluded that increased corrosion resistance is present in alloys with a

	higher Ag percent. Taking into consideration the analyses mentioned above, it can be noticed that the biodegradation behaviour of coated Mg-Zn-Ag alloys is adequate for the potential use of the material in orthopaedic implant manufacture.
17:00-17:15 **KM-103**	Utilizing mineral sequestration technology for enhanced performance of concrete containing BOFS Author(s): Zhaniya Omarova, Dulat Ualiyev, Chang-Seon Shon1, Dichuan Zhang and Jong Ryeol Kim Presenter: Zhaniya Omarova Nazarbayev University, Kazakhstan Abstract: Basic oxygen furnace slag (BOFS) is a widely available by-product of the steel-making industry that poses high interest for scientists in various fields. The carbon capture potential of BOFS is proven to be high. However, its further uses are actively investigated. BOFS is particularly attractive for use as a construction material due to its hydraulic reactivity and good strength, which makes it suitable for use as binding material and aggregate in concrete. However, it has a major drawback - unstable compounds that lead to material deterioration caused by volumetric expansion. Most of the research in the field focuses on the processing of BOFS in laboratory or industrial settings to eliminate the expensive products inside the slag and make it more durable. The suitability of using mineral sequestration technology instead of artificially accelerated carbonation has not yet been studied well. This research aimed to identify the main properties of the mortar mixes containing BOFS that underwent mineral sequestration over a long period to assess the technology's feasibility. The correlation with quantitative data from TGA was also identified. Based on test results, the correlation between aging conditions and CO2 uptake was established, indicating that stockpiled and wet/dry cycle conditions were the most optimal aging methods for BOFS to achieve the highest carbonation, hence the maximum stabilization degree of aggregates.
17:15-17:30 **KM2-013**	Biomechanical Effects of Titanium Alloy Based Single versus Dual Cage Fusion Devices Author(s): Nitesh Kumar Singh, Rati Verma, Pradeep Kumar, Nishant Kumar Singh Presenter: Nishant Kumar Singh National Institute of Technology, India Abstract: Degenerative disc disease is an increasing problematic complication following lumbar fusion surgeries. Posterior lumbar interbody fusion (PLIF) is a well-established surgical method for spine stability following intervertebral disc removal. The position and number of titanium cages in PLIF are remain contingent on individual surgeon experience. Thus, a systemic investigation of the efficacy of titanium single mega cage versus two cages in treating degenerative lumbar spinal diseases is imperative. A biomechanical study was aimed to compare the stability achieved in PLIF through interbody reconstruction using a single mega cage (32 mm) Vs. a dual cage (22 mm). Normal intact finite element model of L3–L4 was developed based on computed tomography images from a healthy 35-year-old male volunteer. The study tested the intact model (Model A) and its surgically operated counterparts using four PLIF implantation methods: single transverse cage (Model B), single transverse cage with bone graft (Model C), dual transverse cage (Model D), and dual transverse cage with bone graft (Model E). Combined loads simulating physiological motions—flexion, extension, axial rotation, and lateral bending — were applied across all loading directions. The assessment includes all model range of motion (ROM), micromotion between the cage and endplate, and stress on the cage and internal fixation system (screw and rod). The ROM between Models B, C, D and E were consistently reduced by over 71% compared to intact Model A under all motion scenarios. Model D exhibited the highest peak stress of 115 MPa on the cage during flexion, surpassing Model C and E (Flexion) by fourfold. Model E demonstrated the lowest cage stress (20 MPa) during extension, outperforming the other

	models. Notably, Model E exhibited minimal endplate stress (2 MPa), cage stress (21 MPa), micromotion (13 μm) during extension, and screw-rod stress (56 MPa) during flexion, making it superior to other implantation methods. In the context of PLIF, Model E showed enhanced biomechanical stability, reducing ROM, stress on the endplates, cage, screw-rod system and micromotion. Alternatively, Model C may be a viable alternative in standard PLIF, especially in cases with limited intervertebral space, providing efficient clinical outcomes with shorter operative times and reduced costs and ease of implantation. Also, this computational study provides valuable understandings into optimizing cage implantation strategies for improved outcomes during PLIF.
17:30-17:45 **KM-104**	Effects of Curing Conditions, Age, and Particle Size on CO2 Sequestration of BOFS Author(s): Dulat Ualiyev, Zhaniya Omarova, Chang-Seon Shon, Dichuan Zhang, and Jong Ryeol Kim Presenter: Dulat Ualiyev Nazarbayev University, Kazakhstan Abstract: Mineral sequestration technology is one of the most effective carbon capture and storage techniques. Basic oxygen furnace slag (BOFS), one of the by-products generated during the steelmaking process, has a particularly high potential for mineral sequestration compared to other similar wastes such as blast furnace slag and ladle slag. In the case of BOFS, mineral sequestration not only contributes to carbon uptake, but also stabilizes its internal structure. So far, most of the investigations on BOFS mineral sequestration rely on accelerated carbonation involving high pressures and supplying concentrated CO2 in a short period. Although these studies are useful for investigating the overall potential for carbon capture of BOFS, they are less useful for practical applications on a large scale. Moreover, it is hard to draw any conclusions regarding the carbonation reactions lasting for years in stockpiles of BOFS. This research aimed to identify the consequences of long-term carbonation on BOFS samples and determine the best conditions for natural mineral sequestration.
17:45-18:00 **KM-093**	Performance Assessment of Basic Oxygen Furnace Slag (BOFS) as an Ice-Melting Abrasive Material Author(s): Saken Sandybay, Islam Orynbassarov, Chang-Seon Shon, Dichuan Zhang and Jong Ryeol Kim Presenter: Saken Sandybay Nazarbayev University, Kazakhstan Abstract: Abrasives play a crucial role in surface blasting, especially in cold climates, where snow and ice significantly challenge transportation infrastructure and road safety. The main purpose of this research is to address the critical need for effective and sustainable winter maintenance techniques. This study examined the possibilities of Basic Oxygen Furnace Slag (BOFS) as a substitute (an abrasive substance) for conventional aggregates in ice-melting applications. Thus, this research assessed the physical properties of BOFS, such as absorption capacity, tested at -5°C, and aggregate angularity test, and designed for evaluation of the surface texture, friction, and percentage of fractured faces in uncompacted voids (SSD%) of the aggregates. Moreover, the potential use of a blend of BOFS with deicing salts, specifically sodium chloride (NaCl) and calcium chloride (CaCl2), was investigated as an effective ice-melting agent. For this purpose, three tests were carried out: the petri dish test according to SHRP H-205.1, the polishing ice melting test using a modified ASTM C 944 (rotational cutter), and the surface temperature measurement test. By assessing the performance of BOFS, our goal was to justify its efficacy, offering a practical alternative for regions experiencing severe winter conditions. ventually, the findings from this study assert

	that BOFS can be used for surface blasting, indicating its potential as a substitute for traditional abrasives.

TECHNICAL SESSION

Zoom ID	83445032263		
Password	ickem	Time	10:00-11:45, March 08, 2024 (GMT+4)

SESSION A. Advanced Building Materials and Mechanical Properties of Composite Materials

Chair: Prof. Huirong Le, Tsinghua University, China

Paper ID	TAIK DETAILS
10:00-10:15 KM-037	A robust statistical analysis of factors affecting interface bonding between asphalt pavement layers Authors(s): Rabea Al-Jarazi, Ali Rahman and Changfa Ai Presenters: Ali Rahman Southwest Jiaotong University, China Abstract: Interlayer bonding within a multilayered pavement system plays an essential role in the overall performance of the pavement structure. Therefore, studying the interlayer shear strength (ISS) as a major index of the bonding strength and its accurate evaluation is of great importance. The main objective of this research is to assess the ISS of pavement using an experimental and statistically rigorous approach. The results showed that the ISS is highly temperature-dependent, experienced a rapid decline with increasing temperature. As tack coat rate increased, the ISS initially increased to reach a pick at 0.8kg/m2 rate and then started to decline. The ISS demonstrated an almost linear correlation with vertical pressure at all temperature levels. Two-way factorial analysis of variance (FAV) underscored the significant impact of any two, namely temperature (T), tack coat rate (TC), and vertical pressure (VP), on ISS results. However, three-way FAV results indicated that the combined effect of T, TC and VP did not hold statistically significant influence on ISS. Moreover, all ISS models developed in this study exhibited statistical significant at a 0.05 significance level, with a good coefficient of determination (R2 =0.73) for multiple linear regression (MLR) and an excellent R2 of 0.976 for polynomial regression (PR).
10:15-10:30 KM-042	Experimental Evaluation of Adobe Bricks Reinforced with Rice Husk, Lime and Neem Fibers for the Construction of Sustainable Housing in Andean Areas Authors(s): Luis Fernando Gutierrez Saldaña and Rick Milton Delgadillo Ayala Presenters: Luis Fernando Gutierrez Saldaña Universidad Peruana de Ciencias Aplicadas (UPC), Peru Abstract: Adobe homes are prone to natural phenomena such as floods, landslides, and earthquakes, due to the intense rains that occur from the month of November to March. This study aimed to investigate the mechanical properties of adobes reinforced with rice husk, lime and neem fibers and evaluate their compressive strength and water absorption capacity. The tests were carried out on adobes with dimensions of 10×10×10 cm3 made with earth, 0.75% rice husk, 0.75% lime and 1 to 3% neem fibers of the total weight of the adobe to determine the evaluations of the specimen. Therefore, a visit was made to the study area located in the province of Yauyos - Peru to classify the type of soil that would be used in the samples, then sift the soil to prepare the mud and let it rest for 24 hours. Then, incorporate

	the reinforcements and mold the adobes to let them dry for 28 days and proceed with the tests. The research recorded an improvement of 39 and 68% respectively on the strength of adobes reinforced only with rice husk and lime; and neem fibers after 28 days of drying with a proportion of 0.75% rice husk, 0.75% lime and 3% neem fibers. The absorption coefficient of adobes reinforced with rice husk, lime and neem fibers are between 16 and 27% better than adobes reinforced separately. Finally, this research will reduce the damage to homes caused by rains through the use of materials found in the localities and reduce pollution, thus creating a sustainable home with low costs for the inhabitants.
10:30-10:45 **KM-065-A**	Experimental Study on the Properties of self-compacting concrete incorporating rubber aggregates and crashed dune sand Authors(s): Abdelkadir Makani, Ahmed Tafraoui and Said Zaoiai Presenters: Abdelkadir Makani TAHRI Mohamed University of Bechar, ALGERIA Abstract: The current research endeavor entails a thorough examination of the mechanical performance of various self-compacting concretes (SCC) incorporating rubber aggregates. The primary objective is to identify the optimal dosage of siliceous fines that can enhance the mechanical properties of these concretes. Throughout this study, we have effectively demonstrated the ability to produce SCC with diverse composition parameters, showcasing favorable rheological and mechanical characteristics. Furthermore, our findings underscore that replacing natural aggregates (NA) with rubber aggregates (RA) in SCC formulations results in slight adjustments to fresh workability parameters while still adhering to the SCC requirements specified by AFGC recommendations. The analysis of experimental results reveals a positive correlation between the compressive strength of SCC and the percentage of crushed sand. Notably, substituting 20% of crushed sand with cement resulted in a substantial increase in compressive strength, measuring 39 MPa at 28 days
10:45-11:00 **KM-033**	Finite Element Simulation of Split Hopkinson Pressure Bar (SHPB) Test to Predict the Dynamic Compressive Behavior of Glass Fiber Reinforced Polymer (GFRP) Composite Authors(s): Nojeem A. Yusuf, Wael Khaireldin, Toshiyuki Tsuchiya and Mohsen A. Hassan Presenters: Nojeem A. Yusuf Egypt - Japan University of Science and Technology, Egypt Abstract: Glass fiber reinforced polymers (GFRPs) are becoming increasingly important in aerospace, construction, and automotive industries due to their potential for weight reduction, high strength, and excellent fatigue resistance. The failure mechanisms of GFRPs are influenced by factors such as strain-rate, frequency, stress state, and temperature. However, existing constitutive models have predominantly focused on characterizing the material's behavior under quasi-static conditions, potentially limiting their accuracy when applied to situations involving higher strain rates. This study employs explicit dynamics finite element analysis to examine the impact of high strain rates on the dynamic compressive behavior of glass fiber reinforced polymers (GFRPs) in an ABAQUS CAE environment using the Split Hopkinson Pressure Bar (SHPB) experimental setup. The mechanical response of the [0/90]16 GFRP laminate system is characterized using the orthotropic elasticity material model and Hashin Damage Criteria is used to model the damage properties. Based on stability of total model energy, mesh convergence test was conducted across various mesh sizes to obtain the optimal mesh size for validating the developed FE-model. The simulation results highlight a notable increase in the compressive stress of the GFRP, rising from 200 MPa to 663 MPa as the strain rate increases from 596 s-1 to 1743 s-1. These results have shown the strain rate sensitivity of GFRPs and offer valuable insights for the prospective design and application of GFRP composites.
11:00-11:15 **KM-079**	Experimental study of damage energy on the bow of a vessel with second-generation viscoelastic layers for the Galápagos Islands Authors(s): Patrick Townsend, Walter Geanpierre Arias Pilco, Jaime J Zamora-Zamora and Juan C. Suárez-Bermejo

	Presenters: Patrick Townsend Escuela Superior Politécnica del Litoral, ESPOL (Facultad de Ingeniería Marítima y Ciencias del Mar), Ecuador Abstract: Experimental study of the damage energy is a reproduction of the GFRP vessels' slamming in the sea. The investigation was carried out to the laboratories by the construction of two types of GFRP panels: viscoelastic and non- viscoelastic modified. Through a bending test, the data collection was developed to get the measurement of the variables in key points. The obtained results showed an expected behavior because the modified specimens were able to spread the force induced from the center to the edges. Besides, the damage energy in the modified panels return in bigger amounts than the unmodified. Flexibility demonstrated a higher rate of increase in the unmodified panels, indicating that the viscoelastic layer contributed to the stiffness increment in the modified panel. In conclusion, viscoelastic materials help to dissipate the energy absorbed by the structure, elongating the lifetime. Also, this study expands the basic knowledge of viscoelastic materials' behavior in the GFRP planing hull vessels.
11:15-11:30 **KM-051**	Evaluation of the influence of brick dust on the mechanical and physical behavior of geopolymeric and eco-efficient concrete with partial cement replacements Authors(s): Eder Soto Noa, Ronald Sanchez Rosario and Karla Lisette Lopez Pasapera Presenters: Eder Soto Noa Peruvian University Of Applied Sciences, Peru Abstract: The construction industry represents one of the key players in the pollution of the planet, as it generates large amounts of waste and consumes significant resources, despite its fundamental role in the economic development of countries. It is evident that construction, both nationally and internationally, has an impact that degrades the environment over time, which is reflected in the small amount of sustainable construction in the world. The present research work addresses the issue of development of geopolymers as an alternative to ordinary Portland cement. For which, descriptions of the materials and instruments used for the necessary tests were made. Also, the experimental methodology for the design of geopolymeric concrete was presented, in which the production process of the precursor material and the activating agent is explained. The dosages and how the four types of mixtures to be tested are composed are shown: the standard concrete (CP) and three mixtures with different replacement variables (M1, M2 and M3). In order to study the behavior and influence of brick dust, a mixture was designed with different dosages to replace the cement with the precursor in 80%, 90% and 95% alkalized by sodium hydroxide (NaOH) 12 M and rice husk ash (RHA) with a proportion of 75% - 25%, respectively. The results show that the master concrete cores presented average resistances of up to 26.52 MPa, while with a replacement of 80%, an average of 27.05 MPa was recorded, with 90% an average of 26.05 MPa and with 95%, resistances up to 22.84 MPa after 28 days of testing. These data indicate that geopolymeric concretes with partial replacement maintain acceptable physical and mechanical properties. The specific combination of replacing cement with brick dust and rice husk ash in the alkaline solution results in favorable concrete conditions. This study demonstrates the quantitative viability of using eco-efficient geopolymers with partial cement replacements, offering a more sustainable alternative in construction.
11:30-11:45 **KM2-012-A**	Design Optimization and 3D Printing of Miniaturized Pneumatic Soft Robotic Arms Authors(s): Yao Chen Presenters: Yao Chen Tsinghua University, China Abstract: Yao Chen This paper reports on the design optimization and fabrication of a miniaturized soft robotic arm with a view for surgical application. Moulds are made by 3D printing with UV curable materials for casting of the robotic arm. The robotic arm is of a

	diameter of 4 mm and a length of about 6 cm. It is designed for pneumatic actuation with 3 channels for pressurized air. The structure is optimized through the materials and the design of the air channels to maximize the bending efficiency while minimize the diametric expansion. A preliminary mechanical model is developed to establish the relationship between the mechanical behavior of the structure with the air pressure, which is verified by experimental measurement.

TECHNICAL SESSION

Zoom ID	83445032263		
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SESSION B. Carbon based Materials and Materials Chemistry

Chair: Prof. Geoffrey R. Mitchell, Polytechnic of Leiria, Marinha Grande, Portugal

Paper ID	TAIK DETAILS
13:00-13:15 KM-008	Optimizing lasing parameters for fabricating an efficient flexible electrothermal heater based on laser-induced graphene Authors(s): Gerrard Nkamuhebwa, Ahmed Abdel-Moneim, Hamdy Abo Ali Hassan, Toshiyuki Tsuchiya and Mohsen A. Hassan Presenters: Gerrard Nkamuhebwa Egypt - Japan University of Science and Technology, Egypt Abstract: This work involved fabrication of an efficient thin film heater from 100 μm thick polyimide (PI) sheet by scribing it using a carbon dioxide lasing machine through optimizing laser power (P), scanning speed (SS), and pulses per inch (PPI). A 15 mm × 15 mm square pattern was designed using CorelDRAW software and scribed in a rastering mode on top of PI with the help of Universal Control Panel (UCP) software of the laser machine. Laser power of 8 %, SS of 4 % and PPI of 1000 were obtained as optimal parameters for producing laser induced graphene (LIG). This LIG exhibited a low sheet resistance of approximately 16.64 Ω/sq and was thermally stable on the PI substrate even after 30 cycles of repeated heating and cooling. The LIG was found to be highly porous with the aid of scanning electron microscope (SEM) and its structure was crystalline from XRD patterns. FTIR was conducted and showed disappearance of functional groups in PI after treatment with the laser beam. Our developed LIG heater showed great electrothermal performance with maximum temperature of approximately 288.7 ˚C, rate of temperature rise of 107.06 ˚Cs-1, and time of 1.85 s to reach 63 % of temperature difference at a low input voltage of 6 V with homogeneous temperature distribution seen in the thermal images taken using FLIR camera. This LIG heating element can be placed in confined spaces because of its flexibility, thinness, and lightness. Additionally, its efficient joule heating effect attracts many applications such as seat warmers, anti-fogging equipment, food shelf displays, etc.
11:45-12:00 KM-010	CTAB-Si Nanoparticles Derived from Rice Husk Ash for Nitrate Ions Removal in Simulated Wastewater Authors(s): Maxine Danico, Rhonalyn Maulion, Amani Llanes, Lovely Charmaine Llave and Benjie Magwari Presenters: Rhonalyn Maulion Batangas State University - The National Engineering University, Philippines Abstract: In this study, silica (Si) nanoparticles derived from rice husk ash is coated with cetyltrimethylammonium bromide (CTAB), a cationic surfactant, and used as adsorbent of nitrate ion in wastewater. CTAB functionalized Si (CTAB-Si) nanoparticles were characterized using scanning electron microscope (SEM), energy dispersive X-Ray (EDX), dynamic light scattering (DLS) Fourier transform infrared spectroscopy (FTIR) and X-ray diffraction (XRD). The synthesized CTAB-Si nanoparticles has a non-spherical shape, with

	visible polydispersity and is amorphous with average particle size of 72nm. It showed stretching vibrations of silanol at 963cm−1, siloxane at 1073cm−1, sharp peaks at 2852cm−1 and 2922cm−1 due to the methylene tail of CTAB and amine peak at 1,384cm−1. An ~80% nitrate removal and adsorption capacity of 7.98 mg NO3/g CTAB-Si nanoparticles was obtained at optimized condition using Face Centered Central Composite Design (FC-CCD) at pH 4, 50 mgL-1 of adsorbate concentration, 0.2 gL-1 adsorbent dose and 30 minutes contact time. The adsorption isotherm and kinetic models fits well in Langmuir model and Pseudo second order with a R2 of 0.984 and 0.999 respectively. The efficiency of the nanoparticle after 5 adsorption cycles was ~50% nitrate removal.
13:15-13:30 **KM-057**	Rice Straw-derived Biochar Electrode for Sustainable Energy Storage Applications Authors(s): Wasiu Makinde, Mohsen Hassan, Guoqing Guan and Ahmed Khalil Presenters: Wasiu Makinde Egypt - Japan University of Science and Technology, Egypt Abstract: In the search for environmentally acceptable and sustainable energy storage solutions, biomass-derived biochar materials are becoming popular in supercapacitor applications. Rice straw is regularly disposed of as agricultural waste, but it is an intriguing biomass precursor for synthesizing activated biochar suitable for supercapacitor electrodes. This study exhibited the utilization of activated biochar synthesized from rice straw through pyrolysis and potassium hydroxide (KOH) activation for supercapacitor applications. Structural examination, such as X-ray diffraction (XRD), transmission electron microscopy (TEM), and nitrogen (N2) adsorption and desorption, showed the activated rice straw-derived biochar's distinct crystal structure, morphological structure, pore structure, and surface area. Rice straw-derived biochar revealed an amorphous structure, nanosheet-like or multilayered morphology, and hierarchical pore structure. Electrochemical characterization showed that the activated rice straw-derived biochar has high specific capacitances of 116.48 F/g at 1 A/g and 84.58 F/g at 5 A/g, respectively. The amorphous character, hierarchical pore structure, and nanosheet-like morphology of the rice straw-derived biochar provided favorable properties for effective ion transfer for high electrochemical performance. These findings exhibited the prospects of rice straw as a sustainable and economical biomass precursor to produce excellent electrode material in supercapacitor applications.
12:00-12:15 **KM-019**	The Effect of Combinations of Wall Materials on Encapsulation of Phenolic Contents from Extract of Clitoria ternatea Authors(s): Thitiphan Chimsook Presenters: Thitiphan Chimsook Maejo University, Thailand Abstract: In our research, we demonstrate an innovative process for preserving polyphenolic compounds in a selected plant extract through a modified encapsulation technique. This can enhance preservation strategies and unlock potential industrial applications. The polyphenolic contents of butterfly pea (Clitoria ternatea) were extracted using the reflux extraction method using distilled water as a solvent. The flower-to-solvent ratio was 1:20 w/v. The total phenolic contents of C. ternatea extract were evaluated. To keep the stability of the phenolic contents in C. ternatea extract, the encapsulates of extract were performed using different combinations of wall material. In preparation for encapsulation, sodium alginate was used as the main wall material, which cooperated with other wall materials including gum arabic, maltodextrin, and casein sodium salt. The encapsulation which was performed using 3.0% w/v of sodium alginate mixed with 1.0% w/v of gum arabic, and C. ternatea extract in 5.0% w/v of CaCl2 solution provided a smooth surface and spherical shape of the particles. However, the optimized condition of encapsulation of C. ternatea extract using the combinations of wall materials which reveal thermal stability and degradation of polyphenolics was performed using 3.0% w/v of sodium alginate mixed with 1.0% w/v of casein sodium salt, and C. ternatea extract in 5.0% w/v of CaCl2 solution. This

	condition exhibited the highest thermal stability at 205°C and offered the lowest polyphenol contents degradation at 2.76±0.52 gallic acid equivalents/100 mg dried bead. The average particle sizes of encapsulates using the three conditions of 3.0% w/v of sodium alginate mixed with 1.0% w/v of casein sodium salt, gum arabic, and maltodextrin were 1247, 977, and 1210 mm in diameter, respectively. This method would be an alternative way to prevent polyphenolic compound degradation and boost shelf life at high temperatures in many potential applications.
13:30-13:45 **KM-031**	Cost-effective hydrothermal synthesis of luminescent carbon dots from date palm midrib Authors(s): Omnia Hassan, Ahmed Saad and Mohsen Ghali Presenters: Omnia Hussny Egypt - Japan University of Science and Technology, Egypt Abstract: Nanocarbon synthesis from diverse sources has garnered significant attention, with a particular focus on materials derived from biomass. Carbon dots (CDs), due to their water solubility, low toxicity, and biocompatibility, have emerged as promising candidates for a wide range of applications. In recent years, CDs have found utility in several applications such as bioimaging, drug delivery, and biosensors. In this study, we present an eco-friendly, straightforward, and cost-effective method for the preparation of carbon dots through a hydrothermal reaction, utilizing peeled date palm midribs as the source material. High-resolution transmission electron microscopy, X-ray diffraction, UV-visible absorption spectroscopy, photoluminescence analysis, Fourier-transform infrared spectroscopy, and zeta potential measurements were employed to investigate the synthesized carbon dots' morphology, crystal structure and optical properties. The results revealed that the carbon dots had a size distribution ranging from 2.5 to 6 nanometers, with an interplanar distance of 0.23 nanometers. When excited at a wavelength of 340 nanometers, the synthesized particles exhibited a prominent bluish emission at 420 nanometers, highlighting their potential for use in various optical and biological applications. This work underscores the feasibility of harnessing sustainable biomass sources, such as date palm midribs, for the green synthesis of carbon dots with desirable properties, opening new avenues for their utilization in cutting-edge technologies.
12:15-12:30 **KM-005**	Carbon Footprint in Bovine Fat Biodiesel Synthesis. Comparison of Environmental Impact Using Methanol and Ethanol Authors(s): Manolo Alexander Cordova Suarez, José Omar Cabrera Escobar, Oscar Eduardo Ruíz Robalino and Enrique Mauricio Barreno Avila Presenters: Manolo Alexander Cordova Suarez Universidad Técnica de Manabí, Ecuador Abstract: Climate change makes the comparison of strategies to mitigate environmental impacts in the production of catalyzed biodiesel derived from animal fat waste a necessity. Transesterification of Bovine Kidney Fat (BKF) into biodiesel is feasible, but the utilized inputs can incur a substantial environmental cost, such as Carbon Footprint (CF). The utilization of Ethanol as a reagent for the transesterification of BKF presents a viable alternative that could influence the Life Cycle Assessment (LCA) of Biodiesel and reduce its CF. This study compares the CF for the LCA of producing 1 kg of Biodiesel for a 1-6 Methanol-BKF and 1-9 Ethanol-BKF ratio, catalyzed by Sodium Hydroxide (NaOH) and Potassium Hydroxide (KOH) at 0.35% at 60°C. The LCA was initially defined following ISO 14067:2018 standards, and subsequently, the Greenhouse Gas (GHG) Emission Inventory was conducted for each stage of Biodiesel manufacturing. Ultimately, CF was calculated using CCalC2 software for the two examined conditions. Five processes were identified in the manufacturing of Biodiesel from BKF in the LCA stages. The CF for Biodiesel derived from BKF with Methanol is 4.36 kg CO2eq/FU, whereas the CF for Biodiesel derived from BKF with Ethanol + 5mol H2O is 0.246 kg CO2eq/FU. Enhanced environmental performance was evidenced using Ethanol + 5mol H2O for the LCA in BKF Biodiesel manufacturing, exhibiting a 1772.35% improvement over Methanol.

13:45-14:00 **KM-029**	Experimental Investigation of the Dynamic Compressive Behavior of Carbon-Flax Fiber Reinforced Polymer Composites at High Strain Rates Authors(s): Osama Mabrouk, Wael Khair-Eldeen, Ahmed Hassanin and Mohsen A. Hassan Presenters: Osama Mohammed Egypt - Japan University of Science and Technology, Egypt Abstract: The present study investigates the dynamic compressive behavior of hybrid carbon/flax fiber-reinforced polymer composites in which epoxy resin is used as the matrix. The hybrid carbon/flax and non-hybrid flax polymer composite laminates were fabricated by hand lay-up followed by hot-compression molding. The Split-Hopkinson pressure bar test (SHPB) was utilized to evaluate the dynamic compressive mechanical properties of the fabricated composites. Compressive strength and failure strain were determined in the sample's out-of-plane direction at strain rates ranging from 2638 s-1 to 6716 s-1. Macroscopic images were used to assess the progressive accumulated damage mechanisms due to the impact loading. Experimental results proved that non-hybrid flax and hybrid carbon/flax epoxy composites are high strain-rate-sensitive materials. For instance, the compressive strength of hybrid carbon/flax composites has increased from 327 MPa to 498 MPa as the strain rate increased from the lowest to the highest value in the considered range. At all impact pressures, hybrid carbon/flax composites have shown higher compressive strength than non-hybrid flax composites. The macroscopic inspection of post-tested composite specimens indicated that the accumulated damage becomes more severe with increasing the strain rate; and the main failure modes were shearing and splitting for both hybrid and non-hybrid composites. Overall, carbon/flax hybridization was found to be an effective technique for improving the load-bearing capacity of the polymer composites subjected to impact loading conditions.

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