The 4th International Conference on Material Strength and Applied Mechanics

MSAM 2021

CONFERENCE PROGRAM

August 16-19, 2021

Online - Microsoft Teams Meeting

China Standard Time (GMT+8)

*For MSAM2021 Academic Exchange Only

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09:00-11:00 14:00-16:00	MS Teams Online Conference Testing and Ice Breaking

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MS Teams Link: http://www.academicconf.com/teamslink?confname=msam2021

08:25-08:30	**Opening & Welcome Speech** ***General Chair*** ***Prof. Nao-Aki Noda,*** *Department of Mechanical Engineering, Kyushu Institute of Technology, Japan*
08:30-09:10	**Keynote Speech 1:** Mechanics and Dynamics of Two-Dimensional Quasi-Crystalline Composites ***Prof. Massimo Ruzzene,*** *P.M. Rady Department of Mechanical Engineering, Smead Aerospace Engineering Sciences, University of Colorado Boulder, USA*
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Part II Keynote Speeches

Keynote Speech 1: Mechanics and Dynamics of Two-Dimensional Quasi-Crystalline Composites

Prof. Massimo Ruzzene

P.M. Rady Department of Mechanical Engineering, Smead Aerospace Engineering Sciences, University of Colorado Boulder, USA

Biography: Massimo Ruzzene is the Slade Professor of Mechanical Engineering and holds a joint appointment in the Smead Aerospace Engineering Sciences Department of CU Boulder. M. Ruzzene currently serves as the Associate Dean for Research of the College of Engineering and Applied Science. He joined CU in the summer of 2019, after serving as the Pratt and Whitney Professor in the Schools of Aerospace and Mechanical Engineering at Georgia Institute of Technology. M. Ruzzene received a PhD in Mechanical Engineering from the Politecnico di Torino (Italy) in 1999. He is author of 2 books, more than 190 journal papers and 250 conference papers. He has participated as a PI or co-PI in various research projects funded by the Air Force Office of Scientific Research (AFOSR), the Army Research Office (ARO), the Office of Naval Research (ONR), NASA, the US Army, US Navy, DARPA, the National Science Foundation (NSF), as well as companies such as Boeing, Eurocopter, Raytheon, Corning and TRW. Most of his current and past research work has focused on solid mechanics, structural dynamics and wave propagation with application to structural health monitoring, metamaterials, and vibration and noise control. M. Ruzzene is a Fellow of ASME and SES, an Associate Fellow of AIAA, and a member of AHS, and ASA. He served as Program Director for the Dynamics, Control and System Diagnostics Program of CMMI at the National Science Foundation between 2014 and 2016.

Abstract. Periodic configurations have dominated the design of phononic and elastic-acoustic metamaterial structures for the past decades. Unlike periodic crystals, quasicrystals lack translational symmetry but are unrestricted in rotational symmetry. This provides the opportunity to investigate novel classes of quasicrystal inspired elastic composites whose mechanical static and dynamic properties are largely unexplored. This presentation illustrates the performance of continuous elastic quasicrystals composites, here denoted as *quasiperiodic* (QP) composites, characterized by different rotational symmetry orders which is directly enforced through a design procedure in reciprocal space. Static mechanical properties are investigated as a function of symmetry order and filling fraction. Results indicate that higher order symmetries, such as 8-, 10- and 14-fold, lead to equivalent stiffness characteristics that interpolate those of the constituent materials while maintaining high levels of isotropy for all filling fractions. Thus, QP composites exhibit more uniform strain energy distributions when compared to periodic 4-fold and 6-fold symmetric configurations. Similarly, nearly-isotropic wave propagation is observed over a broader range of frequencies. The spectral dynamic properties are also investigated by enforcing rotational symmetry constraints in a wedge-type unit cell, which allows for the estimation of bandgaps, whose presence is confirmed in frequency response computations. Wave directionality and bandgaps are also estimated through parallel studies conducted on plate structures characterized by QP patterns of surface stubs. These experiments show clear

bandgaps, illustrate how wave fronts reflect the rotational symmetry of the domains, and demonstrate that higher order geometries lead to isotropic propagation over a broader range of frequencies. The investigations presented herein open avenues for the general exploration of the properties of quasiperiodic media, with potentials for novel architectured material designs that expand the opportunities provided by periodic media.

Keynote Speech 2: Mechanical Behavior of Beta-type Titanium Alloy Lattice Structures Fabricated by Additive Manufacturing

Prof. Lai-Chang Zhang

School of Engineering, Edith Cowan University, Australia

Biography: Lai-Chang Zhang is a Professor of Materials Engineering and the Program Leader–Mechanical Engineering in the School of Engineering at Edith Cowan University (Perth, Australia). After awarded his PhD in Materials Science and Engineering at the Institute of Metal Research, Chinese Academy of Sciences, Prof. Zhang held several positions at The University of Western Australian, University of Wollongong, IFW Dresden and Technische Universität Darmstadt. His research interests include metal additive manufacturing, light-weight alloys, nanocrystalline materials and metallic glasses, and nanomaterials for water treatment. He has published more than about 280 refereed journal papers with an H-index of 61 and 11500+ citations and 22 ESI Highly Cited Papers. He also served as Editor or Editorial Board Members for many journals, e.g. Advanced Engineering Materials, Metals (IF: 2.117), Frontiers in Materials, Materials Science and Technology, etc.

Abstract. Beta-type titanium porous structures are a new class of solution for implants because they offer excellent combination of high strength and low Young's modulus. This presentation studies the influence of porosity variation in 3D printing (via electron beam melting (EBM)-produced and selective laser melting (SLM)) produced beta-type titanium alloy samples on the mechanical properties including super-elastic property, Young's modulus, compression strength, energy absorption and fatigue properties. Compared with Ti-6Al-4V samples, the beta-type titanium porous samples exhibit a higher normalized fatigue strength owing to super-elastic property, greater plastic zone ahead of the fatigue crack tip and the crack deflection behaviour. Stress distribution results, obtained by finite element methods, coupled with the investigation of the slip bands generated have been used to reveal the plasticity mechanism and local stress concentrations for each structure. The topology optimized structure exhibits the best balance of bending and buckling stress with a high elastic energy absorption, a low Young's modulus and a high compression strength.

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Keynote Speech 3: Flow Stress Characterization of Materials for Cold Forming: A Review

Prof. Man-Soo Joun
Gyeongsang National University, South Korea

Biography: Dr. ManSoo Joun is a Professor of Gyeongsang National University (GNU) in South Korea. He graduated from Seoul National University for his bachelor degree, from Korea Advanced Institute of Science and Technology (KAIST) for his master degree, and from Pohang University of Science and Technology (POSTECH) for his Ph.D. degree. His Ph.D. thesis topic was the optimal die shape design in extrusion or drawing, which is the first application example of finite-element based optimal design of die-shape or process conditions in bulk metal forming. After his Ph.D., he has developed and commercialized a general-purpose metal forming simulator called AFDEX, which is competitive in terms of solution accuracy and user-friendliness as an Altair APA software. He has constructed international cooperative network based on the AFDEX, involving ALTAIR (USA/Global), JSOL(Japan), BRIMET(China), ARAI/DHIO(India), MARii/UiTM(Malaysia), UNAM(Mexico), etc. and has organized MFCAE (Metal Forming CAE) for 23 years and GISPAM (GNU International Summer Program of AFDEX for the State of Mexico) for 6 years. He had been in charge of Technology Innovation Center (TIC) of GNU for 18 years, which is the only TIC specialized at metal forming and powder forging in South Korea.

Abstract. Flow stress in cold bulk metal forming has been getting more and more important because of the advances in finite element simulation techniques. It is not simple, compared to hot bulk metal forming, because of the problem at the large strain of over 2.0. It is coupled with strain rate and temperature as well as strain, even though their effects are neglected in most cases for practical application to common cases. However, the problem gets serious when we are interested in the engineering for cold working of difficult-to-form or high strength materials. In this paper, we emphasize the importance of accurate description of flow behaviors at the room temperature in terms of strain, damage, strain rate and temperature for preventing the failure cases occurring especially in cold forging [1]. Then, we conduct literature survey covering the experimental and numerical ways [2, 3, 5] of describing the flow stress and coupling it with strain rate and temperature. An advancement direction is proposed to enhance the practicability.

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Keynote Speech 4: How to Improve Both Fatigue Strength and Anti-Loosening of Bolt Nut Connections with Low Cost

Prof. Nao-Aki Noda
Department of Mechanical Engineering,
Kyushu Institute of Technology, Japan

Biography: “Material Strength” is an academic field to predict the strength of actual structures from test specimens. In this sense, Nao-Aki Noda and his group analyzed the stress concentration factors (SCFs) for notched test specimens and proposed the accurate SCF formulas in their papers and books “Theory of Fatigue Notch Strength Useful for Machine Design”. The formulas provide SCFs under arbitrary dimension of the notch including blunt and sharp notches and shallow and deep notches in the specimens. Regarding this achievement, he received JSMS Academic Contribution Award from Japan Soc, Material Science. To improve the durability of automobile bodies, zinc-coated steel sheets are used in large quantities. They are produced through continuous galvanizing lines (CGLs) in steel manufacturing industries. In a molten zinc bath in CGLs, stainless steel rolls are used under 480 degrees although corrosion and abrasion appear on the roll surface in a few weeks causing the deterioration of quality of plating. Considering those situations, all ceramics rolls were developed as an academic-industrial collaboration METI-funded project. In this

project, Kyutech group studied the strength of shrink-fitted joint structure in the ceramic roll under mechanical and thermal loading. Since only small shrink-fitted ratio can be applied due to the ceramic brittleness, they clarified a new failure of the coming out of the shaft. Regarding this achievement, Nao-Aki Noda received and JSDE Best Paper Award from Japan Society for Design Engineering. Regarding the development of all ceramic roll, the academic-industrial collaboration group received Sokeizai Industry Technology award from Materials Process Technology Center Japan.

Nao-Aki Noda also studied several other joints. For example, bolt-nut connections can be regarded as the most important fastening elements. He has investigated special bolt-nut connections to improve both fatigue strength and anti-loosening with low cost. Supported by an academic-industrial collaboration METI-funded project, the group received Japan Society for Technology of Plasticity JSTP Best Paper Award. Since several Kyutech PhD students contribute to developing special bolt-nut connections, Nao-Aki Noda's group received JSTP Education Award. Similar to bolt-nut connections, adhesively-bonded joints are also widely used. He found that most of the adhesive strength can be expressed as a constant value of ISSF, which is the intensity of the singular stress field. He clarified the ISSF under pull out test and microbond test used to estimate fiber bonded strength in fiber reinforced composites. He received JCOM Award for Scientific Papers from Japan Society of Materials Science for this achievement and JSME Materials & Mechanics Contribution Division Award from JSME for those academic-industrial collaborations. He lectured Mechanics of material for undergraduate course and Theory of Elasticity for graduated. He supervised more than 28 PhD students including 18 international students most of whom are supported by MEXT as well as more than 30 international master students most of whom are working in Japanese companies. He invited more than 25 international researchers to Kyushu Institute of Technology for collaboration. For contributing to the development of excellent international students and foreign researchers, he received the Commendation of Consulate-General of China in Fukuoka.

Abstract. In this talk, how to improve both anti-loosening and fatigue strength with low cost is shown for bolt-nut connection. The authors' previous study clarified that the most suitable pitch difference $\alpha = \alpha 1$ for the fatigue strength is smaller than the most suitable pitch difference $\alpha = \alpha 2$ for the anti-loosening. In this paper, toward improving both fatigue strength and anti-loosening, a larger nut height coupled with pitch difference is studied through experiment and FEM analysis. It is found that with increasing the nut height the suitable pitch difference for the anti-loosening $\alpha = \alpha 3$ becomes smaller without changing the suitable pitch diffence for the fatiguge strength. In other words, a larger nut height with the pitch difference $\alpha = \alpha 3 \approx \alpha 1 < \alpha 2$ is suitable for improving both fatigue strength and anti-loosening.

Part III Poster Session

Poster Presentation Preparation

- There are no constraints for the e-poster size. The A1 size (594mm×841mm) is preferable.
- Please send the poster at **.PDF** format. The Poster would be updated on the conference website after pre-review and confirmation.
- The Poster could design as you like with requirements as below:
  - ✧ The conference logo should be clearly shown in the header.
  - ✧ Title, presenter, and affiliation information should be well indicated.
- Signed and stamped electronic presentation certificate would be issued via e-mail after the conference.

Best Poster Presentations Selection

- One Best Poster presentation will be selected by the General Chair.
- This award consists of a certificate and free attendance to MSAM 2022.

Selection Criteria

- ✓ Research Quality
- ✓ Poster Design

List of Posters

Time: 11:20-12:00, August 17, 2021. China Standard Time (GMT+8)

Conference Room Link: ***http://www.academicconf.com/teamslink?confname=msam2021***

****Should you have any questions on the posters, please feel free to write down in the notebox of each poster at MSAM2021 official website. The presenter will answer your questions as soon as possible.***

MS1527	Simulation and Optimization of a New Energy Vehicle Power Battery Pack Structure *Dr. Guanqiang Ruan, School of Mechanical Engineering, Shanghai Dianji University, China*
MS1597	CFD Simulation on Wind Turbine Blades with Leading Edge Erosion *Dr. Yan Wang, School of Energy and Power Engineering, Lanzhou University of Technology, China*
MS1610	Effects of U-shaped Two-Step Throttling Groove Parameters on Cavitation Erosion Characteristics *Dr. Wenhua Jia, School of Mechanical Engineering, Nanjing Institute of Technology, China*
MS1611	Stability and Second-Order Lateral Stiffness of Embedded Piles with Generalized End-Boundary Conditions on Non-Homogeneous Soil *Dr. Carlos A. Vega-Posada, Department of Civil and Environmental Engineering, University of Antioquia, Colombia*
MS1613	Vacuum-Deposited Metal/Dye-Filled Fluoropolymer Thin Films *Dr. Kostyantyn Grytsenko, Lashkaryov Institute of Semiconductor Physics, Ukraine*
MS1623	Simulation Analysis of the Characteristics of the Truncated Projectile Entering the Water *Ms. Miaomiao Cao, State Key Laboratory of Explosion and Science, Beijing Institute of Technology, China*
MS1651	Analogy between Heterogeneous Photocatalysis and the Photochromic Effect Observed in Fibers of Titanium and Tungsten Oxides *PhD Luana Góes Soares Da Silva, Universidade Federal do Rio Grande do Sul, Brazil*
MS1653	Development and Characterization of Lignin/Polycaprolactone Nanostructures by Electrospinning *Dr. José Fernando Rubio Valle, Department of Chemical Engineering and Materials Science, Universidad de Huelva. ETSI. Campus de "El Carmen", Spain*
MS1665	Evaluation of Small Size Four Rotor Drone Smooth Narrow Passage L-Shaped Movement *Mr. Shota Ishii, Faculty of Engineering, University of Toyama Gofuku Campus, Japan*
MS1681	Optimization Design of Multistage Pump Impeller Based on Response Surface Methodology *Dr. Hao Chang, Research Center of Fluid Machinery Engineering and Technology, Jiangsu University, China*
MS1682	Evaluation of a Hip Stretching Device with Passive Adjustment Mechanism for Rehabilitation Support *Mr. Kameda Ryosuke, Faculty of Engineering, University of Toyama, Japan*

MS1683	Evaluation of Long-Distance Flight Control Performance of Three Size Four Rotor Helicopters *Mr. Harada Taisuke, Faculty of Engineering, University of Toyama, Japan*
MS1695	Numerical Modelling of Laterally Loaded Piles and Anchors to Support the Old Structure and Stabilize the Slope *Mr. Muhammad Rehan, Mehran University of Engineering and Technology, Pakistan*
MS1703	Theoretical Analysis of Factors Affecting the Increase in the Strength Characteristics of Materials during Electrolytic-Plasma Treatment *Dr. Alexander I. Popov, Peter the Great St. Petersburg Polytechnic University, Russia*

Abstracts of Posters

MS1527 Simulation and Optimization of a New Energy Vehicle Power Battery Pack Structure
***** This abstract will be available after the full paper is published.

MS1597 CFD Simulation on Wind Turbine Blades with Leading Edge Erosion
***** This abstract will be available after the full paper is published.

MS1610 Effects of U-shaped Two-Step Throttling Groove Parameters on Cavitation Erosion Characteristics
***** This abstract will be available after the full paper is published.

MS1611
Stability and Second-Order Lateral Stiffness of Embedded Piles with Generalized End-Boundary Conditions on Non-Homogeneous Soil
***** This abstract will be available after the full paper is published.

MS1613
Vacuum-Deposited Metal/Dye-Filled Fluoropolymer Thin Films

K. Grytsenko[1,*], Yu. Kolomzarov[1], O. Kondratenko[1], P. Lytvyn[1] and A. Navozenko[2]
[1]*V.E. Lashkaryov Institute of Semiconductor Physics, pr. Nauki 41, 03650, Kyiv, Ukraine*
[2]*T. Shevchenko Kyiv State University, 64/13 Volodymyrska Str., 01601, Kyiv, Ukraine*

Abstract. Polytetrafluoroethylene (PTFE) thin films are characterized by an outstanding thermal and chemical stability, biocompatibility and transparency over UV-VIS-NIR regions. By co-deposition in a vacuum the nanocomposite films with PTFE matrix, filled with metal and dye nanoparticles (NPs) with required optical properties were produced without restrictions imposed by the solubility and wettability of components of the film.

Polymer thin films filled with metal NPs have been studied mainly for various plasmonic devices. Recently absorption spectra of gold-filled PTFE films were recorded during film growth ***in situ*.** These spectra showed the kinetics of optical absorption changes during film thickness increase. Depositions were made with and without RF plasma treatment of gas phase. The spectra in both cases showed, that the initial plasmon peak at 480 nm was shifted to 520 nm with film thickness growth. Intensity of plasmon band grew with increasing film thickness in comparison with short and long wavelength absorption. The film deposited with plasma revealed the increased absorption at 420- 430 nm. In film the NPs increase can be terminated at a certain film thickness due to the PTFE matrix, depending on the Au NPs concentration and deposition conditions. Normal law described the distribution of NPs size in film deposited without plasma. Distribution of NPs sizes in the film deposited with plasma was wide. Two types of the NPs were seen in transmission electron microscope formed due to aggregation during annealing of the film in air. Dye-filled PTFE films were produced for the first time. Various dyes showed different behavior of optical transmission during film growth. There were dyes, which NPs had absorption like pristine material and the dye NPs with different spectra, which were varied in dependence with dye concentration. Some dyes formed different phases in PTFE matrix. All dyes in PTFE matrix showed extreme stability to all factors of environment: light, oxygen, water, acids. Such the film can be used in optical devices working in aggressive environment. But the films, composed with PTFE matrix filled with metal+dye showed changes in optical spectra under action of acid. The Au NPs promoted the actions of environment, perhaps as the sites for oxygen etc. environmental molecules. Such film can be used as sensor. Only co-deposition in vacuum allows production of metal-dye-filled PTFE films. The films have useful properties which exceed the sum of properties of the PTFE, dye and metal.

Keywords: Polytetrafluoroethylene, Dye, Metal, Nanoparticle, Optical spectra.

MS1623

Simulation Analysis of the Characteristics of the Truncated Projectile Entering the Water

***** This abstract will be available after the full paper is published.

MS1651

Analogy between Heterogeneous Photocatalysis and the Photochromic Effect Observed in Fibers of Titanium and Tungsten Oxides

Luana Góes Soares Da Silva* and Annelise Kopp Alves
Universidade Federal do Rio Grande do Sul, Brazil

Abstract: Photochromism and heterogeneous photocatalysis are processes that are correlated by the occurrence of similar phenomena, which occur simultaneously during photocatalytic and photochromic tests. They are electromagnetic radiation, the need for a specific wavelength, migration of electrons from the valence band to the conduction band, generating positive holes (electron hole) in the valence band, when irradiated with light at a level of energy higher than the band gap of the samples, which will degrade the dye and reflect/absorb the light, changing the color of the material and forming O_2 vacancies. This observed synchronism occurs, due to the chemistry and physics of these materials, TiO_2 and WO_3, when optically and photocatalytically activated are similar. Within this context, in this

work we produce fibers from titanium and tungsten oxides by *electrospinning*. These samples were characterized by X-ray diffraction (XRD) to identify the present phases, scanning electron microscopy (SEM) to evaluate the morphology and microstructure. Photochromic tests were performed by a Konica Minolta spectrophotometer and analyzed according to the CIEL-a*b* system. The heterogeneous photocatalysis tests were performed by photodegradation of 125 ml of a 20ppm solution of the methyl orange dye, observed during 135 minutes of exposure to UVA-visible radiation. The results indicate that all fibers could be used as photocatalysts and in photochromic tests, that is, they were able to degrade the orange methyl dye and change its color. The presence of tungsten increased the photocatalytic efficiency of the materials, inhibited the recombination of the pair electron/hole, allowing the transfer of charges between TiO_2 and WO_3.

MS1653

Development and Characterization of Lignin/Polycaprolactone Nanostructures by Electrospinning

J.F. Rubio-Valle, J.E. Martín-Alfonso, M. Sánchez, C. Valencia and José M. Franco
Pro2TecS - Chemical Product and Process Technology Research Center, Department of Chemical Engineering and Materials Science, Universidad de Huelva. ETSI. Campus de "El Carmen", 21071 Huelva, Spain

Abstract. Electrospinning is one of the most important techniques in the manufacture of polymer nanofibers. Despite this process was patented more than eighty years ago, until relatively recently, no special attention has been paid to this technology. Its great interest is due to the extraordinary possibilities offered by the nanostructures designed due to the combination of their small size and high surface/volume ratio. Therefore, the objective of this work was to develop nanostructured membranes of Eucalyptus Kraft lignin (EKL), which was doped in small quantities with polycaprolactone (PCL), in order to improve electrospinnability. For this, the properties of the solutions were evaluated through rheological, electrical conductivity, and surface tension tests. In addition, the morphological and functional characterization of the nanostructures obtained was carried out. The results show that the use of different concentrations of polymers and different ratios of EKL and PCL produce significant variations in the morphological properties of the membranes obtained.

Keywords: Lignin, PCL, Electrospinning, Rheology properties, Morphological properties.

Acknowledgments: This work is part of a research project (RTI2018-096080-B-C21) sponsored by the MICINN-FEDER I + D + i Spanish Programme. JF. acknowledges the Ph.D. Research Grant (Ref. PRE2019-090632) from MECD (Spain)

MS1665

Evaluation of Small Size Four Rotor Drone Smooth Narrow Passage L-Shaped Movement

Shota Ishii and Hideki Toda*
Faculty of Engineering, University of Toyama Gofuku Campus, 3190 Gofuku, Toyama, Japan

Aims: In this paper, L-shaped movement control experiment assuming the narrow passage movement inside the building of four rotor helicopter was confirmed and the control stability was evaluated in a small size room (4×4 m, 3 m height).

Methods: In this experiment, HS210 (0.08×0.08×0.03 m) small size four rotor drone of Holy stone Corp. was used. To verify the problem of the orbit control with an L-shaped bend passage, an autonomous flight movement control experiment was conducted by including movement direction reversing 10 times with three different control strategies (the PID, the boundary condition and the proposed V^2 control).

Results: Experimental result shows that (1) the stability of the L shaped movement of the drone was seen the S.D. of the between trajectory of two 90 degree curves, and the overshoot fashion of the second 90 degree curves position. (2) In the three control cases, even if there is no control within d=15 cm on the ideal trajectory, the stability was increased from the condition when the PID control is always working.

Conclusions: This means that in such a case of drone flight of the L shaped corridor in the building, the above two evaluation methods are useful, and especially, the control stability was reduced such a PID control method when the PID control is always working case. Our proposed the boundary condition or the V^2 condition control would be more useful in those case. As a result, it is necessary to carefully select the control method of the drone according to the usage scene.

MS1681 Optimization Design of Multistage Pump Impeller Based on Response Surface Methodology

***** This abstract will be available after the full paper is published.

MS1682

Evaluation of a Hip Stretching Device with Passive Adjustment Mechanism for Rehabilitation Support

Ryosuke Kameda and Hideki Toda*
Faculty of Engineering, University of Toyama, Japan

Aims: This paper proposed a hip joint stretching device which is intended for physical therapist's rehabilitation support by using a passive adjustment mechanism.

Physical therapists treat their patients to prevent contracture of subject hip joint and to improve walking function, but a sufficient rehabilitation therapy can not be done due to demand a labor-task of the hip joint rehabilitation.

To reduce the labor-task, there is a demand of the physical therapist rehabilitation mechanical support long time, especially it can be installed easily in bed in patient home.

Methods: For the passive adjustment mechanism, we compared the results with the slider fixed and open.

Results: As a result of the experiment, it was confirmed that the misalignment between the knee and the actuator was suppressed more when the slider was open than when it was fixed.

Conclusions: The results showed that the proposed passive adjustment mechanism was effective in optimizing the actuator position and reducing patient pain.

Acknowledgements: I express my sincere thanks to Associate Professor Hideki Toda for his guidance and advice in conducting this research.

MS1683

Evaluation of Long-Distance Flight Control Performance of Three Size Four Rotor Helicopters

Taisuke Harada and Hideki Toda*

Faculty of Engineering, University of Toyama, Gofuku Campus, 3190 Gofuku, Toyama, 930-8555, Japan

Aims: In this paper, long-distance (> 10 m) movement control experiment of three size of four rotor helicopters were confirmed and the control stability was evaluated in a small size room (4 × 4 m ,3 m height).

Methods: In this experiment, we used (1) Parrot's A.R.Drone 2.0 (large: 0.5 × 0.5 m), (2) Potensic's A20W (small: 0.09 × 0.08 m), and (3) YTFU's QUADCOPTER (medium: 0.3 × 0.3 m). Assuming that control instability would occur during the direction change operation, we evaluated the autonomous flight control experiment by reversing the movement direction 10 times, focusing on (1) movement speed, (2) aircraft size, and (3) control method.

Results: The experimental results showed that (1) the stability of the drone basically improved under high speed conditions, (2) the stability of the drone's forward motion improved for the small aircraft compared to the large aircraft, and for the medium aircraft compared to the small aircraft. (3) Regardless of aircraft size, PD control was found to be more stable under high-speed conditions, while BC control was found to be more stable under low-speed conditions.

Conclusions: The reason why the high-speed state of BC control is not stable is thought to be that the smaller the drone, the more susceptible it is to wind, and the drone is unable to cope with the blurring of its trajectory when a sudden left-right force is applied across the boundary in the high-speed state. In summary, the size, travel speed, and control method of the drone should be carefully selected according to the usage scenario.

MS1695

Numerical Modelling of Laterally Loaded Piles and Anchors to Support the Old Structure and Stabilize the Slope

Muhammad Rehan Hakro*, Aneel Kumar, Zaheer Almani and Syed Raghib Ali Shah
Mehran University of Engineering and Technology, Pakistan

Abstract. In comparison to field experiments, numerical modelling is a cost-effective method of analyzing the response of laterally loaded piles in sloping terrain. This paper presents a two-dimensional finite element analysis for different slope angles and pile lengths to examine the effect of edge distance from the slope crest of a laterally loaded pile embedded in the sloping earth. The laboratory and field experiments performed to know the properties of soil of the study area. The numerical modelling performed in Plaxis 2D for determining the behaviour of secant pile on the horizontal and vertical displacement. This study observed that the settlement of building increased due to increase of load, and with installation of secant pile on the crest reduce the settlement. The length and location of pile has little influence on the settlement.

MS1703

Theoretical Analysis of Factors Affecting the Increase in the Strength Characteristics of Materials during Electrolytic-Plasma Treatment

Alexander I. Popov *
Peter the Great St. Petersburg Polytechnic University, Russia

Aims: theoretical analysis of the main factors affecting the increase in the strength characteristics of materials due to electrolytic-plasma treatment.

Methods: In the work, statistical methods were used to process the results of measurements of the surface roughness parameter Ra, the depth of material removal and weight characteristics, after jet focused electrolyte-plasma treatment.

Results: The main factors that reduce the strength of materials are defects in the surface layer created by previous operations by turning, milling, grinding. These defects are stress concentrators. As a result of surface treatment with a focused jet of electrolyte plasma based on sodium chloride, at a volumetric flow rate of electrolyte of 2-90 l / h, interelectrode gaps of 2-30 mm, using a hollow tube in the form of cathodes, set of copper current conductors, a magnetron spray head. For heat-resistant blade steel 20X13, and stainless steel - an analogue of AISI 304, high rates of removal of the surface metal of the anode 70-150 μm / min were obtained, a low surface roughness parameter Ra 0.034 μm was obtained.
Conclusions: Our research results show a multiple reduction (until complete removal) of surface defects formed by previous mechanical operations. An increase in the cyclic strength of the material operating under these loads is predicted, for example, turbine blades
Acknowledgements: The author would like to thank graphic designer Diana A. Popova for preparing illustrations.

Part IV Online Oral Presentations

Online Oral Presentation Guidelines

- Online Oral Presentation will be conducted via Microsoft Teams Meeting (Click to see how to join MSAM 2021 via MS Teams).
- All presenters are requested to reach the Online Session Room prior to the scheduled time and deliver their presentations on time.
- The presentation timetable is shown in **China Standard Time (GMT+8).**
- If a presenter is not able to show up via MS Teams, the session chair/conference secretary will download and play the pre-recorded video presentation during his/her scheduled presentation time; if listeners have questions about the presentation, please contact the conference secretary to forward the questions.
- If a presenter cannot show up on time or have problems with internet connection, the session chair has the right to rearrange the presentation order and let the next presenter start.
- Signed and stamped electronic presentation certificate would be issued and delivered via e-mail after presentation.

Best Oral Presentations Selection

The session chair will select one best oral presentation from his/her session based on the following criteria:

- ✓ Research Quality
- ✓ Presentation Performance
- ✓ Presentation Language
- ✓ PowerPoint Design

Best Oral Presentations Award

Best Presenters will receive an official certificate and free registration to the MSAM 2022.

Oral Session 1: Experimental Methods and Application

Time: 14:00-18:50, August 17, 2021. China Standard Time (GMT+8)
Session Chair: Assoc. Prof. Qiyin Lin, Xi'an Jiaotong University, China
Session Room Link: http://www.academicconf.com/teamslink?confname=msam2021

14:00-14:25	**MS1593**	Experimental Study on Rod Shearing in Automatic Multi-Stage Cold Forging *Prof. Mansoo Joun, School of Mechanical and Aerospace Engineering, Gyeongsang National University (GNU), South Korea*
14:25-14:50	**MS1664**	Innovative Method for Performance Improvement and Optimization of Assembly Connection surfaces Based on Surface Mechanical and Physical Characteristics Design *Assoc. Prof. Qiyin Lin, School of Mechanical Engineering, Xi'an Jiaotong University, China*
14:50-15:05	**MS1627**	Mechanical Behavior of Metallic Glasses with Pressure-Promoted Thermal Rejuvenation *PhD Shan Li, State Key Laboratory for Strength and Vibration of Mechanical Structures, Xi'an Jiaotong University, China*
15:05-15:20	**MS1675**	The Interaction Force Between Vapour-Mediated Droplets *PhD Zhiwu Jiang, Department of Modern Mechanics, University of Science and Technology of China, China*
15:20-15:45	**MS1661**	Structure, Magnetic and Thermodynamic Properties of Heterometallic Ludwigites: Cu_2GaBO_5 and Cu_2AlBO_5 *Prof. Rushana Eremina, Zavoisky Physical-Technical Institute, FRC Kazan Scientific Center of RAS, Russia*
15:45-16:00	**MS1684**	Frictionless Contact Treatment with Bézier-based Isogeometric Analysis *Ms. Ncamisile Khanyile, Laboratoire de Mécanique Multi-physique Multi-échelle - UMR 9013 (LaMcube), France*
16:00-16:15	**MS1676**	Experiment on Dynamical Wetting Transition in a Square Capillary *Ms. Chang-E Wu, Department of Modern Mechanics, University of Science and Technology of China, China*
16:15-16:30	**MS1690**	Single-camera 3D-DIC System Based on Fiber Bundle *Ms. Han Tu, CAS Key Laboratory of Mechanical Behavior and Design of Materials, Department of Modern Mechanics, University of Science and Technology of China, China*
16:30-16:40		**BREAK**
16:40-17:05	**MS1650**	Conceptualizations of New Approaches to Estimate the Chloride Content in RC Structures *Dr. Enrico Zacchei, Itecons - Institute for Research and Technological Development in Construction, Energy, Environment and Sustainability, Portugal*
17:05-17:20	**MS1687**	Thermomechanical Analysis of PVA-based Electrospun Mats Reinforced with Cellulosic Compounds *Ms. Marta A. Teixeira, Centre for Textile Science and Technology (2C2T), University of Minho, Portugal*

17:20-17:35	**MS1639**	Seismic Analysis of RC Structures by the Non-Linear Static Method *Mr. Anas Hlim, I2SI2E Laboratory ENSAM Casablanca, University Hassan II, Morocco*
17:35-17:50	**MS1689**	Asymptotic Theory of Gas Entrainment in a Two-phase Couette Flow *Mr. Hewei Du, Department of Modern Mechanics, University of Science and Technology of China, China*
17:50-18:05	**MS1688**	Effects of Particle Clustering and Interface Property on the Large Deformation Behavior of Carbon Black Filled Elastomer *Mr. Dongzi Ding, Department of Engineering Structure and Mechanics, Wuhan University of Technology, China*
18:05-18:20	**MS1693**	Photocatalytic Activity Enhancement: a New Vision *Dr. Ahmed Helal Amin, Nanostructured Materials Lab, Central Metallurgical R & D Institute, Egypt*
18:20-18:35	**MS1660**	Investigation on Thermal & Mechanical Behavior of Hybrid Metal Matrix Composites by Experimental and Computational Approaches *Dr. S A Mohan Krishna, Department of Mechanical Engineering, Vidyavardhaka College of Engineering, India*
18:35-18:50	**MS1658**	Usefulness of Slope Linear Regression Through the Data Points for Enhancement of Discussion of Results: The Case of Fluid Dynamics *Dr. Isaac Lare Animasaun, Department of Mathematical Sciences, Federal University of Technology, Nigeria*

Abstracts of Session 1

MS1593

Experimental Study on Rod Shearing in Automatic Multi-Stage Cold Forging

***** This abstract will be available after the full paper is published.

MS1664

Innovative Method for Performance Improvement and Optimization of Assembly Connection surfaces Based on Surface Mechanical and Physical Characteristics Design

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Aims: The performances of assembly connection surfaces directly influence the static and dynamic performances of the involved mechanical equipment, such as the stiffness, damping and vibration, etc. According to the state of motion, assembly connection surfaces can be divided into static assembly surfaces (e.g., bolt-flange assembly connection surfaces) and dynamic assembly surfaces (e.g., journal bearing assembly surfaces). Traditionally, to improve the performances of assembly connection surfaces, the adopted method is to design their surface topographies, optimize layout of the fasteners or optimize the assembly process. A novel design concept for enhancing the assembly connection surfaces' performances will be presented here.

Methods: Besides the surface topography, the surface mechanical and physical characteristics (such as surface hardness, material stiffness and velocity slip characteristic, etc.) could be utilized as design variables to improve the performances of assembly connection surfaces. The design approach of surface hardness and material stiffness near the assembly surfaces is developed to improve the uniformity of contact stress distribution for the bolt-flange assembly connection surfaces. The optimization of the velocity slip surfaces' location and area in the bearing bush is conducted to enhance the load carrying capacity for journal bearing assembly surfaces.

Results: After the design of surface hardness and material stiffness near the bolt-flange assembly connection surfaces, the distribution uniformity of contact stress increases more than 95%, and the effective contact area can be doubled. The velocity slip surfaces located in the pressure build-up region will enhance the load carrying capacity of journal bearings, slip surfaces located in the pressure drop region will reduce the load carrying capacity, and this detrimental influence also increases with the region area of velocity surface.

Conclusions: In addition to the surface topography, the design of surface mechanical and physical characteristics is an innovative and effective approach to improve the performances of both static and dynamic assembly connection surfaces.

MS1627
Mechanical Behavior of Metallic Glasses with Pressure-Promoted Thermal Rejuvenation

S. Li [1], J.C. Zhang [1] and Z.D. Sha[1,2,*]
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[2]*State Key Laboratory of Structural Analysis for Industrial Equipment, Dalian University of Technology, Dalian, 116024, China*

Aims: The molecular dynamics simulations have been performed to investigate the atomic structure and mechanical behavior of the rejuvenated MGs with pressure-promoted thermal processing.

Methods: molecular dynamics simulation.

Results: The MGs can be rejuvenated either by the application of negative pressures with the low annealing temperature, or by the application of positive pressures with the high annealing temperature. Accompanied by the rejuvenation, a transition in failure mode from localized shear banding to homogeneous plastic deformation occurs due to the higher-energy glassy state induced by the thermal-pressure loading process.

Conclusions: Our present study reveals that the rejuvenation can be achieved by the negative pressures with the lower annealing temperature when the cooling rate after isothermal annealing is higher than that of the initial quenching process. This is because the fast cooling can promote rejuvenation during the glass-forming quenching process. Another key finding is that the failure mechanism undergoes a transition from localized shear banding to nearly homogeneous plastic deformation due to the higher-energy glassy state in the rejuvenated MGs.

Acknowledgements: Z.D. Sha would like to acknowledge financial support by the National Natural Science Foundation of China through Grant Nos. 11772250, 11972278 and 11790293.

MS1675
The Interaction Force Between Vapour-Mediated Droplets

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Aims: To develop a new non-contact droplet control technology, to reveal the attraction or repulsion mechanism between vapour-mediated droplets, and try to obtain the form of the interaction force and scaling law of the droplets motion.

Methods: The experimental fluid mechanics method is employed for our research, more specifically, we use high-speed camera to capture the motion and distortion of droplets. The theoretical fluid mechanics method is employed to build model for data analysis.

Results: The attraction or repulsion mechanism between vapour-mediated droplets is revealed, the driven force is originated from the air humidity gradient resulted from the evaporation of the neighbored droplet. Our theoretical model predicts the interaction force and motion scaling law between droplets, and agreed well with the experimental results.

Conclusions: We employed experimental fluid mechanics method and theoretical fluid mechanics method, to investigate the the interaction force between vapour-mediated droplets. We reveal the attraction or repulsion mechanism, obtain the form of interaction force, and the scaling law of the droplets motion.

Acknowledgements: We acknowledges the Thousand Young Talents Program of China, the National Natural Science Foundation of China (grants nos 11772327, 11642019 and 11621202).

MS1661

Structure, Magnetic and Thermodynamic Properties of Heterometallic Ludwigites: Cu_2GaBO_5 and Cu_2AlBO_5

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[4]Institute for Solid State and Materials Physics, TU Dresden, 01069, Dresden, Germany

Aims: These considerations motivated our present study to reveal the details and explain the mechanism of the field-driven destruction of long-range magnetic order in favor of a spin-glass-like state in copper ludwigites.

Methods: The magnetization *M* of single crystalline samples were measured on the PPMS-9 device within a temperature range 2K<T<400K in zero-field-cooled (ZFC) and field-cooled (FC) regimes in magnetic fields *H* up to 9 T.

Results: Here we presented the investigations of single crystals of Cu_2GaBO_5 and Cu_2AlBO_5 oxyborates with ludwigite. The distinctive features of the investigated structures are the selective distribution of Cu, Ga and Al cations. The magnetic properties of the investigated homomagnetic copper ludwigites are discussed in comparison with known heterometallic bimagnetic ludwigites.

Conclusions: The analysis of the phonon contribution to the specific heat was performed, that allowed to separate the magnetic contribution to the specific heat for both compounds.

MS1684
Frictionless Contact Treatment with Bézier-based Isogeometric Analysis

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Abstract. The aim of this work is to develop an advance numerical tool for numerical simulation of contact, based on the isogeometric analysis (IGA), that can accurately capture the contact stresses. IGA can exactly represent the contacting surfaces and has been shown to be more accurate and robust on per-degree-of-freedom basis than the standard finite element methods.

Taking advantage of the implementationally friendly isogeometric finite elements that can fit into existing FE data structures and coupling this with the point to surface (PTS) method, we develop a Bézier-based IGA method for contact treatment that interpolates the physical geometry. To achieve this, first we perform a Bézier extraction process of a BSpline to derive Bézier elements (Borden et al., 2011). This is then followed by Bézier interpolation (Kamoso, 1999) which transforms the non-interpolatory control points into physical points that are located on the actual geometry. Consequently, essential boundary conditions can be applied directly, and therefore simplify greatly the computation of contact integral that must be collocated on physical points.

The method developed was used to simulate, i) the classical Hertz frictionless contact between an elastic sphere and a rigid foundation, and ii) the indentation of an elastic half-space by a flat base rigid punch. Comparing the numerical results with the analytical solution, we found with a relatively coarse mesh, we can predict the contact radius with less than 1% error. The relative error on the contact pressure was found to be less than 5%.

MS1676
Experiment on Dynamical Wetting Transition in a Square Capillary

Chang-E Wu[1], He-Wei Du[1], Jian Qin[1], Er-Qiang Li[1] and Peng Gao[1, 2,*]
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[2]*State Key Laboratory of Fire Science, University of Science and Technology of China, Hefei, Anhui 230026, China*

Aims: We experimentally study the displacement of a viscous liquid by a gas in a square capillary tube to obtain a comprehensive description of the flow regimes.

Methods: To realize the gas-liquid displacement, the glycerol in the capillary tube is extracted by the syringe pump. The displacement process in the square capillary is illuminated horizontally and imaged by a high-resolution CCD camera.

Results: The gas-liquid interface exhibits a variety of morphologies with increasing displacement rate.

At low displacement rate, a constantly moving meniscus can be observed, without any liquid deposition on the tube wall. An increase of the displacement rate gives rise to the deposition of two ultra-thin liquid filaments at each corner, which immediately break into tiny droplets. An additional thicker filament is entrained at each corner as the displacement rate further increases, connecting the thinner ones and the meniscus. When the displacement rate is high, liquid films are entrained on the tube wall and eventually collapse, entrapping an amount of gas in the form of Taylor bubbles.

Conclusions: Quantitative measurements show that both the thicker filaments and the liquid films retract at a constant speed. Empirical relations predicting the film thickness and the bubble length are proposed and agree with the experimental results.

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MS1690
Single-camera 3D-DIC System Based on Fiber Bundle

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Aims: This study proposes a single-camera 3D-DIC system based on a fiber bundle (FB), aiming to make full use of the flexibility of the FB and further broaden the range of application of the 3D-DIC method.

Methods: Since the customized fiber bundle can convert the multiple inputs into one output, the surface of the specimen can be viewed from different angles and recorded by a single digital camera.

Results: A three-point bending deformation measurement experiment and a cylinder 3D reconstruction experiment were carried out to verify the effectiveness of the proposed method.

Conclusions: Compared with exiting single-camera 3D-DIC methods, it can isolate the imaging sensor from the environment, allowing for the measurement system to be used in harsh environments. Therefore, when the accuracy-related requirement of deformation measurement is not particularly high, the proposed method provides a useful approach for the use of the DIC to conduct measurements in extreme environments.

Acknowledgements: This work was supported by the National Natural Science Foundation of China (Grant Nos. 11627803, 11702287, 11872354) and the Fundamental Research Funds for the Central Universities (WK2090000033).

MS1650

Conceptualizations of New Approaches to Estimate the Chloride Content in RC Structures

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Aims: This presentation is about the chloride ions diffusion in sound and cracked reinforced concrete (RC) structures under external environmental actions and loadings. The diffusion of chloride ions in RC structures varies in space and time, depending on a variety of uncertain factors such as surface and inner concentration of chloride in concrete, water/concrete ratio, volume fraction of coarse aggregate, temperature, aging, humidity, deformation, damage. Considering all these factors, it would be possible to estimate more reliable scenarios for short and large periods.

Methods: The purpose of this presentation is to show some advanced methods for this issue, e.g. modified analytical analyses, numerical analyses, dynamic models, probabilistic analyses, non-linear models. Alternative methods are also shown as (i) the use of carbon nanotubes (CNTs) for monitoring the chloride concentration and the (ii) self-diffusion voltage distortions due to other multispecies in concrete.

Results: Results, in terms of scenarios, would define the corrosion initiation time and chloride ions content in concrete. In this sense, it is possible to quantify a new service life for RC structures. Results show that the chloride content for constant diffusivity poorly estimates the chloride content.

Conclusions: All these aspects should be accounted for estimating the concentration of the chloride ions in concrete and its trend. This strictly relates to United Nations Sustainable Development Goals – 2030 Agenda, that is, to “build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation”.

Acknowledgements: The author thanks the institutions that have supported his research: University of Salamanca (USAL), Spain; State University of São Paulo (UNESP), Brazil; University of São Paulo (USP); Iberian-American University Postgraduate Association (AUIP); Itecons, Coimbra, Portugal.

MS1687

Thermomechanical Analysis of PVA-based Electrospun Mats Reinforced with Cellulosic Compounds

Marta A. Teixeira[1*], Aureliano Fertuzinhos[2], M. Teresa P. Amorim[1], Diana P. Ferreira[1] and Helena P. Felgueiras[1]

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Aims: Establish the thermal and mechanical profile of uncrosslinked and crosslinked polyvinyl alcohol (PVA)-based electrospun mats reinforced with 0-20% w/v of cellulosic compounds (cellulose acetate (CA) and cellulose nanocrystals (CNCs)) and verify which cellulosic component is the most impactful in the mats' properties.

Methods: Thermal analyses were performed through thermogravimetry and differential scanning calorimetry. The mats' tensile mechanical properties were measured using uniaxial tensile test. Stiffness was obtained from force-displacement curves, while the ultimate tensile strength and the failure strain were obtained from stress-strain curves. Dynamic tensile analyses were also performed to evaluate the mats' viscoelastic behavior. The storage, loss modulus and tanδ were determined in tension mode over 20-250ºC at 3°C/min, by applying different frequencies (0.5, 1, 2, 5, and 10 Hz).

Results: The addition of CA and CNC improved the thermal resistance of the mats and contributed to an increase of their stiffness, reducing the PVA characteristic high strain. However, the strain at break was dramatically reduced and the results of the storage and loss modulus suggested a strong physical interaction between the polymers, which contributed to the observed excellent mechanical features.

Conclusions: The thermal and mechanical properties of the composites were enhanced by the addition of CA and CNCs to the PVA polymer matrix. From the group, nanofibers reinforced with CNC showed higher stiffness and storage modulus than CA, demonstrating a superior mechanical reinforcing effect.

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MS1639
Seismic Analysis of RC Structures by the Non-Linear Static Method

Anas Hlim*, Benaissa Kissi and Chafik Guemimi
I2SI2E Laboratory ENSAM Casablanca, University Hassan II, Casablanca, Morocco

Aims: The Presentation aims to evaluate the performance of a building structure (RC) by using the Non-Linear Static method (pushover analysis). The pushover analysis was introduced these last years as an attractive alternative to nonlinear dynamic analysis and realistic compared to conventional seismic calculation techniques.

The aim of this work is to study the seismic response of a building (RC) by the pushover analysis using the code SAP2000 in order to achieve performance and recommendations for future users.

Methods: The method used in this work is the non–linear static method using the code Sap2000, based on Moroccan earthquake regulations.

Results: The results obtained from the plastic analysis of the structures in terms of capacity and failure mechanism give an insight into the actual behavior of the post elastic structure. The determination of the performance point by this method is very useful because it gives a clear idea about the degree of damage of the structure.

Conclusions: Evaluating the performance of the existing buildings designed under the Moroccan seismic code, Gives an idea on the resilience of some of Moroccan building structures to critical earthquakes.

Acknowledgements: the authors express its deep appreciation to the I2SI2E Laboratory, ENSAM CASABLANCA, University Hassan II for supporting this presentation.

MS1689
Asymptotic Theory of Gas Entrainment in a Two-phase Couette Flow

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[2]*State Key Laboratory of Fire Science, University of Science and Technology of China, Hefei, Anhui 230026, China*

Aims: To investigate the behaviour of a two-phase flow in a Couette geometry, in which one plate is stationary and a gas film is entrained over the moving plate.

Methods: An asymptotic theory of the selection of gas film thickness, based on lubrication approximations.

Results: It is found that the gas film thickness relies primarily on the curvature of the meniscus, which represents a balance between the capillary force and gravity. The influence of the plate speed follows the classical 2/3 power law analogous to liquid deposition, with a mild modification from the viscosity ratio of gas to liquid. The relation between gas film thickness and gravity follows different power laws when gravity is negligible or significant. A maximum of the gas film thickness exists when the distance between two plates increases. The viscosity ratio, on the other hand, has only a mild effect when its value is comparable with the gas film thickness.

Conclusions: We have performed a lubrication analysis of the two-phase Couette flow, focusing on the thickness selection of the entrained gas film. An asymptotic relation on thickness is derived through curvature matching, and shows the power law between the thickness and the effects of capillary force, gravity and viscosity ratio. The asymptotic predictions agree well with the exact solutions of the lubrication equation.

Acknowledgements: This work was supported by NSFC (Grant Nos. 11972340, 11672287, 11932019 and 11621202), the Strategic Priority Research Program of the Chinese Academy of Sciences (Grant No. XDB22040103), and the Fundamental Research Funds for the Central Universities.

MS1688

Effects of Particle Clustering and Interface Property on the Large Deformation Behavior of Carbon Black Filled Elastomer

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Aims: The rubber elastomer reinforced with particle filler, such as carbon black (CB), is an important class of composite materials used in engineering applications. However, the strong non-linearity of matrix made very difficult to obtain accurate predictions on its effective properties. So it's of theoretical and practical interest to develop various strategies to model the mechanics and damage behavior in the case of large deformation.

Methods: Firstly, under the framework of finite element analysis, a series of numerical RVE models made up of randomly distributed particles and hyper-elastic rubber matrix have been established, based on the feature of CB morphology within this industrial material. Secondly, the simulations taking into account the composite microstructure, the large deformation and the damage by interface decohesion are carried out.

Results: Mechanical simulations show that particle clustering has little influence on the effective stiffness and overall stress-strain response of the filled hyper-elastic composite. But it tends to make the stress concentration and strain amplification phenomenon more severe. On another hand, the influence of interface strength is significant on material. The agglomerate distribution of CB filler usually induces interface decohesion earlier.

Conclusions: Using these novel computational models, the effects of particle clustering and interface property on the tensile behavior of rubber composite and on the failure mechanism during its dominant deformation are investigated. It is helpful to enhance our understanding on multiscale characteristics of the particle filled elastomer.

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MS1693
Photocatalytic Activity Enhancement: A New Vision

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Abstract. Semiconductor photocatalysis has received much attention as a potential solution to the worldwide energy shortage and counteracting environmental degradation. The role of photocatalysis is to initiate or accelerate specific reduction and oxidation (redox) reactions in the presence of irradiated semiconductors. This reaction occurs when the energy of the incident photons matches or exceeds the bandgap. The potential applications of photocatalysis are found mainly in the following fields: (i) photolysis of water to yield hydrogen fuel; (ii) photo-decomposition or photo-oxidization of hazardous substances; (iii) artificial photosynthesis. Significant progress has been made in the development of novel nanomaterials in recent years.

Nevertheless, the efficiency of nanomaterials, especially in solar photocatalysis, must be improved to meet engineering requirements. Therefore, another critical issue influencing the photocatalytic capability will be discussed in present work, like surface/interface chemistry. The surface energy, chemisorption properties play crucial roles in the transfer of electrons, the energy between substances at the interface, in governing the selectivity, carrier density of the electrons, and in determining the susceptibility of the photocatalyst toward photo-corrosion.

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MS1660

Investigation on Thermal & Mechanical Behavior of Hybrid Metal Matrix Composites by Experimental and Computational Approaches

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Abstract. The development of Aluminium Matrix Composites (AMCs) has been a major transformation in the technology of materials. Aluminium matrix composites have evoked an intense curiosity for potential applications in aerospace and automotive industries owing to their high strength-to-weight ratio and desirable thermal properties. One of the major advantages of Aluminium-Silicon Carbide-Graphite hybrid composites is that they have dual characteristics of self lubricating effect of the reinforcement of Graphite and improved strength of the Silicon Carbide ceramic phase. Persistent efforts are being made by the researchers to fabricate Aluminium-Silicon Carbide-Graphite composites and investigate the salient thermal characteristics.

In the present scenario, Aluminium matrix composites have been given greater emphasis. Aluminium matrix composites with two or more reinforcements have become admired amongst researchers. Many experimental investigations have been carried out pertaining to thermal characterization of Aluminium Silicon Carbide composites but, limited work has been accomplished on Aluminium-Silicon Carbide-Graphite hybrid composites. It has been established that, the inclusion of Graphite reinforcement to Aluminium Silicon Carbide composites enhances self lubricating properties.

Microstructural analysis of hybrid metal matrix composites by employing Optical Microscope, Scanning Electron Microscope and Energy Dispersive X-ray Spectroscopy for the examination of morphology, formation of grain boundaries, interdendritic segregation, dispersoid distribution of the reinforcements, porosity, particle size and elemental compositions. The microstructural analyses carried out on hybrid metal matrix composites with equal percentage reinforcements by employing optical microscope have revealed the formation of grain boundaries and interdendritic segregation. The microstructures illustrate that, the Silicon Carbide and Graphite reinforcements have been dispersed along the grain boundary in the matrix Aluminium. The distribution of the particulates of Silicon Carbide and Graphite has been homogeneous with no parallel striations and deleterious pores. The uniform distribution of the reinforcements has led to the continuous dispersion along the grain boundary. From the surface morphological studies, it appears that cohesive interfacial bonding has been accomplished between the matrix alloy and reinforcements. Also, due to constant stirring, the dispersoid concentration of the reinforcements is found to be uniform with minimum porosity and without any clustering. The elemental compositions of the hybrid MMCs have been characterized by using energy dispersive x-ray spectroscope.

The thermal conductivity of hybrid composites essentially depends on the particle or grain sizes of Silicon Carbide (average particle size of around 15 to 25 microns) and Graphite (average particle size of around 60 to 70 microns) reinforcements, where interfacial thermal resistance has a strong influence in comprehending the effect of thermal conductivity behavior of composites. The emphases have been given for the determination of thermal properties viz., specific heat capacity, thermal diffusivity, thermal conductivity and coefficient of thermal expansion by employing prominent thermal analyzers.

The experimental investigations carried out by him on hybrid metal matrix composites by maintaining equal proportions of Silicon Carbide and Graphite reinforcements viz., 2.5%, 5%, 7.5% and 10%. The thermo-elastic models for the validation of thermal expansion and thermal conductivity behavior of hybrid metal matrix composites have been carried out.

Computational thermal analyses of composite materials based on finite element analysis have also been given prominence. The main objectives in carrying out computational thermal analysis are to determine the temperature and heat distribution on the prominent nodes in both the matrix and reinforcements. Computational or numerical investigation have been carried out for the computation of thermal properties viz., thermal displacement, thermal strain, thermal stresses, thermal gradient, thermal flux and rate of heat flow by the use of commercially available CFD package ANSYS 12.1. Computational contour plots have been depicted to demonstrate the different distribution patterns.
It can be observed from the experimental results that the thermal properties viz., specific heat capacities, thermal conductivities and thermal expansivities of the hybrid composites tend to increase with increase in chosen range of temperature, for each of the combinations having equal proportions of Silicon Carbide and Graphite reinforcements viz., 2.5%, 5%, 7.5% and 10%. Analogously the computational thermal properties viz., thermal displacement, thermal strain, thermal stresses, thermal flux and rate of heat flow increase with increase in temperature for each of the combinations having equal proportions of Silicon Carbide and Graphite reinforcements. The experimental and computational results that have been obtained agree well with the available literature.

It has been established from the literature that, the addition of Silicon Carbide with matrix Aluminium drastically increases the thermal properties viz., specific heat capacity, thermal conductivity and thermal expansivity with the increase in temperature. But in this research work, the effect of adding Graphite as reinforcement with Aluminium Silicon Carbide composites does not show substantial variation in thermal properties due to the self lubricating property of Graphite and eventually these thermal properties seem to be unaffected. The percentage decrease in specific heat capacity, thermal conductivity and thermal expansivity of Aluminium-Silicon Carbide-Graphite hybrid composites is about 3% to 5% for the chosen range of temperature. Also, adding Graphite with Aluminium Silicon Carbide composites depicted that, there has been very marginal decrease in these thermal properties at 3000C having equal percentage compositions of Silicon Carbide and Graphite reinforcements. Aluminium Graphite composites possess a desirable combination of thermal properties to make it an ideal solution for thermal management problems and the use of the particulates of Graphite with Aluminium alloys will improve sliding wear and seizure resistance in automotive components.

MS1658

Usefulness of Slope Linear Regression Through the Data Points for Enhancement of Discussion of Results: The Case of Fluid Dynamics

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Abstract: Enhancement of the discussion of results can be referred to as one of the essential yardsticks, leading to the understanding of research outputs in fluid dynamics and other research areas. Besides, is it possible to use a number to quantify an observed increase or decrease of a particular parameter on the transport phenomenon? It is worth noting that there are thousands of published facts within the scope of boundary layer analysis and heat and mass transfer, a division in fluid dynamics without a single meta-analysis. However, there exists no meta-analysis due to the unavailability of a technique and approach. This report shows that a Microsoft Excel Package helps to quantify the observed effects of buoyancy parameter, thermophoresis parameter, and Brownian motion of particles. Scrutinization of the effects of Grashof number on the flow of different fluids driven by convection over various surfaces (https://doi.org/10.1016/j.molliq.2017.11.042), a meta-analysis on the effects of the haphazard motion of tiny/nano-sized particles on the physical properties of some fluids (https://doi.org/10.1016/j.cjph.2019.06.007), and meta-analysis on thermo-migration of tiny/nano-sized particles in the motion of various fluids (https://doi.org/10.1016/j.cjph.2019.12.002) are further deliberated upon and explored.

Keywords: Fluid dynamics, Boundary layer analysis, Meta-Analysis, Enhancement of results.

AMS 2010 Classification: 76Dxx, 76Vxx, 80A32, 76Rxx

Oral Session 2: Computational Methods, Modeling, and Numerical Simulation

Time: 08:30-13:05, August 18, 2021. China Standard Time (GMT+8)
Session Chair: Dr. Naved Akhtar, Department of Applied Sciences and Humanities, Jamia Millia Islamia, India
Session Chair: Dr. Saurabh Kumar Gupta, Raj Kumar Goel Institute of Technology, India
Session Room Link: http://www.academicconf.com/teamslink?confname=msam2021

08:30-08:45	**MS1608**	Simplified Analytical Solution for Tapered Circular Elements on Homogeneous or Non-homogeneous Soil *Dr. Carlos A. Vega-Posada, Department of Civil and Environmental Engineering, University of Antioquia, Colombia*
08:45-09:00	**MS1594**	Elasto-thermoviscoplastic Finite Element Analyses of Cold Upsetting and Forging Processes with An Emphasis on Dynamic Strain Aging *Mr. Mohd Kaswandee Razali, Graduate School of Mechanical and Aerospace Engineering, Gyeongsang National University (GNU), South Korea*
09:00-09:15	**MS1618**	COMSOL Fluid Simulation Analysis of An Industrial-scale Electroforming Tank *Mr. Chen Minghao, School of Civil Engineering, Sun Yat-Sen University, China*
09:15-09:30	**MS1631**	Numerical Analysis Based on Numerical Viscosity/Implicit Large-Eddy Simulation for Steady Turbulence with Reynolds Number Dependency *Mr. Naoyuki Iwata, Graduate School of Sciences and Technology for Innovation, Yamaguchi University, Japan*
09:30-09:45	**MS1628**	Loading and Unloading of Rigid Spheres and Elastic-Plastic Flat *PhD Yanbin Zheng, Department of Engineering Mechanics, SVL, Xi'an Jiaotong University, China*
09:45-10:00	**MS1595**	Flow Stress Characterization of Magnesium Alloys at the Elevated Temperature: A Review *Mr. Jae Dong Yoo, MFRC, Research Center, South Korea*
10:00-10:15	**MS1632**	Numerical Examination on the Effects of Spatial Resolution Anisotropy for Viscous Terms Using Isotropic Steady Turbulence *Mr. Riku Hirabayashi, Graduate School of Sciences and Technology for Innovation, Yamaguchi University, Japan*
10:15-10:30	**MS1633**	Numerical Analysis on the Effects of the Conservation Error of Kinetic Energy on Unsteady/Steady Isotropic Turbulence *Mr. Shinnosuke Nakamura, Graduate School of Sciences and Technology for Innovation, Yamaguchi University, Japan*
10:30-10:40		**BREAK**

10:40-10:55	**MS1625**	A Weak Form Time Quadrature Element Formulation for Mathieu's Equation *Mr. Junning Qin, Department of Civil Engineering, Tsinghua University, China*
10:55-11:10	**MS1696**	Mathematical Modelling for Multiple Straight Cracks with Coalesced Yield Zones *Dr. Naved Akhtar, Department of Applied Sciences and Humanities, Jamia Millia Islamia, India*
11:10-11:25	**MS1691**	Models of Failure and Phase Transitions in Strong Ceramics under Intense Shock Loading *Dr. Sergey Dyachkov, Dukhov Research Institue of Automatics, Russia*
11:25-11:40	**MS1686**	Structural Stiffness Through Generalized Conics *Dr. Tamás Baranyai, Budapest University of Technology and Economics, Hungary*
11:40-11:55	**MS1680**	Fuzzy Expert System for Prediction of Properties Friction Stir Welded Dissimilar Aluminum Alloys *Dr. Saurabh Kumar Gupta, Mechanical Engineering Department, Raj Kumar Goel Institute of Technology, India*
11:55-12:10	**MS1647**	Study on the Dynamic Response of Concrete Filled Steel Tubular Long Column under Axial Impact by Rigid-Body *Ms. Huidi Zhang, Department of Civil Engineering, China Agricultural University, China*
12:10-12:25	**MS1635**	Progressive Collapse Analysis of Steel Structures Under Abnormal Loads *Ms. Hanaa Maimouni, University Hassan 2 of Casablanca, National Higher School of Arts and Crafts of Casablanca (ENSAM), Morocco*
12:25-12:50	**MS1700**	Experimental and Numerical Studies on the Structural Performance of Composite Aluminium-Concrete Members *Dr. Michaela Gkantou, School of Civil Engineering and Built Environment, Liverpool John Moores University, United Kingdom*
12:50-13:05	**MS1695**	Numerical Modelling of Laterally Loaded Piles and Anchors to Support the Old Structure and Stabilize the Slope *Mr. Muhammad Rehan, Mehran University of Engineering and Technology, Pakistan*

Abstracts of Session 2

MS1608

Simplified Analytical Solution for Tapered Circular Elements on Homogeneous or Non-homogeneous Soil

***** This abstract will be available after the full paper is published.

MS1594

Elasto-thermoviscoplastic Finite Element Analyses of Cold Upsetting and Forging Processes with An Emphasis on Dynamic Strain Aging

***** This abstract will be available after the full paper is published.

MS1618

COMSOL Fluid Simulation Analysis of An Industrial-scale Electroforming Tank

Minghao Chen [1,*] and Qiwen Li [2]

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[2]*School of Intelligent System Science and Engineering/JNU-Industry School of Artificial Intelligence, Jinan University, Jinan University, No.206, Qianshan Road, Zhuhai City, Guangdong Province, China*

Abstract. Electroforming, which applies electrochemistry to build a micro-structure layer by layer on the surface of nickel clad, has been successfully used in the production of inkjet printer, micro-reactor, and capsule endoscope. However, society's current understanding of the electroforming efficiency and quality is based on empirical data, and academic engagement in this field has been limited, which hinders the development of the electroforming industry. The process of electroforming is usually carried out in an electroforming tank, which is already widely used in the industry. Recently, an innovative design of electroforming tank, whose working volume is twice as that of the traditional electroforming tank while maintaining the same electroforming quality, is invented. In this paper, the effects of electrolyte convection on the flow field and the variation of nickel ion concentration distribution in the inner tank structure have been investigated on the COMSOL® Multiphysics software. First, 3-D modeling and CFD method are used to simulate the data including the velocity and the flow direction, and several different parameters are tested and compared as well. Based on the temperature state of electrolyte liquid, fluid flow type, material transfer, temperature transfer and other constraints, the mathematical model is established. With the change of parameters in different scenarios, the distribution of pressure, temperature change and velocity change are analyzed, and the efficiency figures are given. Second, in order to understand the influence of the size of the hole diameter and the number of holes on the liquid flow state in the tank, the fluid dynamics simulation of the pipeline with different diameter and number of holes is carried out to analyze the pressure and flow change at the pipeline. The simulation results are compared with the experimental data, which suggests that the model can simulate the whole electroforming process correctly. Besides, the results show that when the parameters of the hole are different, the magnitude and direction of the steady-state fluid force on the spot are different, and the velocity of the fluid will also be affected. This study can also be used to guide the further structural optimization design for the industrial-scale electroforming tank.

MS1631

Numerical Analysis Based on Numerical Viscosity/Implicit Large-Eddy Simulation for Steady Turbulence with Reynolds Number Dependency

***** This abstract will be available after the full paper is published.

MS1628

Loading and Unloading of Rigid Spheres and Elastic-Plastic Flat

Yanbin Zheng, Tong Liang , Xuanming Liang and Gangfeng Wang*
Department of Engineering Mechanics, SVL, Xi'an Jiaotong University, Xi'an 710049, China

Aims: This study will solve the problem of loading and unloading of rigid sphere and elastoplastic flat (indentation models). The results will be compared with the results of loading and unloading of elastoplastic sphere and rigid flat (flattening models).

Methods: Numerical results were obtained after solving the loading and unloading problems of the rigid sphere and the elastoplastic flat through finite element. Then, a dimensionless analytical formula of the contact load and area during the loading and unloading process was got after fitting the previous numerical results, during which the Mises yield criterion was employed to solve the critical indentation depth.

Results: The indentation models in this study proposed that, during the loading process, when the indentation depth is below the critical indentation depth, the changes in force and area are consistent with the Hertz conclusion and flattening models since only elastic deformation occurs. However, when the indentation depth is greater than the critical indentation depth (in plastic stage), the contact load and area corresponding to the same indentation depth in the indentation models are greater than the values in the flattening models. The obvious difference of indentation models and flattening models is that, at the beginning of the unloading, the former postulate that the area corresponding to the same indentation depth during unloading is larger than that during loading, while the latter claims the opposite result.

Conclusions: Under the condition of pure elasticity, contact response of the indentation models and the flattening models are consistent. In terms of the condition of elastic-plasticity, however, the results obtained by the two models are different.

Acknowledgements: Supports from the National Natural Science Foundation of China (Grant No. 11525209) are acknowledged.

MS1595

Flow Stress Characterization of Magnesium Alloys at the Elevated Temperature: A Review

***** This abstract will be available after the full paper is published.

MS1632

Numerical Examination on the Effects of Spatial Resolution Anisotropy for Viscous Terms Using Isotropic Steady Turbulence

***** This abstract will be available after the full paper is published.

MS1633

Numerical Analysis on the Effects of the Conservation Error of Kinetic Energy on Unsteady/Steady Isotropic Turbulence

***** This abstract will be available after the full paper is published.

MS1625

A Weak Form Time Quadrature Element Formulation for Mathieu's Equation

Junning Qin and Hongzhi Zhong*
Department of Civil Engineering, Tsinghua University, China

Aims: This paper aims to propose a weak form time quadrature element formulation for solving the Mathieu's equation which commonly occurs in nonlinear vibration systems.

Methods: The weak form quadrature element method developed by Zhong et al has been applied to various problems. It combines the numerical integration and numerical differentiation at the same set of quadrature points, leading to high accuracy with minimal computational effort. An attempt is made in this paper to apply the weak form quadrature element method to the solution of Mathieu's equation. Radau quadrature and the generalized differential quadrature analog are chosen to turn the weak form of Mathieu's equation into a set of equations. The whole time interval can be divided into several time quadrature elements and a time-marching technique is applied to obtain the overall responses.

Results: Numerical results show that the weak form time quadrature element formulation enjoys high accuracy and efficiency compared to other time integration schemes like the Kim-Lee method.

Conclusions: The weak form quadrature element method has been first applied to the solution of Mathieu's equation. Comparison is made with the results of the Kim-Lee method, indicating that the present formulation can offer highly accurate predictions. Division of a long time domain into time quadrature elements of moderate size is an effective way to increase the computational efficiency of the present formulation.

Acknowledgements: This work is supported by grants from the National Natural Science Foundation of China (No.51378294).

MS1696
Mathematical Modelling for Multiple Straight Cracks with Coalesced Yield Zones

Naved Akhtar[1,*], S. Hasan[2] and S. Shekhar[2]
[1]*Department of Applied Sciences and Humanities, Jamia Millia Islamia, New Delhi-110 025, India*
[2]*Department of Mathematics, Jamia Millia Islamia, New Delhi-110 025, India*

Aims: The aim of the current work is to obtain the load carrying capacity, yield zone length and Crack tip opening displacement (CTOD's) of an infinite isotropic elastic-perfectly plastic plate containing five collinear straight cracks with coalesced yield zones under normal loading conditions.

Methods: Dugdale strip yield model and Complex variable method proposed by Muskhelishvili (1963) have been used.

Results: Load carrying capacity of an infinite isotropic elastic-perfectly plastic plate containing five collinear straight cracks with coalesced yield zones as a function of yield zone length are obtained analytically and the Crack tip opening displacement (CTOD's) are also calculated at each crack tips.

Conclusions: On the basis of numerical study carried out in the paper following conclusion have been made.

- Length of yield zones are almost same at each crack tips when inter crack distance is large, whilst the bigger yield zones are developed at inner crack tips in comparison to outer crack tip.
- For a fixed yield zone size, load carrying capacity of outer crack tip is higher in comparison to that at inner crack tips.
- Furthermore, the unified yield zone makes a significant effect on the load bearing capacity of the plate. Also, when the size of unified yield zone increases the bearing capacity of the plate also increases.

MS1691
Models of Failure and Phase Transitions in Strong Ceramics under Intense Shock Loading

Sergey Dyachkov
Dukhov Research Institute of Automatics, 127055, Moscow, Russia

Abstract. Ceramic materials are widely used in industry, and high quality models are demanded by users of modern computational fluid dynamics software. Strong ceramics such as boron carbide, silicon carbide, and aluminum nitride experience failure (local structural transformations which significantly reduce material strength) during shock compression and tensile stresses. Such behavior complicates the development of an adequate model for them. Moreover, high velocity impact may also induce polymorphic phase transitions in these materials. The improved and adjusted failure model for ceramics is developed on the basis of earlier works of Johnson and Holmquist with using new experimental data on the velocity of LiF/ceramics interfaces measurements in plate impact tests. The developed model allows to take into account all kinds of transformations in a particular simulation, thus providing correct wave structure within the bulk of materials. The model reveals an interesting

structure of failure bands in ceramics which may be related to ones observed in ballistic experiments. It was also found that strength limit in the failed state of material may vary as a result of different manufacturing of ceramics samples.

Keywords: Fluid dynamics, Brittle failure, Ceramics, Shock waves, Phase transitions, Strength models.

MS1686
Structural Stiffness Through Generalized Conics

Tamás Baranyai
Budapest University of Technology and Economics, Hungary

Aims: The goal is to find the transformation rules for projective transformations of mechanical problems, along with the limits of their applicability. The transformations are to preserve static equilibrium, kinematical compatibility and compatibility of forces and displacements. This would complement the current civil engineering use of transformations for structural optimization.

Methods: Infinitesimal displacements are identified with points, while forces with hyperplanes of projective space. Structural members are identified with conics. This way the known transformation rules of these geometric objects can be naturally extended to mechanical quantities. In case of 2 dimensional mechanical problems these objects will live in the projective plane. In case of 3 dimensional problems the Klein Correspondence of projective lines is used to relate 3-dimensional line geometry to the 5-dimensional projective space associated the 6-dimensional vector space of the mechanical quantities.

Results: The transformation rules are presented, along with the property that the positivity of the own work of a force is a projective invariant. Fully supported straight, uniform, rods stay straight uniform under similarity transformations.

Conclusions: The geometric approach to classical mechanics starting from Plücker can be extended with stiffness relations of the structures, in a way that naturally incorporates projective transformations of the problems.

Acknowledgements: The work has been supported by the ÚNKP-20-4 New National Excellence Program of the Ministry for Innovation and Technology from the source of the National Research, Development and Innovation Fund.

MS1680

Fuzzy Expert System for Prediction of Properties Friction Stir Welded Dissimilar Aluminum Alloys

Saurabh Kumar Gupta
Mechanical Engineering Department, Raj Kumar Goel Institute of Technology Ghaziabad, 201003 India

Abstract. Defect free joining of aluminum alloys is very difficult task to a welding engineer using conventional welding processes. Friction Stir Welding (FSW) has been established as one of the most promising technique for defect free joining. The aim of this research is to develop the fuzzy expert system for prediction of quality characteristics of FS welded joints of aluminum alloys. A fuzzy logic has been used for predicting the quality characteristics of welded joints. The predicted results of quality characteristics have been compared with experimental results and found suitable.

Keywords: Friction stir welding, Aluminum alloy, Fuzzy logic.

MS1647 Study on the Dynamic Response of Concrete Filled Steel Tubular Long Column under Axial Impact by Rigid-Body

***** This abstract will be available after the full paper is published.

MS1635

Progressive Collapse Analysis of Steel Structures Under Abnormal Loads

Maimouni Hanaa*, Benaissa Kissi and Hamza Khatib
Faculty Benmsik of Science, University Hassan 2 of Casablanca, National Higher School of Arts and Crafts of Casablanca (ENSAM), Morocco

Aims: The following study aims for studying the progressive collapse of steel structures due to extreme loading. Particularly the analytical aspect of the structural analysis in order to prevent catastrophic failure of buildings by predicting the behavior of the latter in the plastic limit state, as well as finding practical solutions to reinforce the structure resistance to local damages caused by the abnormal loading.

Methods: The method used to achieve the wanted results includes the structural analysis using force-deformation and Euler load incremental models, Euler-Lagrange energy functional, and ANSYS modelling so as to conclude the overall parameters of the analysis. The study of the structural responses takes into consideration geometric and material nonlinearities and axial/flexural/shear deformations, this by investigating the three types of localized damage modes in order to identify different damage scenarios for the structure.

Results: The analysis method conducted during the following study fully traces the progressive collapse during the change noticed in the topology of the structure, same goes for the inelastic analysis

procedure involving axial, flexural, and shear deformations, which effectively simulates the inelastic behavior of steel building. The results show the major effect that have connexion damage and shear failure of elements due to debris loading on progressive collapse.

Conclusions: The proposed analysis is an effective tool, however, many research areas and developments are still required in future works concerning progressive collapse analysis such as special structural analysis, dynamic analysis, experimental study based on the proposed model, and risk and reliability analysis.

Acknowledgements: I would like to acknowledge the enthusiastic supervision of professors Benaissa Kissi, Hamza Khatib, and Ahmed Mouchtachi and their insightful remarks and guidance, as well as every institutional member who helped closely or from afar in the achievement of the following study.

MS1700

Experimental and Numerical Studies on the Structural Performance of Composite Aluminium-Concrete Members

Michaela Gkantou
School of Civil Engineering and Built Environment, Liverpool John Moores University, United Kingdom

Abstract. The use of aluminium alloys as a structural material has recently increased because of their advantageous properties such as high strength-to-weight ratio and corrosion resistance. However, due to their low Modulus of Elasticity, instability is a major concern for aluminium alloy structural members subjected to compression. One of the ways to improve the performance of aluminium alloy hollow sections on this count is to have concrete infill within them. Past research studies have demonstrated the potential of these members but research remains limited. An experimental and numerical programme is currently ongoing in Liverpool John Moores University with the aim to provide design guidelines for concrete-filled aluminium alloy tubular columns.

Oral Session 3: Material Properties and Miscellaneous Problems

Time: 14:00-18:10, August 18, 2021. China Standard Time (GMT+8)

Session Chair: Dr. Mohamed ElFawakhry, Central Metallurgical Research and Development Institute (CMRDI), Egypt

Session Room Link: http://www.academicconf.com/teamslink?confname=msam2021

14:00-14:25	**MS1644**	Transport Mechanisms and Metal-Insulator Transition of Lead-Yttrium Ruthenate Pyrochlores *Dr. Sepideh Akhbarifar, The Catholic University of America, Vitreous State Laboratory and Department of Physics, USA*
14:25-14:50	**MS1697**	On Fatigue Life Scatter under Variable Amplitude Load History *Prof. Liyang Xie, Northeastern University, China*
14:50-15:05	**MS1679**	Tuned Third-Order Nonlinear Optical Properties of QDs Nanocomposites *PhD Ali Fetemi, Department of Physics, Faculty of Sciences, Azarbaijan Shahid Madani University, Iran*
15:05-15:20	**MS1603**	Local Topotactic Micro and Nanotransformation between Perovskite and Brownmillerite $SrFeO_{3-d}$ *Dr. Elias Ferreiro Vila, Centro de Investigación en Química Biolóxica e Materiais Moleculares (CIQUS), Universidade de Santiago de Compostela (USC), Spain*
15:20-15:45	**MS1673**	Contemporary Challenges of Mechanics of Materials and Structural Components *Dr. Tadeusz Szymczak, ITS – Motor Transport Institute, Poland*
15:45-16:00	**MS1604**	Joining of Alumina Ceramics by Conventional and Microwave Brazing *Dr. Sumana Ghosh, Bio-ceramics and Coating Division, CSIR-Central Glass and Ceramic Research Institute (CSIR-CGCRI), India*
16:00-16:15	**MS1685**	Improved Mechanical Properties Natural Polymeric Scaffolds Using Modified Glass-Flake Nanoparticles *Dr. Mojdeh Mohseni, Radiation Biology Research Center, Iran University of Medical Sciences, Iran*
16:15-16:30	**MS1622**	Assistive Health Care through Flexible Robotic System: Indigenous Firmware Using Compliant and Low Density Composite Materials *Dr. Debanik Roy, Division of Remote Handling & Robotics, Bhabha Atomic Research Centre, Department of Atomic Energy (DAE), India*
16:60-16:40		**BREAK**
16:40-16:55	**MS1701**	Application Potential of Treated Coir Geotextiles in Unpaved Roads *Dr. Vivek, Department of Civil Engineering, Jawaharlal Nehru Government Engineering College, India*

16:55-17:10	**MS1694**	Performance Evaluation of Nanofluid Enriched with Activated Carbon in Modified Jatropha Oil for Minimum Quantity Lubrication Turning *Dr. Norfazillah Talib, Faculty of Mechanical and Manufacturing Engineering, Universiti Tun Hussein Onn Malaysia, Malaysia*
17:10-17:25	**MS1672**	Recycling of Ceramic Tiles and Marble Powder Waste in Concrete Production *Dr. Sajjad Ali, Mehran University of Engineering & Technology, Pakistan*
17:25-17:40	**MS1616**	Recycling Poly(butylene Terephthalate) and Polypropylene (R-PBT/PP) blend *Dr. Nga Thi-Hong Pham, Mechanical Engineering Faculty, HCMC University of Technology and Education, Vietnam*
17:40-17:55	**MS1704**	Applicability of 2024 Aluminum Alloys TBC System in High Temperature Environments *Dr. Dipak Kumar, Mechanical Engineering Department, Raj Kumar Goel Institute of Technology, India*
17:55-18:10	**MS1646**	Ceramic Metal Composite Approach for Advanced Hadfield Steel *Assoc. Prof. Mohamed ElFawakhry, Central Metallurgical Research and Development Institute (CMRDI), Egypt*

Abstracts of Session 3

MS1644

Transport Mechanisms and Metal-Insulator Transition of Lead-Yttrium Ruthenate Pyrochlores

Sepideh Akhbarifar

The Catholic University of America, Vitreous State Laboratory and Department of Physics, Washington, D.C, United States of America

Aims: Find and understand the metal-to-insulator transition (MIT) in these ceramics. Use of quantum physical models a) to identify and understand the scattering mechanisms underlying electrical (σ) and thermal conductivity (κ) in lead-yttrium ruthenate pyrochlore solid solutions; b) understand the temperature dependence of the Seebeck coefficient (S)

Methods: All materials were synthesized by solid state reaction at high temperature. Thermoelectric properties were measured from 25 to 300ºC.

Results: At 0.2 moles of yttrium (Y) a metal-insulator transition was discovered, which is explained by the Mott-Hubbard model. $S(T)$ is discussed in terms of the effect of minority carrier excitation at lower- and a broadening of the Fermi distribution at higher temperatures. $\kappa(T)$ showed glass-like behavior in these crystalline pyrochlores. On the metallic side (<0.2 moles Y) 'electron impurity scattering' prevailed. On the semiconductor/insulator side between 0.2 and 1.0 moles Y several mechanisms were equally likely. At higher Y concentrations the Mott Variable Range Hopping mechanism was active.

Conclusions: The hitherto unknown thermoelectric properties of lead-yttrium ruthenate pyrochlores were measured, a metal-insulator transition was found, and all properties were explained using quantum-physical models.

Acknowledgements: The author thanks Drs. Werner Lutze, Nicholas A. Mecholsky, David McKeowan, Marek Brandys, Ian Pegg for contributions and discussions.

MS1697

On Fatigue Life Scatter under Variable Amplitude Load History

***** This abstract will be available after the full paper is published.

MS1679

Tuned Third-Order Nonlinear Optical Properties of QDs Nanocomposites

Seyedali Fatemi[1,*], Milad Rasouli[2], Mahmood Ghoranneviss[3] and Davoud Dorranian[4]
[1]*Department of Physics, Faculty of Sciences, Azarbaijan Shahid Madani University, Tabriz, Iran*
[2]*Department of Physics and Institute for Plasma Research, Khrazmi University, Tehran, Iran*
[3]*Plasma Physics Research Center, Science and Research Branch, Islamic Azad University, Tehran, Iran*
[4]*Laser Lab, Plasma Physics Research Center, Science and Research Branch, Islamic Azad University, Tehran, Iran*

Aims: Ability to tuning the nonlinear optical properties under varying material make us capable to designing optoelectronics, LEDs, and opto-switch devices.

Methods: Synthesis of CdS, CuS and, Ag_2S were done in the presence of PVA as polymer stabilizer by chemical bath way. The morphological studies followed by XRD (x-ray diffraction) and AFM (atomic force microscopy). Nonlinear optical properties including nonlinear refractive index and nonlinear absorption of synthesized QDs measured by Z-scan technique under 632.8 nm wavelength He_Ne CW laser.

Results: The bandgap of samples was measured using absorption data is 4.3, 5.1 and, 5.2 (eV) for CdS, Ag_2S and, CuS bandgap respectively, PVA/Ag_2S nanoparticles displayed reverse saturable absorber (RSA) and self-defocusing while PVA/CdS and PVA/CdS displayed saturable absorber and self-focusing behavior under the same condition.

Conclusions: Collectively, nonlinear optical properties of polymer base nanoparticles studied under varying nanocomposite metal variation. In the case of using silver nanoparticles, RSA behavior switched under the same experimental condition.

MS1603

Local Topotactic Micro and Nanotransformation between Perovskite and Brownmillerite $SrFeO_{3-d}$

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Abstract. Reversible crystallographic transformation between perovskite (PV) ABO_{3-d} and brownmillerite (BM) $ABO_{2.5}$ (A=Ca^{2+}, Sr^{2+}; B=$Fe^{4+/3+}$, $Co^{4+/3+}$) oxides can be induced by topotactic

oxygen exchange at moderate-high temperatures on the presence of reducing/oxidizing agents or using different electrochemical configurations. This is possible by a combination of large oxide-ion conductivity in these structures, and a small free energy difference between (4+/3+) redox pairs of many 3*d* transition metal ions. Here we demonstrate the room temperature topotactic transformation between PV $SrFeO_{3-d}$ and BM $SrFeO_{2.5}$ induced either by the electric field of an Atomic Force Microscopy (AFM) tip or low dose focused ion radiation (FIB). Charged oxygen vacancies in the PV can be manipulated with nano size resolution, creating accumulation regions where they spontaneously rearrange to produce the BM phase. The stability provided by the change in the crystallographic transformation reduces the oxygen diffusion once the electric field and ion radiation are removed (high retention of on/off states). This allows the local control of the chemical, electrical and magnetic properties, with very high spatial resolution. Our results open the door to the fabrication of stable ionic-based devices which imply local crystallographic transformations.

MS1673
Contemporary Challenges of Mechanics of Materials and Structural Components

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Aim: To focus an attention on the selected contemporary approaches for investigations either materials or structural components with special emphasis on their joining.

Methods: Digital Image Correlation (DIC) technique, enabling analysis of deformation maps variations in materials containing artificial stress concentrators, was used to capture data representing their mechanical properties evolution up to the fracture.

A quality of the welded joints (made of High Strength Steel) was determined based on the results of fracture toughness and fatigue tests. Such experimental program enabled, respectively, an identification of the CTOD parameter for each zone of the welding joint and determination of the Wöhler diagram. The characteristic features of fracture regions from both types of mechanical tests were additionally captured using macro-photography.

Mutual reactions between the selected components of the Rear Underrun Protective Device (RUPD) under loading conditions were observed by means of DIC system (PONTOS 5M). It enables determination of vectors reflecting a deflection parameters of the components in the three-dimensional coordinate system (3D).

Results: In the case of tests carried out on specimens containing notches, the deformation field distributions and their mutual interactions until decohesion were determined. The differences in behaviour between material with and without notches were represented by a change in the yield stress values only.

The CTOD parameter values of the parent material, heat affected zone and weld were equal to 0.268

mm, 0.220 mm, 0.386 mm, respectively, thus indicating differences in the fracture toughness of the zones. The dominant feature of the parent material fracture can be characterised by the longitudinal cracks. In the case of HAZ, the number of longitudinal cracks was reduced due to welding, while in the weld zone such form of defects entirely vanished.

The results of the fatigue tests showed a high sensitivity of the weld to the cyclic loading. It is well reflected by the line of limited fatigue strength within the stress range from 650 MPa to 125 MPa, and moreover, for the relatively low value of the fatigue limit (100 MPa).

The results of the stand tests showed significant differences in the RUPD behaviour depending on the area position tested. Thanks to them, an occurrence of the plateau effect in the force course was easily identified.

Conclusions: Database for the material and components subjected to loading can be efficiently captured using DIC method.

Thanks to the selected features of DIC, such as the possibility of using different sizes of the measuring points for example, it can be used in the study of components of various shapes and dimensions.

Application of the welding joints between components built with the use of modern materials into engineering practice should be decided on the basis of comprehensive mechanical tests, definitely including tests for the fatigue life and fracture toughness determination.

MS1604
Joining of Alumina Ceramics by Conventional and Microwave Brazing

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Aims: The objective of the present study is to compare the performance of alumina-alumina joints fabricated by microwave-assisted brazing method with the similar joint formed by conventional brazing method.

Methods: Alumina was joined with alumina by microwave-assisted and conventional brazing methods using TICUSIL (68.8Ag–26.7Cu–4.5Ti in wt.%) as the brazing alloy at 910^{o}C-960^{o}C for 5-20 min.

Results: X-ray diffraction analysis showed that the Ti-based compounds were formed at the substrate-filler alloy interfaces of the brazed joint as reaction products. The cross-sectional microstructure of the brazed joint observed by scanning electron microscopy showed defect free interfaces. The energy dispersive X-ray analysis determined the elemental compositions at the selective points of the joint cross-section, which supported the X-ray diffraction results. The nanohardness and Young's modulus of the substrate-filler alloy interfaces showed no abrupt change, which suggests consistent joint performance in service. Brazing strength measurement and helium leak test provided the evidence for good alumina-alumina joint formation.

Conclusions: Alumina ceramics were successfully brazed by conventional and microwave-assisted brazing techniques. Gradual transition of microhardness values was observed across the cross-section of the joints indicating reliable performance. Helium leak test indicated good hermiticity for the microwave and conventionally brazed joints. However, it was observed that most reliable performance can be obtained in case of the joint microwave brazed at lower brazing temperature.

Acknowledgements: The present work was financially supported by CSIR, India (Grant no. PSC0101).

MS1685

Improved Mechanical Properties Natural Polymeric Scaffolds Using Modified Glass-Flake Nanoparticles

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Aims: Mechanical properties improvement in the context of tissue engineering scaffolds is considered a chief challenge. Embedding flake-like glass nanoparticles with the approach of surface modification would restrict crack growth and result in increased mechanical behavior. In this study, chitosan-alginate scaffolds containing modified glass-flake nanoparticles were characterized.

Methods: For nanoparticles silanization, Cyclohexane and n- propylamine (98:2) were used as solvent and catalyst respectively and the proportion of silane to nanoparticles was considered 30 wt.%. To produce silanized nanoparticles, the silane (Y-MPS), solvent and catalyst were stirred in a rotatory system at 70 °C for 90 min. To fabricate scaffolds, 0.24 gr of low molecular weight chitosan and 0.16 gr of sodium alginate were dissolved in 10 ml acetic acid, stirred for 10 h at 40 °C, homogenized for 8min, stirred at 250 rpm for 4 h, frozen at -20 °C for 48h and finally, freeze-dried. Different amounts of silanized and unmodified nanoparticles were embedded in scaffolds with the freeze-drying method.

Results: The surface modification of glass-flake nanoparticles was characterized using FTIR, SEM, and TGA analyses. According to TGA data, the degree of grafting was 2.2 wt.% (weight loss between 600-250 °C, attributed to Y-MPS decomposition and absorbance peak at 1720 cm^{-1} indicates the carbonyl group of Y-MPS. Regarding mechanical properties, the more silanized nanoparticles the scaffolds have, the higher young's modulus they will achieve (346 and 446 MPa for scaffolds having 0.01 and 0.03 gr nanoparticles as opposed to 196.43 MPa for pure scaffolds).

Conclusion: In natural polymeric scaffold incorporated with silanized glass-flake nanoparticles dramatically enhanced mechanical features were observed.

MS1622

Assistive Health Care through Flexible Robotic System: Indigenous Firmware Using Compliant and Low Density Composite Materials

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Abstract. The ensemble of Assistive Robotics is slowly emerging as the new front-edge research arena due to its wide-spread applications in health care sector. Although exoskeletons are in use to a limited extent in the field of health care, it has its own limitations so far the design, selection of materials for manufacturing, prototyping & miniaturization are concerned. Patient-centric customized health care is the need of the hour worldwide and research frontiers are also getting negotiated accordingly. One such promising application manifold of Assistive Robotics is the incorporation of multi-degrees-of-freedom flexible robotic system, equipped with a tailor-made mini-gripper. We have postulated a novel application domain for flexible manipulators in health care and social sector that is a path-shift from the traditional usability of the same in space exploration research. In-line with the proposition an indigenous design, modeling and firmware of Patient Assistant Robot (PAR) has been accomplished by us as version 1.0 prototype. The characteristics of PAR v1.0 are identical to that of Flexible Robotic System with multiple links & intercepting joints. Prior to the hardware realization of PAR, our maiden achievement in flexible robotics was with the hardware of a serial-chain multi-degrees-of-freedom flexible robot (SCFR), interfaced with a dexterous miniature gripper.

Keywords: Compliant materiasl, Composite, Flexible robot, Assistive.

MS1701

Application Potential of Treated Coir Geotextiles in Unpaved Roads

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Abstract. Topic presents the application potential of untreated/treated woven/nonwoven coir geotextile in the unpaved roads. The chemicals used for the treatment of the coir geotextiles were p aminophenol, sodium periodate and sodium hydroxide. For this, laboratory monotonic load test was conducted in a test tank for the sand layer overlying clay and the untreated/treated coir geotextiles were placed at the interface under the unsoaked/soaked condition. The results of this topic reveal that the models reinforced with untreated/ treated woven and nonwoven coir geotextiles show the improvement in the bearing capacity beyond a deformation of 9 to 13 mm. Further, models reinforced with untreated/treated woven and non woven coir geotextiles show better improvement in the bearing capacity in the unsoaked condition in comparison to the soaked condition. Untreated/treated woven/nonwoven coir geotextiles when placed at the interface of the sand layer overlying clay can be useful in unpaved roads in improving the bearing capacity especially in those situations where the rut depth is high as the improvement in the bearing capacity was realized up to larger deformation.

MS1694

Performance Evaluation of Nanofluid Enriched with Activated Carbon in Modified Jatropha Oil for Minimum Quantity Lubrication Turning

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Abstract. Crude jatropha oil (CJO) has been known as an environmentally benign metalworking fluid in the machining industry. However, the limitation of CJO is that it has poor thermal-oxidative stability that leads to poor lubrication behaviour. Hereafter, CJO needs to be chemically modified and added with additives to boost its performance. The objective of this study is to evaluate the tribological and machining performances of newly formulated nanofluid for minimum quantity lubrication (MQL) oil. The nanofluid sample was prepared using modified jatropha based oil mixed with various concentration ratios of activated carbon nanoparticles (ranging between 0.01wt.% to 0.05wt.%) and was compared with synthetic ester. Four ball test was carried out according to ASTM D4172. Whilst the orthogonal cutting process was conducted via NC lathe machine on AISI 1045 through MQL method to evaluate the cutting temperature, chip thickness and tool chip contact length. Results show that MJOa2 (MJO+0.025wt.% activated carbon) exhibited the best tribological behaviour by reducing the coefficient of friction and mean wear scar diameter. The best tribological behaviour of MJO2 correlated with excellent machining performances which resulted in lower cutting temperature, chip thickness and tool chip contact length. Thus, MJOa2 exemplified its potential on the lubricant market place which emphasized the element of sustainability.

MS1672

Recycling of Ceramic Tiles and Marble Powder Waste in Concrete Production

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Abstract. Recycling the waste has been one of the most influential aspects affecting global conditions of the world. In the world of Civil Engineering, it serves the purpose of preservation of the natural building materials such as Sand, Stones, etc. Fair amount of work has been done on utilization of the waste such as Fly ash, marble waste, tiles waste, plastic, etc. used as different forms of replacement, provokes the need of work still to be done. So much of the work has been done on wastes available from Marble and Tiles. The combined effect of waste marble powder (M.P) and Ceramic tile waste (CTW) as partial replacement of Cement (10%) and Coarse Aggregates (10%, 20%, 30% respectively) is to be observed and analyzed. The obtained results compared with the conventional cement concrete at 7 and 28 days of Curing. Total 24 cylinders casted and tested for their workability and Compressive strength. The Workability of Concrete with replacement decreased with increasing ratio of replacement as well as its Compressive Strength. The Compressive strength of concrete with replacement is approximately of the same value as that of Conventional Concrete at (10%+10%) partial substitution ratio.

Keywords: Concrete, Marble powder, Ceramic tile waste.

MS1616

Recycling Poly(butylene Terephthalate) and Polypropylene (R-PBT/PP) blend

***** This abstract will be available after the full paper is published.

MS1704

Applicability of 2024 Aluminum Alloys TBC System in High Temperature Environments

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Abstract. Yttria stabilized zirconia (YSZ) thermal barrier coatings (TBCs) are being used on several Al-alloys for automotive applications. Evaluation of TBC coated Al-alloys such as AA 2024 under thermal cycling conditions at temperatures up to 700°C has been reported. In the present study, the microstructural aspects of air plasma sprayed 7% YSZ (7YSZ) coating on alloy AA 2024 has been examined under both isothermal and cyclic loading conditions at 600 and 700°C. The purpose of testing the coated Al-alloy at the above temperatures was to check the ability of 7YSZ coating in providing thermal insulation to this alloy. The extent of cracking in the coating, as observed on the sample surface, increased with increase in cycling temperature. Localized through-thickness cracks were found at the corners of the square-shaped specimens and the extent of such cracking also increased with increase in cycling temperature. The above localized cracking led to rapid delamination of the coating at the sample corners. Under isothermal loading, however, the coating spallation occurred over the entire sample surface, which was unlike the localized spallation observed under thermal cycling.

Keywords: BCs, 2024 aluminum alloys, High temperature, Yttria Stabilized Zirconia (YSZ)

MS1646

Ceramic Metal Composite Approach for Advanced Hadfield Steel

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Abstract. This work is aiming at attaining the highest wear abrasion resistance of Hadfield steel, through using ceramic metal matrix approach. The metal matrix composite structure was attained through using honey comb method. Then, microstructure observations, mechanical and technical properties of the metal matrix composite structure were well tracked by using optical microscope, SEM, XRD, compression test. Comparing with the reference A128 steel, it was found that Wear abrasion resistance has been multiplied through using ceramic metal matrix composite structure. These results refer to the possibility of using this new technique for producing the crusher components to be applied under severe mining conditions.

Oral Session 4: Applied Mechanics

Time: 08:30-12:40, August 19, 2021. China Standard Time (GMT+8)
Session Chair: Dr. Swee Leong Sing, National University of Singapore, Singapore
Session Room Link: http://www.academicconf.com/teamslink?confname=msam2021

08:30-08:45	**MS1692**	Developing and Characterising Novel CFRP Tubes for Enhanced Energy Absorption *Dr. Yuan Chen, The University of Sydney, Australia*
08:45-09:00	**MS1626**	On Measuring the Fracture Energy of Ductile Metallic Glasses *PhD Hong Li, State Key Laboratory for Strength and Vibration of Mechanical Structures, School of Aerospace Engineering, Xi'an Jiaotong University, China*
09:00-09:25	**MS1640**	Study on the Interface Adhesion and Mechanical Properties of Elastomeric Composites Reinforced with NiTi Shape Memory Alloy *Assoc. Prof. Xu Li, Hubei Key Laboratory of Theory and Application of Advanced Materials Mechanics, Wuhan University of Technology, China*
09:25-09:50	**MS1654**	*In-situ* Alloying using Powder Bed Fusion Additive Manufacturing *Dr. Swee Leong Sing, Department of Mechanical Engineering, National University of Singapore, Singapore*
09:50-10:05	**MS1652**	Exploring Magnetoelectric Coupling in Lead-Free Ferroelectric/Ferrite Heterostructure Thin Films *Dr. Jyoti Rani, Department of Physics, Maulana Azad National Institute of Technology, India*
10:05-10:20	**MS1663**	Phase Controlled Synthesis of Iron Oxide Nanoparticles for Electrochemical Sensing of Acetaminophen *Dr. Beer pal Singh, Department of Physics, Chaudhary Charan Singh University, India*
10:20-10:35	**MS1649**	Defects Engineering Studies for Enhancing the Thermoelectric Properties of InGaSb Immiscible Alloys *Dr. Nirmal Kumar Velu, Advanced Materials Technology Department, CSIR-Institute of Minerals and Materials Technology, India*
10:35-10:45		**BREAK**
10:45-11:00	**MS1590**	Methods Development for the Synthesis of Metal Oxides/Reduced Graphene Oxide Nanocomposites and Their Applications *Assoc. Prof. Muhammad Akhyar Farrukh, Department of Chemistry, Forman Christian College (A Chartered University), Pakistan*
11:00-11:15	**MS1671**	Domain Wall Thermal Stability in Magnetic Nanowires for Storage Nanodevices *Dr. Mohammed Al Bahri, Department of Basic Sciences, A'Sharqiyah University, Oman*

11:15-11:30	**MS1624**	Ablation of Chalcogenide Bulk Glasses and Thin Films with A Deep Ultraviolet Nanosecond Laser *Dr. Petr Knotek, University of Pardubice, Department of General and Inorganic Chemistry, Czech Republic*
11:30-11:55	**MS1669**	Additively Manufactured Metamaterial-Based Flexible Wings for Micro-Robotic Applications *Dr. Anastasiia Krushynska, Engineering and Technology Institute Groningen (ENTEG), Faculty of Science and Engineering, University of Groningen, the Netherlands*
11:55-12:10	**MS1643**	Study and Adaptation of the Adhesion Connectors for Composite Steel-Concrete Bridges *Ms. Ilhame Azdine, University of Hassan II Casablanca, National High School for the Arts and Professions, Morocco*
12:10-12:25	**MS1642**	Study on the Mechanical Properties of A Type of Spherical Bearing *Ms. Yan Zhang, Department of Civil Engineering, China Agricultural University, China*
12:25-12:40	**MS1702**	Models of Flexural Stiffness of Multilayer Plates *Dr. Tatiana Tovstik, Institute for Problems in Mechanical Engineering RAS, Russia*

Abstracts of Session 4

MS1692
Developing and Characterising Novel CFRP Tubes for Enhanced Energy Absorption

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Aims: This study aims to develop novel CFRP tubes by reinforced with composite sandwich panels (CSPs) for enhanced energy absorption and crushing performance.

Methods: First, CSP-reinforced CFRP tubes were proposed and manufactured via bottom confinement using epoxy adhesives and then subjected to a 2 mm/min quasi-static compression. Then, numerical models were developed, based on the continuum damage mechanic for intralaminar failure and the cohesive zone method for interlaminar damage of CFRP materials with an elastic-plastic model for honeycombs, to predict the progressive failure of the composite tubes. Finally, the numerical results were validated with experimental study of tubes' energy absorption and failure mechanisms.

Results: The total energy absorption and crushing force efficiency of the CSP-reinforced CFRP tubes were 37% and 24% greater, respectively, than those of unreinforced CFRP tubes, although the corresponding specific energy absorption exhibited a slight decrease of 1%, demonstrating an overall improvement in energy absorption of the proposed composite tube. Moreover, the relative errors between simulation and experiment in CFE were 11% and 6% (compared to 6% and 1% in SEA) in the CFRP and CSP-CFRP tubes, respectively.

Conclusions: The novel CSP-CFRP tubes show advantages for energy absorption, and the presented numerical models can simulate the primary damage behaviours as validated by the experiments, providing a new available approach for predicting the progressive failure of composites with different layer types (i.e. unidirectional, woven) and composite structures with complex constituents (laminate, honeycomb).

MS1626

On Measuring the Fracture Energy of Ductile Metallic Glasses

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Aims: Despite the critical importance for the use of metallic glasses (MGs) as structural materials, the precise measurement of their toughness is still challenging. We measure the fracture energy (G) of MGs, with focus on the effects of cooling rate and strain rate. Correlations between the free volume, crack extension speed and fracture energy have been analyzed.

Methods: Molecular dynamics simulations have been performed to study the fracture energy (G) of MGs.

Results: The results show that high fracture energy can be achieved through high cooling rates and high strain rates. This can be attributed to the more free volumes at high cooling rates and the slow front propagation speed of shear bands at high strain rates, both of which lead to the increased energy dissipated in the plastic deformation.

Conclusions: The present study not only sheds light on the structural origins of the influences of sample processing conditions and loading conditions on the fracture energy measurement, but also provides useful guidelines in designing MGs with high toughness for their engineering applications.

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MS1640

Study on the Interface Adhesion and Mechanical Properties of Elastomeric Composites Reinforced with NiTi Shape Memory Alloy

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Abstract: In order to investigate the interfacial mechanical behavior a novel composite made of shape memory alloy (SMA) and rubber elastomer under the temperature effect, a series of pull-out

experiments on NiTi SMA wires within rubber matrix were carried out. As a result, the relationship between adhesion force and sample displacement of SMA/rubber composites at different temperatures were obtained, and the influence of environmental temperature in combination with pre-strain of SMA wire on its interfacial bonding performance with rubber matrix were analyzed. The experimental observations reveal that the phase transformation induced by temperature variation plays a significant role for the enhancement of mechanical and interfacial properties, mainly due to the recovery stress if the SMA wire was pre-strained. On the other hand, simulations employing finite element software have been developed, in which the constitutive equations of hyper-elastic elastomer and SMA were introduced and the cohesive damage law was taken into account. The large deformation and adhesion response in tensile loading of a snake-like NiTi wires textile, silicone elastomer matrix and their interface zone are studied numerically. From these computational results, it can be concluded that to better utilize the intrinsic properties of SMA reinforced elastomer, more effective improvements on its interface strength is necessary.

Keywords: SMA Wire; Rubber Elastomer; Interface Behavior; Temperature Effect; Finite Element Simulation

MS1654

In-situ Alloying using Powder Bed Fusion Additive Manufacturing

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Abstract. Currently, pre-alloyed powders are typically used in metal additive manufacturing (AM). AM, or commonly known as 3D printing, has been using materials that are designed for other fabrication processes. These established materials face challenges in AM due to the unique characteristics and phenomena that occur within the processes. Furthermore, pre-alloyed powders are expensive and inflexible in terms of composition. *In-situ* alloying, which makes use of powder blends, enables high-throughput experimental alloy design and screening. This production approach allows high flexibility in varying the composition.

For bulk production, laser powder bed fusion (L-PBF) of elemental powder blends was used as proof of concept. The *in-situ* alloyed produced materials are promising materials for wide range of applications due to their superior properties, even when compared to established materials. *In-situ* alloying has been shown to be an effective approach in creating these new alloys. The material processed were characterised using optical microscopy, electron backscatter diffraction, scanning electron microscopy, energy-dispersive X-ray spectroscopy, X-ray diffraction, hardness and tensile testing.

MS1652

Exploring Magnetoelectric Coupling in Lead-Free Ferroelectric/Ferrite Heterostructure Thin Films

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Abstract. Multiferroic materials exhibit the properties of two or more ferroic (like ferroelectric and ferromagnetic) order parameters simultaneously. These materials are of great interest due to their magnetoelectric (ME) properties in which electric polarization can be modulated by magnetic field and magnetic properties by electric field. ME coupling is appealing not only for its potential application in technology such as sensors, energy harvesting, four-stage memory devices, tunable frequency devices, and spintronic devices but also exciting for fundamental physics concepts like magnetic and electric coupling. Strong ME coupling in heterostructure at room temperature is needed for practical application. We have grown ferroelectric/ferrite heterostructure thin films using pulsed laser deposition technique and investigate their structural, electrical, magnetic and magnetoelectric properties. The results indicate their strong ME coupling at room temperature which indicates their potential in next-generation devices.

Keywords: Magnetoelectric, Thin film, Ferroelectrics, Ferrites.

MS1663

Phase Controlled Synthesis of Iron Oxide Nanoparticles for Electrochemical Sensing of Acetaminophen

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Abstract. Iron oxides nanoparticles are well-researched due to their unique properties and functions in both natural and engineered systems. The sensing capability of nanostructured iron oxides in different gas and bio sensors is a recent research interest of many researchers. Different controlled phases of iron oxide (magnetite, hematite and maghemite) nanoparticles were synthesized using co-precipitation method. The synthesized magnetite (Fe_3O_4) hematite (α-Fe_2O_3) and maghemite (γ-Fe_2O_3) nanoparticles were characterized using X-ray diffraction (XRD), thermogravimetric (TG) and differential scanning calorimetric (DSC) analysis, Raman, and Fourier transform infrared (FTIR) spectroscopy. The different phases of as-synthesized iron oxide nanoparticles were confirmed by XRD and Raman studies. The as-synthesized iron oxide nanoparticles (Fe_3O_4 α-Fe_2O_3 and γ-Fe_2O_3) were found electrochemical active towards acetaminophen (Paractamol or Tylenol) and used for electrochemical sensing of the acetaminophen. The sensing was performed by iron oxide nanoparticles modified glassy carbon (GC) electrode using a potential controlled cyclic voltammetric (CV) electrochemical technique. The results suggest that the iron oxide is an excellent electrode material in environmental and pharmaceutical fields for the analysis of pollutants and/or active ingredients of formulations.

Keywords: Iron Oxide nanoparticles, Electrochemical sensing, Glassy carbon electrode, Cyclic Voltammetric.

MS1649

Defects Engineering Studies for Enhancing the Thermoelectric Properties of InGaSb Immiscible Alloys

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Aims: Enhancing the thermoelectric properties of InGaSb immiscible alloys by controlling their crystalline defects and compositional segregations.

Methods: InGaSb ternary alloys were grown by melt solidification process in a quartz crucible under hydrogen flowing atmosphere. The growth kinetics were controlled by optimizing temperature profile. The grown crystals were analyzed by wet chemical etching, X-ray diffraction, Raman spectroscopy, Seebeck and thermal conductivity measurements.

Results: The Seebeck coefficient was affected mainly by carrier concentration rather than point defects. The highest thermoelectric figure of merit (ZT) of 0.62 was achieved by $In_{0.95}Ga_{0.05}Sb$ crystals.

Conclusions: Reducing point defects and increasing carrier concentration are efficient ways to enhance the thermoelectric power factor of crystalline materials. The interrelated electron and phonon transport properties of crystals could be optimized via defect engineering process.

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MS1590

Methods Development for the Synthesis of Metal Oxides/Reduced Graphene Oxide Nanocomposites and Their Applications

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Aims: Multiple approaches have been carried out to synthesize the rare earth-transition metal oxides nanocomposites as well as reduced graphene oxide doped with metal oxides for the purpose to achieve enhanced activities for the degradations of textiles pollutants, pesticides, organic pollutants, explosive materials etc.

Methods: We have successfully synthesized more than 50 nanocomposites with variety of metals. Various factors e.g. change in precursors, pH, temperature, feed rate, surfactants, solvents, methods of

preparation, concentration of precursors, were studied which change the efficiency of the nanocomposites. Our focus is to synthesize nanocomposites having band gap in the visible region so that they may be used for enhanced catalytic activity under sun light.

Results: The structural investigation, thermal degradation, crystallite size, morphology, surface and photocatalytic properties of synthesized samples were studied by using different characterization techniques i.e. Thermogravimetric analysis (TGA), *Differential scanning calorimetry* (*DSC*) Fourier transform-infrared spectroscopy (FTIR), Particle Size Analyzer (PSA), Powder X-ray diffraction (XRD), Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), and Ultraviolet-Visible spectrophotometer (UV-VIS).

Conclusions: Applications of nano-materials in formulation of nanofiltration nano-medicines, solar cells, forensics, slow release fertilizers, photodegradation, and nanocatalysts for synthesis of organic reactions were also studied.

Acknowledgements: Higher Education Commission of Pakistan and The World Academy of Sciences, Italy.

MS1671

Domain Wall Thermal Stability in Magnetic Nanowires for Storage Nanodevices

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Aims: This study aims to investigate the domain wall thermal stability due to the device temperature and control the domain wall thermal switching in magnetic nanowires by manipulating some parameters such as magnetic properties and device dimensions.

Methods: The micromagnetic simulation was conducted by object-oriented micromagnetic framework (OOMMF) software.

Results: The one problem that faces DW memory is the random DW nucleation at the stabilized position or any position through the nanowire. This random DW nucleation contributes to memory failure. Also, random DW nucleation introduces physical damages or locally varies the strength of the pinning sites, which are not preferred in some device applications. One reason behind DW random nucleation is the device temperature (T). Therefore, in this study, we focus on the effectiveness of a device's temperature on domain wall (DW) generation and dynamics in nanowires by conducting a micromagnetic simulation. This simulation was implemented by using OOMMF software based on the Landau-Lifshitz-Gilbert (LLG) equation with spin-transfer torque (STT) term.

Also, the effectiveness of device temperature on the DW movement is investigated for different temperatures. DW average velocity increases by increasing device temperature, and this good for applications. Furthermore, it was found, there is a strong correlation between magnetic properties and DW creation based on thermal activation. For example, it was observed that the DW creation temperature increases exponentially with magnetic anisotropy (Ku) and this because by increasing Ku,

so magnetization has more energy to line in the easy axis. Therefore, DW needs more thermal activation to create and magnetize switching in the opposite direction.

The second factor that influencing on DW creation is nanowire dimensions like width and thickness. Thus the effectiveness of nanowire width on DW creation temperature (Tc) was investigated by selecting three nanowire widths of 30 nm, 40 nm and 50 nm with fixed length and the thickness of nanowire to 200 nm and 3 nm, respectively.
It was found that Tc is decreasing by increasing the width of nanowire and this due to the shape anisotropy, which is increasing by reducing nanowire width.

MS1624

Ablation of Chalcogenide Bulk Glasses and Thin Films with A Deep Ultraviolet Nanosecond Laser

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Aims: The determination the key parameters of the ablation process for the large set of the chalcogenide glasses.

Methods: The craters with the help of digital holographic microscopy (DHM), atomic force microscopy (AFM), phase shift imaging mode of AFM, Raman scattering, scanning electron microscopy and energy-dispersive X-ray spectroscopy were characterized.

Results and conclusion: Binary (As_2S_3, As_2Se_3, GeS_2 $GeSe_2$ and $GeSe_3$) and ternary (stoichiometric and nonstoichiometric Ge-Sb-S) bulk glasses and corresponding thin films were prepared and illuminated with deep ultraviolet nanosecond (DUV ns) pulsed laser operating at 213 nm. The illumination of samples led to the reproducible crater's formation. Subsequently, the influence of the pulses number and laser fluence on their creation was studied. The ablation rate and laser-induced ablation threshold (LIAT) were determined based on these experiments. The LIAT and ablation rate were compared with the chemical composition of stoichiometric, non-stoichiometric and phase separated glasses and thin films. As an application possibility, the formation of the diffraction gratings by laser direct writing is presented and their functionality is demonstrated.

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MS1669

Additively Manufactured Metamaterial-Based Flexible Wings for Micro-Robotic Applications

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Aims: The goal of this work is to develop artificial flexible wings with controllable aerodynamic and vibroacoustic characteristics that can be manufactured at a fast rate by additive manufacturing technologies, e.g. fused deposition modeling (FDM) or selective laser sintering (SLS), from widely available polymer materials.

Methods: The proposed wing model is inspired by the structure and shape of a natural dragonfly wing scaled up in sizes to satisfy manufacturing constraints. To enable controllable dynamics, the complex natural vein-membrane pattern is replaced by a honeycomb lattice defined by a few geometric parameters.

The finite-element modeling of the wings is based on evaluating structural dynamic properties, solving fully-coupled fluid-structure interactions problem for laminar flows, and performing multi-objective analysis of the target characteristics. Representative models are 3D-printed by an FDM printer (Ultimaker 3.0) from a TPU polymer and tested experimentally in permanent and transient dynamic regimes.

Results: The numerical results reveal that the wing exhibits the highest lift force when excited close to the first flexural resonance, the frequency of which perfectly agrees with the measured frequency of the 3D-printered wings. The optimization procedure shows that aerodynamic and vibroacoustic properties of the wings can be manipulated by varying the geometry of the honeycomb lattice.

Conclusions: The obtained results suggest a promising way to design easy-to-manufacture wings with predefined dimensions and controllable dynamics that opens broad perspectives for further developments of flying micro-robots.

Acknowledgements: The authors gratefully acknowledge the financial support of the ENTEG, the University of Groningen for conducting experiments.

MS1643
Study and Adaptation of the Adhesion Connectors for Composite Steel-Concrete Bridges

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Aims: The objectives of this study are to achieve a faster and more cost-effective use of prefabricated composite bridges, by developing a new connection to assemble the concrete slab with the steel beam, known as adhesion connection, also to complete existing research, by proposing scientific tools to predict the ultimate strength and deformation capacity of the connection, including post-rupture behavior. Develop an analytical model that takes into account the kinematics of the deformation of the connection and the behavior laws of the different interfaces.

Methods: To achieve these objectives, a state-of-the-art study is established on experimental and analytical research carried out on the new "adhesion" connections, to understand the behavior of the interfaces in order to highlight the parameters responsible for the resistance and to obtain information on the nature of the damage mechanisms under static and cyclic loading.

Results: The results of the state-of-the-art study show that these connections have a high resistance to horizontal shear forces and are very rigid compared to traditional connectors (head studs), however, their ductility is limited. Among the parameters affect the performance of this connection: geometry, material and applied loads.

Conclusions: The state of the art shows that for innovative connections, the solutions proposed so far present several advantages for fast construction in comparison with older methods; The connection's resistance to longitudinal shear is based on the shear resistance of interacting confined interfaces that develop between different materials of the connection. However, before applying the new connection in engineering practice further investigation is needed.

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MS1642 Study on the Mechanical Properties of A Type of Spherical Bearing
***** This abstract will be available after the full paper is published.

MS1702
Models of Flexural Stiffness of Multilayer Plates

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Aims: To compare the results of bending stiffness of multilayer plates with alternating rigid and soft layers. In this case, the flexural stiffness is calculated using various models of the theory of plates. The difficulty of calculating bending stiffness is to find the shear stiffness of multilayer plates.

Methods: The most accurate of the approximate formulas, applicable for strongly inhomogeneous plates, was found by the method of asymptotic expansion of the solution of the three-dimensional problem in a series in powers of a small dimensionless thickness.

Results: The vibration frequencies of a rectangular multilayer plate with transversely isotropic layers are compared using approximate formulas and the solution of an exact three-dimensional problem.

Conclusions: The degree of inhomogeneity of the plate, measured by the ratio of Young's moduli of rigid and soft layers, is considered in a wide range, namely, from 1 to 10000.

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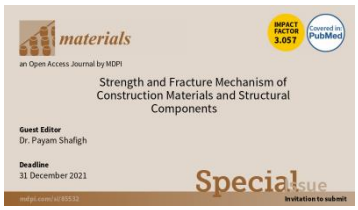
Part V Call for Papers for Peer Review Journals

Strength of Materials (IF: 0.592)
ISSN: 1573-9325
Indexed by: SCIE, EI Compendex, EBSCO database, Scopus, etc.

High Temperature Materials and Processes (IF:0.677)
ISSN: 2191-0324
Indexed by: SCIE, EI Compendex, Scopus, etc.

Journal of Theoretical and Applied Mechanics (IF: 0.927)
ISSN: 1429-2955
Special Issue
Indexed by: SCIE, Scopus, Google Scholar, etc.



Materials (IF: 3.623)
Special Issue: Strength and Fracture Mechanism of Construction Materials and Structural Components
ISSN: 1996-1944
Indexed by: SCIE (Web of Science), Ei Compendex, Scopus, etc.

Part VI Acknowledgements

On behalf of the MSAM2021 Organizing Committee, we would like to take this opportunity to express our sincere gratitude to our participants. Without their support and contributions, we would not be able to hold the conference in any form. We also would like to express our acknowledgements to the Technical Program Committee members who have given their professional guidance and valuable advice as reviewers. For those who contribute to the success of the conference organization without listing the name here, we would love to say thanks as well.

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