THE 3RD INTERNATIONAL CONFERENCE ON MATERIAL STRENGTH AND APPLIED MECHANICS

MSAM 2020

December 6-9, 2020 | Online Conference

CONFERENCE PROGRAM

Online - Microsoft Teams Meeting

China Standard Time (GMT+8)

***For MSAM2020 Academic Exchange Only**

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Part I Conference Schedule Summary

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December 7, 2020 / China Standard Time (GMT+8) ***MS Teams Link: http://www.academicconf.com/teamslink?confname=msam2020***	
	Keynote Speeches Chaired by: ***Prof. Tatsuhiko Aizawa,*** *Surface Engineering Design Laboratory, Shibaura Institute of Technology, Japan*
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09:05-09:50	**Keynote Speech 1:** Mechanical Pre-strain and Chemical Modification for Enhanced Interfacial Shear Strength in Graphene Reinforced Metal Composites ***Prof. Jie Yang,*** *Engineering Mechanical & Automotive Engineering, School of Engineering, RMIT University, Australia*
09:50-10:35	**Keynote Speech 2:** An Analysis of Propagation and Properties of Axisymmetric Waves in Elastic Solids ***Prof. Ji Wang,*** *Department of Mechanics and Engineering Science, Ningbo University, China*
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December 8, 2020 / China Standard Time (GMT+8) ***MS Teams Link: http://www.academicconf.com/teamslink?confname=msam2020***	
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Part II Keynote Speeches

Keynote Speech 1: Mechanical Pre-strain and Chemical Modification for Enhanced Interfacial Shear Strength in Graphene Reinforced Metal Composites

Prof. Jie Yang

Engineering Mechanical & Automotive Engineering, School of Engineering, RMIT University, Australia

Biography: Dr. Yang received his PhD degree in solid mechanics from Shanghai Jiao Tong University in 2002 and is currently a Professor in Engineering with the School of Engineering, RMIT University, Australia. Prior to this position, he was a Postdoctoral Research Fellow at the Department of Civil Engineering, the University of Queensland from 2002-2004, a Lecturer at the Department of Building and Construction, City University of Hong Kong from 2004-2007 before joining RMIT in 2008 where he was a Senior Lecturer from 2010-2013 and Associate Professor from 2014-2016. His main research interests include advanced composite structures, nanocomposites, structural stability and dynamics, smart structures and control, and nano/micro-mechanics. He is an author of over 330 publications including 230 journal papers and 20 ESI highly cited articles. His publications have so far attracted more than 10700 (13100) citations with personal h-index 63 (68), according to Web of Science (Google Scholar).

Prof Yang is the 2019 Highly Cited Researcher (Cross Field) by Clarivate Analytics, the Australian Research Field Leader in Mechanical Engineering in 2019 and 2020, and the Global Field Leader in Mechanical Engineering in 2020. He is the Associate Editor of (1) Engineering Structures (JCR Q1), (2) Mechanics Based Design of Structures and Machines (JCR Q2); and the Editorial Board Member of (1) Mechanics of Advanced Materials and Structures (JCR Q1), (2) Thin-Walled Structures (JCR Q1), (3) International Journal of Structural Stability and Dynamics (JCR Q2), (4) Materials (JCR Q2), and (5) Shock and Vibration (JCR Q3). He is also a frequent keynote/invited speaker and the scientific committee member in many international conferences.

Abstract. Due to their outstanding mechanical properties, graphene and its derivatives such as graphene nanoplatelets (GPLs) have attracted tremendous attention and are well accepted as ideal reinforcing nanofillers in developing new generation lightweight structures that are of prime importance in aerospace, automotive, marine, and defence industries. However, its reinforcing effect has been considerably affected by the poor interfacial strength between graphene and the matrix. It has been demonstrated in a series of recent studies that this challenging issue can be considerably alleviated by the use of chemically functionalized graphene fillers with mechanically induced wrinkles. By employing molecular dynamics simulations, this talk explores an effective route to improve the interfacial shear strength (ISS) of graphene sheets through the introduction of mechanically induced wrinkles formed by shear/compressive pre-strains to graphene and the chemical modification of graphene using various functional groups. The slide-out tests of a functionalized wrinkled graphene

sliding over metal matrix show that such graphene sheet gives rise to larger surface roughness and better bonding which leads to stronger interfacial interactions between graphene and matrix and consequently, significant improvement in ISS. It is also found that shear induced wrinkles are much more effective in enhancing ISS than compression induced ones. Compared with its counterpart functionalized with hydrogen, graphene functionalized with alkyl (methyl, ethyl, propyl, and butyl) offers better interfacial interactions with metal matrix because these functional groups are longer than hydrogen functional group and can be embedded deeper into the matrix.

Keynote Speech 2: An Analysis of Propagation and Properties of Axisymmetric Waves in Elastic Solids

Prof. Ji Wang

Department of Mechanics and Engineering Science, Ningbo University, China

Biography: Professor Ji Wang has been a Qianjiang Fellow Professor of Zhejiang Province at Ningbo University since 2002. He also served as Associate Dean for Research and Graduate, School of Mechanical Engineering and Mechanics, Ningbo University, from 2013 to 2019. Professor Ji Wang is the founding director of the Piezoelectric Device Laboratory, which is a designated Key Laboratory of City of Ningbo. Professor Ji Wang was employed at SaRonix, Menlo Park, CA, as a senior engineer from 2001 to 2002; NetFront Communications, Sunnyvale, CA, as senior engineer and manager from 1999 to 2001; Epson Palo Alto Laboratory, Palo Alto, CA, as Senior Member of Technical Staff from 1995 to 1999. Professor Ji Wang also held visiting positions at Chiba University, University of Nebraska-Lincoln, and Argonne National Laboratory. He received his PhD and Master's degrees from Princeton University in 1996 and 1993 and bachelor from Gansu University of Technology in 1983.

Professor Wang has been working on acoustic waves and high frequency vibrations of elastic and piezoelectric solids for resonator design and analysis with several US and Chinese patents, over 120 journal papers, and frequent invited, keynote, and plenary presentations in major conferences around world. He has been board members, advisors, and consultants to many leading companies in acoustic wave device industry. Professor Wang has been a member of many international conference committees and currently serving the IEEE UFFC Technical Program Committees of the Frequency Control and Ultrasonics Symposia, the IEEE MTT-S, and the IEC TC-49. He is also the funding chair of Committee on Mechanics of Electronic and Magnetic Devices, CSTAM, and the SPAWDA. From 2015, Profess Wang is the editor-in-chief of Structural Longevity and members of the editorial boards of several international journals.

Abstract. The wave propagation in elastic solids is widely treated as plane waves with Cartesian coordinates for known modes such as Rayleigh and Love waves in broad engineering applications. Such distinct wave phenomena also exist in other coordinate systems but the essential property such as the velocity should be the same as known ones while many other special features related to coordinate systems are not presented in details in earlier literature. In a series of recent research, it confirmed that typical wave modes can be found in cylindrical coordinate system with axisymmetric feature and wave velocities are independent from coordinate systems of elastic solids. In general, the deformation solution is given in Bessel functions with a decaying feature along the radius that is different from the constant amplitude in Cartesian coordinates. Such feature is consistent with the energy decaying along the wavefront away from the origin. Consequently, there is a distinct feature of enhancement or reduction of signal strength and amplitudes related to the direction of wave propagation. Clearly, this feature can be exploited further through the consideration of wave modes and direction of propagation in relation with the source in measurement and detection by sensors

utilizing the axisymmetric waves. Furthermore, it also showed through the properties of Bessel functions that wave modes are consistent with Cartesian coordinates from the asymptotic expansions, confirming the plane wave characteristics we are familiar with. However, in the vicinity of origin, wave properties can be better represented with cylindrical coordinates and solutions. These results, similar with major wave modes in cylindrical coordinates including Rayleigh, Love, Sezawa, and others, are analyzed in details for better understanding of their special properties to aid future applications involving elastic solids with axisymmetric configurations and required interests near the origin of typical wave propagation problems in engineering applications. These analyses are essential in future study of axisymmetric waves in finite elastic solids with practical engineering applications.

Keywords: Wave, Vibration, Axisymmetric, Propagation, Solid.

Part III Poster Session

Poster Presentation Preparation

- There is no size constraint for the e-poster, if you have difficult to decide one, then A1 size (594mm×841mm) is recommended.
- 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 based on the "**Votes**" received on the website and evaluation from the General Chair.
- This award consists of a certificate and free attendance to MSAM 2021.

Selection Criteria

- ✓ Research Quality
- ✓ Poster Design

List of Posters

Time: 10:35-11:35, December 7, 2020.

Please Click Paper ID to Access e-Posters.

Conference Room Link: http://www.academicconf.com/teamslink?confname=msam2020

****Should you have any questions on the posters, please feel free to write down in the notebox of each poster at MSAM2020 official website. The presenter will answer your questions as soon as possible.***

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Abstracts of Posters

MS1492

Comparing of Long-Distance Flight Control Performance of Two Size Four Rotor Helicopters

Taisuke Harada and Hideki Toda*

Faculty of Engineering, University of Toyama, Japan

Aims: In this paper, long-distance (>10m) movement control experiment of two 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, (1) A.R. Drone2.0 (large size: 0.5×0.5 m) of Parrot Corp. and (2) A20W (small size: 0.09×0.08 m) of Potensic Corp. were used. By the assumption that a movement control instability is occurred in the movement direction change, an autonomous flight movement control experiment was conducted by including movement direction reversing 10 times with two different velocity speeds.

Results: Experiment result shows that (1) the stability was basically increased in high speed condition. (2) The stability of the forward movement of the drone was increased in the small size drone comparing with the large size. (3) The stability depends on the kind of controller (PD vs BC) especially in the high speed movement case.

Conclusions: This means that the smaller the drone, the more likely it is to be affected by the wind, which may have caused the trajectory to become unstable due to the high speed. In addition, the small drone had a very low friction with the air, which caused the aircraft to slip significantly. As a result, it is necessary to carefully select the size and moving speed of the drone according to the usage scene.

MS1493

Proposal of Ankle Joint Stretching Machine that Incorporates A Mechanism for Passively Adjusting the Leg Length

Takahisa Ino and Hideki Toda*

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

Aims: In this paper, we proposed a mechanism to reduce the pain when lifting the lower limbs with an actuator by passively adjusting the body position, and examined the effect of the mechanism by experiments.

Methods: Motion capture was used to compare leg movements with and without a position adjustment mechanism when lifting the lower limb of a person sitting in a chair from vertical to horizontal with respect to the ground using a lift mechanism.

Results: Actuator for lifting lower limbs and actuator for body position adjustment Using two actuators to lift the lower limbs to a horizontal position and measuring the positional deviation between the ankle joint and the center of rotation of the device, ⊿y = It was 87 mm. On the contrary, when the lower limb was lifted only by the lower limb lift actuator, the displacement was measured as Δy = 295 mm. When using a single actuator to lift the lower limb process, there is a displacement of 295-87 = 208 mm between the ankle joint and the center of rotation of the device.

Conclusions: The proposed lower limb lift mechanism, which incorporates the proposed passive body position adjustment mechanism, works effectively to develop an ankle extension system. Also, you can adjust the position more naturally by moving the seat surface of the chair to adjust the body position.

MS1494

Hip Joint Stretching Device Using 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: By using a passively adjustment mechanism made of a linear guide rail, the developed device can work anywhere independently the position on the patient's on the bed.

Results: Experiment confirmed that the proposed mechanism can work at from 30 to 50 cm displacement of the hip position without any pains.

Conclusions: Our proposed system including a passive adjustment mechanism will leads to help the physical therapists' heavy load work and hopefully, it leads to self-rehabilitation for hip joint medical treatment.

MS1499

Application of Switching Control by Two Types of Drones of Different Sizes

Koichi Hasegawa* and Hideki Toda
Electric and Electronic Engineering, University of Toyama Institute Gofuku Campus, 3190 Gofuku, Toyama, 930-8555, Japan

Aims: In this research, we propose drone motion control (switching control) that alternately uses pitch and roll motion control. A flight test with the proposed control is performed on two aircraft with different characteristics to compare with the conventional control.

Methods: The experiment, the red marker is used to measure the left-right deviation for each drone when flying over a distance of 50 m or more. The drone was controlled by the red marker's position on the front camera image, and it was moved back and forth within 3.0 m about 30 turns by changing the control parameter of pitch direction γ positive or negative. The position of the drone was measured by another camera attached to the ceil, and the x and y position was continuously measured by the image. Axis x and y correspond to the roll and pitch direction of the drone respectively. In this situation, three control methods (P-D control, boundary condition, using pitch and roll alternately) were performed.

Results: In the control with the switching control added to the simple P control, the left/right blur was improved by 79% compared to the simple P control.
In the experiment in which the switching control was added to the PID control, the improvement was 91% compared to the P control, and the improvement was 56% compared to the PID control.

Conclusions: Boundary control and switching control both showed better results than ordinary PID control. It is considered that the switching control showed excellent performance because, unlike the other two types of control, simultaneous input of the pitch axis and roll axis, which causes instability, was not performed.

MS1545

Use of the CIELab System in the Visual Perception of Different Colors in Fibers Synthetized by Electrospinning

L G Soares da Silva*
Universidade Federal do Rio Grande do Sul, Brazil

Abstract. Colorimetry is used to evaluate the efficiency of systems that include colors, applying mathematical models to quantitatively explain the human eye's ability to perceive color variations, is based on a complicated methodology and makes use of specific software. For the formation of color three fundamental elements are needed: a light source, an object to be illuminated and a photosensitive detector. The CIE system, organized by the *Commission Internationale de L'Eclairage*, is used to characterize colors, normalize observers and illuminants. The ability of human eyes to perceive electromagnetic waves is understood at wavelengths between 380 and 780 nm. Strictly speaking, the

human eye captures three different color stimuli: blue, green and red. The union of these three stimuli defines the colored reproductions in the brain, so any color can be constituted by the addition of red, green and blue. Thus, the present work investigated the ability of human eyes to perceive the different colors in TiO_2 and TiO_2 fibers mixed with H_2WO_4 and $Na_2WO_4.2H_2O$. The fibers were synthesized by electrospinning and heat treated between 650 ºC and 800 ºC. The samples were characterized by: X-ray diffraction (XRD), scanning electron microscopy (SEM), diffuse reflectance spectroscopy (ERD) and colorimetry using the CIELa* b* system. The best results were obtained with the fibers of TiO_2／$Na_2WO_4.2H_2O$. These samples were more efficient in absorbing light, possibly due to the increase in specific defects in the TiO_2 network. These defects occupy atomic network positions.

MS1560

Effect of Zinc Addition on Structural and Mechanical Properties of Rapidly Solidified Aluminum Alloys

Nermin Ali
Mansoura University, Egypt

Abstract. Al-Zn alloys satisfy a significant division of industry interest for the development of lightweight materials having high strength and toughness characteristics. The scanning electron microscopy (SEM) was used to study the morphology of the melt spun alloys and x-ray diffractometer (XRD) for the identification of the phases present in these melt-spun bearing alloys. The tensile properties and elastic constants of Al-Zn alloys were studied by using tensile test machine. It is noticed that mechanical proprieties attributed to fine-grained structure and reduced levels of segregation due to the high casting rate by rapid solidification processes. From the elastic moduli and stress-strain diagram, the results show that the small addition of zinc metal enhances the mechanical properties of aluminum metal and especially for 0.1 wt.%Zn due to the smaller value of particle size as showed from x-ray analysis and the increasing number of grains as showed from SEM analysis.

Keywords: Metals, Alloys, Rapid-solidification, Grain boundaries, X-ray diffraction, Tensile proprieties, Indentation creep, Vickers hardness.

MS1578

Elaboration and Characterization of PE-TE Multilayer for Energy Harvesting

Imane Salhi
Chouaib Doukkali University of El Jadida, Morocco

Abstract. PU/PZT and PEDOT: PSS have been an interesting research topic for many researchers since they are well-known materials for piezoelectricity and thermoelectricity effects, respectively. This research work proposes to elaborate the composite PU/ PZT and PEDOT: PSS and to investigate their electrical and thermal characterization to conceive a multilayer material for energy harvesting. This part of the work focuses on the composite PU/PZT. We investigate the electrical characterization that involves the relative permittivity and the electrical conductivity of each sample with 20% and 40%

of PZT. While the thermal characterization focuses on measuring the thermal conductivity using both, an indirect and a direct measurement technique. The indirect one uses Flash method to figure out thermal diffusivity and DSC to measure the specific heat capacity. As for the direct method, an experimental set-up has been proposed.

Keywords: Waste heat recovery, Mechanical vibrations, Energy harvesting, Piezoelectricity, Thermoelectricity, Hybrid device, Multilayer material, Polymer.

MS1584
Recovery Ocean Energy by Piezoelectric Material

Aziza belhassani
Chouaïb Doukkali University, Morocco

Abstract. Marine energy generation technologies include offshore wind, wave, and tidal energy generation, which are considered to be the fundamental renewable technologies for the long-term aim to reduce our climate's CO_2 emissions. Hence, marine energy is the key to develop future sustainable energy supply by using piezoelectric material.

Keywords: Energy, Marine, Wind Offshore, Renewable Energy, Wave Energy, Piezoelectric, Material

MS1586
Mechanical Behaviour and Damage of a Woven Eco-Composite Reinforced by Vegetable Jute Fibers

Abderrahim Benmoussat [1,*], Sid ahmed Benmansour [2], and Abderrahim El Mahi[3]
[1]*Sciences and Technology, University Centre of Tamanrasset- Algeria*
[2]*Higher School of Applied Sciences of Tlemcen, Algeria,*
[3]*University of Maine Acoustics Laboratory (LAUM UMR CNRS 6613) Le Mans, France*

Aims: Biodegradable materials as stratified eco-composite with various vegetable fibers such as jute are mainly used for their rigidities and specific resistances offering an environmental protection, by replacing synthetic reinforcements such as glass or carbon fibers allowing associating a resistant material, light, abundant, non-abrasive, and inexpensive. The mechanical behavior and fracture in static and dynamic stresses remain one of the major concerns of high-tech industries such as aviation and aerospace

Methods: The mechanical behavior of the prepared stratified eco-composite consisting of a GreenPoxy 56 resin reinforced with jute is considered in static and dynamic includes a characterization of the mechanical properties carried out from the tensile tests on test specimens by considering the effect of the orientation of the fibers (warp and weft direction) and an analysis of the impact type dynamic behavior. The damage mechanisms have been followed by acoustic emission methods.

Results: The results showed that the mechanical static behavior in both directions is non-linear before

the final fracture. The dynamic tensile testing conducted by impact excitation using a hammer in a recessed / free configuration showed that the recorded resonance frequencies of the first three vibration modes as a function of the excitation level were deduced to determine the Young's modulus for the two orientations of the fibers. The fibers oriented in the warp direction have better mechanical characteristics than in the weft direction.

Conclusions: Multivariate statistical analysis of the acoustic emission signals (EA) made to identify different damage mechanisms during the tests. One distinguishes first of all matrix microcracks which are the most visible and finally the rupture of the fibers causing the rupture associating different classes of EA with the damage mechanisms.

Acknowledgements: The authors are very grateful to LAUM Acoustics Laboratory, Le Mans University, France, for their great help to make a part of this work to be done. They appreciate to thank Professor Abderrahim EL MAHI for his experimental contribution.

Part V Online Oral Presentations

Online Oral Presentation Guidelines

- Online Oral Presentation will be conducted via Microsoft Teams Meeting (Click to see how to join MSAM 2020 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 and the "votes" on the conference website:

- ✓ 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 2021.

Oral Session 1: Material Properties

Time: 14:25-17:35, December 7, 2020. China Standard Time (GMT+8)
Session Chair: Dr. Song Xue, Xidian University, China
Please Click Paper ID to Access the Video Presentation.
Session Room Link: http://www.academicconf.com/teamslink?confname=msam2020

14:25-14:40	**MS1563**	Current Research State of Fiber-Reinforced 3D Printing Technology *Mr. S M Fijul Kabir, North Carolina State University, USA*
14:40-15:05	**MS1484 (Invited)**	Anti-Galling Beta-SiC Coating Dies for Fine Cold Forging of Titanium *Dr. Tatsuhiko Aizawa, Surface Engineering Design Laboratory, SIT, Japan*
15:05-15:20	**MS1572**	Stepped Nanowire for Domain Wall Pinning with High Storage Multi-Bit Memory *Dr. Mohammed Al Bahri, A'Sharqiyah University, Oman*
15:20-15:45	**MS1574 (Invited)**	Thermal Restraint of Polymeric Materials Investigated by Means of Elastic Incoherent Neutron Scattering *Dr. Maria Teresa Caccamo, University of Messina, Italy*
15:45-16:00	**MS1546**	Study on Interfacial Reaction between Liquid Tin and Metallic Substrates *Dr. Satyanarayan, Alva's Institute of Engineering and Technology, India*
16:00-16:10		**BREAK**
16:10-16:25	**MS1577**	Development of Al6061/CNT Metal Matrix Nano Composites and Optimization of its Process Parameters in Drilling *Dr. Rajesh Nagadolla, Sri Venkateswara College of Engineering, India*
16:25-16:40	**MS1570**	Structural and Impedance Studies of Mn Modified PZT Ferroelectric Ceramics *Dr. Balgovind Tiwari, Department of Physics, IIIT RKValley, RGUKT, India*
16:40-16:55	**MS1561**	Amorphous Graphene and Related Hybrids as Cold Cathode Emitter *Dr. Diptonil Banerjee, Teerthanker Mahaveer University, India*
16:55-17:10	**MS1573**	In Vitro and in Vivo Evaluation of Î²-TCP /Fap Bioceramics Scaffolds *Dr. Rym TAKTAK, National School of Engineering Sfax, Tunisia*
17:10-17:35	**MS1562**	Application of TOPSIS and Grey Relational Analysis for Multi-Objective Optimization of Machining Process Parameters during EDM and Powder Mixed EDM *Dr. Sasmeeta Tripathy, Siksha 'O' Anusandhan (Deemed to be University), India*

Abstracts of Session 1

MS1563
Current Research State of Fiber-Reinforced 3D Printing Technology

S M Fijul Kabir*, Kavita Mathur and Abdel-Fattah M. Seyam
Wilson College of Textiles, North Carolina State University, Raleigh, NC, USA

Abstract. Three-dimensional (3D) printing technology developing an object by sequential layering has gained tremendous attention due to its endless potentials in designing intricate structures with minimum cost and process steps. Although it is approximately a decade old technology, fiber-reinforced 3D printing technology is a very recent and promising innovation adding a new dimension to the material fabrication that has enabled the developed composites to apply in many high performance application areas such as aerospace, automobile and naval industries. In the present work, current research on 3D printed fiber-reinforced composites is discussed including history from plastic to composite printing, configuration of printer to develop the composites, mechanical properties of 3D printed composites relative to the composites developed following to the established traditional technology (i.e. injection molding and vacuum assisted resin transfer molding) as wells as the limitations and potential areas of development of the existing fiber-reinforced 3D printing technology.

Keywords: Fiber-Reinforced Composites, 3D Printing, Mechanical Properties.

Acknowledgements: North Carolina State University, Raleigh, NC, USA

MS1484 To avoid repeatability issue, this abstract will be available after the full paper is published in the conference proceedings.

MS1572
Stepped Nanowire for Domain Wall Pinning with High Storage Multi-Bit Memory

Mohammed Al Bahri *
Department of Basic Sciences, A'Sharqiyah University, Post Box 42, PC 400, Ibra, Oman

Aims: This study aims to investigate the domain wall dynamics and pinning through the stepped magnetic nanowire by using spin-transfer torque.

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

Results: Controlling Domain wall (DW) dynamics and stability in a nanowire is a crucial issue for

DW storage memory. In this study, DW pinning was investigated by using micromagnetic simulation. A new way is proposed for DW pinning by creating a stepped notch. This way is a convenient way to pin DW with different structures. A stepped area is constricted at the center of the nanowire with proportions of length (*d))* and width (λ) to pin the magnetic domain wall (DW) with high barrier potential energy to achieve a high information storage capacity.

Conclusions: From this study, it can be concluded that the stability type of the VDW with CW chirality and up polarity during its propagation in stepped nanowire could be controlled by either increasing saturation magnetization or decreasing current density.

MS1574

Thermal Restraint of Polymeric Materials Investigated by Means of Elastic Incoherent Neutron Scattering

Maria Teresa CACCAMO *

Department of Mathematical and Computer Sciences, Physical Sciences and Earth Sciences, University of Messina, Messina 98166, Italy

Aims: The present work is addressed to the study of the thermal stability of polymer materials by means of Elastic Incoherent Neutron Scattering (EINS) on a nanoscopic scale. In particular, the elastically scattered neutron intensity is collected and then analyzed as a function of the exchanged wavevector and as a function of temperature for PolyEthylene-Oxide systems for different molecular weight values.

Methods: The collected scattered intensity versus exchanges wavevector and temperature data fulfil a sigmoid behavior and are analyzed by applying a fitting model that takes into account the sigmoid amplitude, whose inverse is the thermal restraint, the sigmoid steepness and the mechanical relaxation temperature value.

Results: The application of the thermal restraint model to global EINS intensity data as a function of temperature allows to extract information on the structural restraint of the investigated systems, on a nanoscopic scale, when the temperature is raised.

Conclusions: The application of a fitting model to global EINS intensity data as a function of temperature allows to put into evidence both the different wavevector dependence of the system relaxation times and the higher thermal resistance when the molecular weight is increased.

MS1546

Study on Interfacial Reaction between Liquid Tin and Metallic Substrates

Satyanarayan*
Department of Mechanical Engineering, Alva's Institute of Engineering and Technology, Moodbidri 574225, India

Aims: In the current study, diffusion of copper (Cu), brass and mild steel (MS) substrates in liquid tin (Sn) was investigated.

Methods: All the metallic substrate specimens were immersed in liquid Sn for the duration of 1min to 3mins and drown out from molten Sn. Interfacial microstructure and the formation of intermetallic compounds (IMCs) at the interface between liquid tin and metallic substrates were assessed using metallurgical microscope as well as electron probe microanalyzer (EPMA).

Results: It was observed that, the thickness of intermetallic (IMC) layer increased with increasing immersion time. Cu and mild steel metallic substrates exhibited higher dissolution compared to brass substrate.

Conclusions: Thickness of intermetallic layer increased with increasing immersion time. Copper and mild steel showed higher dissolution compared to brass metallic substrate.

Acknowledgements: Author thank, Hithesh G Shetty, Ranjan Kishor for their support.

MS1577

Development of Al6061/CNT Metal Matrix Nano Composites and Optimization of its Process Parameters in Drilling

N. Rajesh
Sri Venkateswara College of Engineering, Tirupati, A.P, India

Abstract. Now a days the area of Metal Matrix Composites (MMCs) is attracting the scientific and intellectual communities due to their broad technological and industrial applications. Further Aluminium based Metal Matrix Composites have gained importance as materials for engineering applications due to their lightness, higher specific strength, wear resistance and enhanced mechanical properties.

In this work three different types of AMMNC samples are prepared by reinforcing CNT percentages of 0.3%, 0.6% and 0.9% with Al6061 base material using ultrasonic stir casting furnace. The fabricated samples are tested for its properties such as tensile strength, compressive strength, hardness and metallurgical properties.

A Taguchi experimental design is prepared by considering influential parameters type of tool, speed, feed and coolant at different levels. Drilling experiments are conducted according to Taguchi

experimental design with different parametric combinations. The machining responses such as temperature, surface roughness, material removal rate, power, thrust force, torque and diametrical error are measured and recorded for each experimental run.

Regression equations are developed for the machining response. The optimum parameter values are evaluated from the regression models through Taguchi S/N ratio analysis and Sine Cosine Algorithm (SCA). From the result it is concluded that SCA is the best method compared to Taguchi S/N ratio analysis for obtaining better results. ANOVA is also performed on each response to evaluate the contribution of each influential parameter on the particular response.

The work is more suitable for development of new AMMNCs for different machining applications under suitable strengths and microstructural requirements.

Keywords: Al6061, CNT, Drilling, Chip Morphology, Taguchi S/N Analysis, Sine Cosine Algorithm.

MS1570

Structural and Impedance Studies of Mn Modified PZT Ferroelectric Ceramics

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[2]*Department of Physics, Sri Chaitanya High School Andhra Pradesh, India*
[3]*Department of Physics, ITER, SOA University, Odisha, India*

Aims: To understand the effects of Mn substitution on structure and impedance properties of PZT.

Methods: A high temperature solid state reaction method had been used. After stoichiometric calculation and weighing, grinding – XRD – grinding was done. Calcination was done at temperature, 900ºC for 4 Hrs and sintering temperature was 1100 ºC for 2 Hrs. After pellet preparation and sintering, air drying silver paint was used as electrode for characterization. XRD, SEM and Impedance measurements were performed.

Results: Because of Mn Modification we observed:
(1) Reduction in grain size and densification of grains
(2) A typical dielectric behavior at room temperature
(3) Increase of max. Dielectric constant and decrease in $T_{c.}$
(4) Dielectric loss increases only after 275 ºC.
(5) Grains contribute mostly in impedance of these material systems.
(6) The relaxations are of non-Debye nature.
(7) Decrease in bulk resistance indicates semiconductor nature of the samples.
(8) Presence of space charges and electrical relaxation.

Conclusions: Mn modification does change the microstructure, dielectric and impedance properties.

Acknowledgements: Authors are thankful to IIT Kharagpur and DST-SERB.

MS1561

Amorphous Graphene and Related Hybrids as Cold Cathode Emitter

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Abstract. In this lecture a novel approach will be discussed for the synthesis of 2 dimensional carbon nanostructures in gram scale and with very high yield. Also it will be shown how this material can be incorporated into the other to make different hybrids suitable for different fields of applications.

The efficiency of such materials in one of such application i.e. as cold cathode emitter has been discussed. The 2D carbon has been deposited on carbon cloth via electrophoretic deposition thus to make the basic of flexible cold emitter.
It has been seen that all the, pure and hybrid sample give good field emission characteristics and the best result comes from the (EP) deposited a-G sheets on carbon cloth. The turn field in this case becomes as low as 0.52 V/μm thus comparable or even better than the existing graphene-based materials. This report can propose a possibility of substituting some graphene-based devices with this amorphous graphene like carbon nanosheets having further advantages of its simple synthesis procedure as well as gram level higher yield.

MS1573

In Vitro and *in Vivo* Evaluation of β-TCP /Fap Bioceramics Scaffolds

Rym Taktak
National School of Engineers of Sfax, Tunisia

Abstract. Biocomposites consisting of β Tricalcium phosphate (β-TCP) with 26.52% Fluorapatite (Fap) were elaborated and characterized in order to evaluate it potential application in bone graft substitute. Bioactivity was determined with *in vitro* tests by immersion of samples in simulated fluid body for several periods of times. The SEM, EDS and Atomic Absorption Spectroscopy showed the deposition of apatite layer on the surface of samples showing a good bioactivity. However, after 6 days of soaking, the dissolution rate of $Ca^{2+}$and PO^{43-} decreased which due probably to the improvement of crystallization of the apatite layer. These findings agree with those observed after 6weeks postimplantation of prepared macroporous scaffolds in rabbits. All histological observations of the preliminary *in vivo* study in the tibia of rabbits proved the biocompatibility and the resorption of the investigated bioceramic. In contrast, the implantation period will have to be optimized by further extensive animal experiments.

MS1562

Application of TOPSIS and Grey Relational Analysis for Multi-Objective Optimization of Machining Process Parameters during EDM and Powder Mixed EDM

S. Tripathy

Mechanical Engineering Department, ITER, Siksha 'O' Anusandhan (Deemed to be University), Bhubaneswar, 751030, India

Abstract. Electrical Discharge Machining (EDM) process is being widely used throughout the globe to impart intricate shapes to conductive metals and alloys possessing high hardness and toughness which possess huge application in the mould and die making industries, aerospace, automobile and electronic industries. The process though has a lot of capabilities, consist of few limitations like low volumetric material removal rate and poor surface quality. Powder Mixed Electro- Discharge Machining (PMEDM) is a new development in EDM to enhance its machining capabilities. The present article aims at investigating the effect of process parameters on the surface properties of H-11 die steel during PMEDM. It was found that considerable research has been done on different aspects during electric discharge machining of various steels, but sufficient data is not available on the surface properties and optimum process parameters for machining of H-11 die steel. It is a hot work steel which possesses very high hardenability and toughness. The typical applications of this grade of steel is found in a wide range of aircraft and structural use, die casting dies, mandrels, piercing tools, extrusion tooling, forging dies, punches. The present work investigates the effect of process parameters like powder concentration (C_p), peak current (I_p), pulse on time (T_{on}), duty cycle (DC) and gap voltage (V_g) on Material Removal Rate (MRR), Tool Wear Rate (TWR), Electrode Wear Ratio (EWR) and surface roughness (SR) simultaneously during EDM and PMEDM of H-11 die steel. Taguchi's orthogonal array has been used to conduct the experiments using suspension of graphite powder in the dielectric fluid. Electrolytic Copper was selected as the tool electrode. Multi-objective optimization using Technique for order of preference by similarity to ideal solution (TOPSIS) and Grey Relational Analysis (GRA) have been used to determine the optimal setting of process parameters for MRR, TWR, EWR and SR. Taguchi's L_{27} orthogonal array was used to carry out the experiments with no powder and graphite powder suspended in the dielectric fluid using copper as tool electrode. Predicted results have been verified by confirmatory tests which show an improvement of 0.115631 and 0.14211 in the preference values using TOPSIS and GRA respectively. The recommended settings of process parameters is found to be C_p=6g/l, I_p=3Amp, T_{on}=200µs, DC=80% and V_g= 50V from TOPSIS and C_p=6g/l, I_p=3Amp, T_{on}=150µs, DC=80% and V_g= 30V from GRA. ANOVA and F-test were performed to understand the significance of each process parameter. The results were verified by conducting confirmatory tests. The microstructure analysis has been done for the optimum set of parameters using Scanning Electron Microscope (SEM).

Oral Session 2: Strength of Materials

Time: 09:00-12:30, December 8, 2020. China Standard Time (GMT+8)
Session Chair: Dr. Bing Wang, Fuzhou University, China
Please Click Paper ID to Access the Video Presentation.
Session Room Link: http://www.academicconf.com/teamslink?confname=msam2020

09:00-09:25	**MS1523 (Invited)**	Multiscale Shear Failure Mechanisms of a Bistable Composite Tape-Spring *Dr. Bing Wang, Fuzhou University, China*
09:25-09:40	**MS1567 (Invited)**	Numerical Method of Fretting Fatigue Based on Wear and Continuum Damage Mechanics *Dr. Yazhou Xu, Xi'an University of Architecture and Technology, China*
09:40-09:55	**MS1454**	Shear Banding and Fracture Behaviour in Bulk Metallic Glasses at Various Strain Rates: A Comparative Study under Compressive and Shear Loading *Dr. Ding Zhou, Nuclear Power Institute of China, China*
09:55-10:10	**MS1476**	The Dynamic Response of Honeycomb Enhanced Ceramic Armor under Combined Blast and Fragment Impact *Mr. Zhong-Nan Zhao, Xi'an Jiaotong University, China*
10:10-10:25	**MS1477**	Blast Resistance of Metallic Corrugated Sandwich Cylindrical Shells with Multilayered Graded Cores *Mr. Pengbo Su, Xi'an Jiaotong University, China*
10:25-10:40	**MS1533**	L21-Strengthened Face-Centered Cubic High-Entropy Alloy with High Strength and Ductility *Mr. Yongliang Qi, Xi'an Jiaotong University, China*
10:40-10:50		**BREAK**
10:50-11:15	**MS1557**	Experimental and Numerical Studies on Free Vibration of Laminated Composite Shallow Shells in Hygrothermal Environment *Dr. Shishir Kumar Sahu, National I nstitute of Technology, India*
11:15-11:30	**MS1568**	Three-Dimensional Analysis of Dislocation Structure at Grain Boundary Pop-ins in Tungsten *Dr. Farhan Javaid, National University of Sciences and Technology, Pakistan*
11:30-11:45	**MS1565**	In-plane biaxial stress distribution along GFRP cruciform Geometry *Dr. Abdul Mateen Mohammed, TKR College of Engineering & Technology, India*
11:45-12:00	**MS1543**	Investigation of the Microstructure and Mechanical Properties of Gas Metal Arc Welded AISI 430/AISI 304 Dissimilar Stainless Steels Butt Joints *Dr. Gürel Cam, Iskenderun Technical University, Turkey*
12:00-12:15	**MS1585**	Fracture and Fatigue Resistance of Different CAD/CAM Occlusal Veneers Restorations *Dr. Eman H. Albelasy, Mansoura University, Egypt*

12:15-12:30 **MS1525** CFRP New Small-Diameter Material for Strengthening of Steel Bridge Girders

Dr. Hamid Kazem, North Carolina State University, USA

Abstracts of Session 2

MS1523

Multiscale Shear Failure Mechanisms of a Bistable Composite Tape-Spring

Bing Wang [1,2,*]

[1]*School of Mechanical Engineering & Automation, Fuzhou University, Fuzhou, China*

[2]*Department of Engineering, University of Cambridge, Cambridge, UK*

Aims: A bistable composite tape-spring (CTS) is stable in both the extended and coiled configurations. The factors governing its bistability have been well-understood, but there is limited research concerning the mechanics of structural failure. Since fibres are oriented in ±45˚, axial tension or compression of the CTS corresponds to its shear behaviour. Here, we investigate the multiscale shear failure mechanisms of the CTS.

Methods: We perform *in-situ* neutron diffraction on composite specimens using the ENGIN-X neutron diffractometer at Rutherford Appleton Laboratory (STFC, UK), and shear failure is characterised at both macroscopic and microscopic scales.

Results: There are clear observations of microstructural phase changes upon straining. The elastic and viscoelastic strain evolutions infer the shear failure mechanisms of the CTS, which is temperature-dependent. The premature failure of crystalline regions correlates well with the macroscopic shear failure. The load-bearing efficiency of the crystalline regions varies with temperature: crystalline regions carry 100% of loads at −180 °C since the molecules are ‘‘frozen’’, and have zero load capability at 165 °C as when approaching the melting temperature of the matrix.

Conclusions: Elastic and viscoelastic strain evolutions at different strain levels reveal the fundamentals of micromechanical shear failure, and their temperature dependency. Multiscale shear failure mechanisms are then proposed, which will benefit the optimisation of structural design to maintain structural integrity of CTS in aerospace applications.

Acknowledgements: We thank the financial support from Innovate UK (Grant No. 113077, RG82506), in close partnership with SAFRAN Landing Systems. The award of the ENGIN-X beamtime (RB1910213) from the Science and Technology Facilities Council (STFC), UK, is also acknowledged.

MS1567

Numerical Method of Fretting Fatigue Based on Wear and Continuum Damage Mechanics

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Aims: This paper aims to obtain a high-precision numerical simulation method of fretting fatigue process by considering wear.

Methods: Continuum damage mechanics combined with wear is used to solve the fretting fatigue process, including crack initiation and propagation.

Results: Considering the wear, the maximum equivalent damage stress in the initiation stage and the stress intensity factor in the early stage of propagation are reduced. Total life results fall within the scatter bands of $\pm 50\%$.

Conclusions: The numerical calculation method of fretting fatigue considering wear has high accuracy, especially when the number of cycles is large. At the same time, wear changes the geometry and stress state of the crack. Compared with the numerical method without considering wear, wear inhibits the initiation and propagation of cracks and increases the fatigue life.

Acknowledgements: This research is supported by the National Natural Science Foundation of China (Grant No. 51578444).

MS1454

Shear Banding and Fracture Behaviour in Bulk Metallic Glasses at Various Strain Rates: A Comparative Study under Compressive and Shear Loading

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Abstract. The intrinsic fracture mechanism of bulk metallic glasses (BMGs) is often obscured under compressive or tensile loading due to the involvement of normal stress. To decouple the strain-rate and stress-state effect, shear banding and fracture behaviors are compared under compressive and shear loadings at various loading rates. Real-time deformation processes are captured by using high-speed photographing, which confirms multiple shear banding at low strain rates and single shear banding at high strain rates. More importantly, the transition from shear band to crack could be observed under shear loading. Such transition is found to be induced by cavitation mechanism and shows obvious rate dependence. We clarify that strain rate controls cavitation concentration level and normal stress controls cavitation instabilities, respectively.

MS1476

The Dynamic Response of Honeycomb Enhanced Ceramic Armor under Combined Blast and Fragment Impact

Zhong-Nan Zhao[1,2,3*], Lang Li[2], Bin Han[2], Qian-Cheng Zhang[1] and Tian Jian Lu[3]
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[3]*Nanjing Center for Multifunctional Lightweight Materials and Structures (MLMS), Nanjing University of Aeronautics and Astronautics, Nanjing 210016, P.R. China*

Aims: The dynamic response of honeycomb enhanced ceramic armor was studied under the impact of a novel composite projectile, which was comprised of a cylindrical aluminum foam projectile embedded with a fragment simulation projectile (FSP) to simulate combined blast and single fragment impact loading.

Methods: Numerical simulations were carried out to provide insight into the interaction between the composite projectile and honeycomb enhanced ceramic armor. The effect of (i) arrival time interval between blast and fragment, (ii) the shock blast wave form and (iii) the nose shape of FSP were explored systematically.

Results: The (i) arrival time interval and (iii) nose shape has significant effect on the deformation and perforation of the plate as well as the synergetic effect of combined loading on the residual velocity of the FSP. The influence caused by (ii) shock blast wave form was small enough to be neglected.

Conclusions: The armor response under combined impact was different from that under an individual impact. The prototypical problem underlying the synergetic effect was the ballistic penetration of a deforming plate wherein the deforming was caused by an impinging planar air blast. Modern armor systems needed to be optimized for different protection requirements.

Acknowledgements: The Zhejiang Provincial Natural Science Foundation of China (LGG18A020001).

MS1477

Blast Resistance of Metallic Corrugated Sandwich Cylindrical Shells with Multilayered Graded Cores

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[3]*State Key Laboratory of Mechanics and Control of Mechanical Structures, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, P.R. China*

Aims: Dynamic response, blast resistance and optimization of metallic corrugated sandwich cylindrical shells with multilayered graded cores subjected to inner blast loading were investigated and compared with conventional ungraded ones.

Methods: Numerical simulations were performed and validated with existing experimental results. The structures were composed of metallic face sheets and multilayered graded corrugated cores. Gradient of multilayered cores was defined and achieved via two approaches: core wall thickness variation and core height variation. The single and multi-objectives optimization was carried out to find the optimal gradient, where surrogate models were established to formulate radial deflection.

Results: Radial deflection and velocity of sandwich cylindrical shells with internally hard and externally soft core arrangement were smaller than those of ungraded ones. Graded structures with thickness gradient performed better than those with height gradient. The radial deflection could be further reduced by optimizing the gradient.

Conclusions: Sandwich cylindrical shells with thickness/height tapered gradient from the inner to the outer layer had superior blast resistance in terms of radial deflection and velocity of the outer face sheets.

Acknowledgements: Zhejiang Provincial Natural Science Foundation of China (LGG18A020001).

MS1533
L21-Strengthened Face-Centered Cubic High-Entropy Alloy with High Strength and Ductility

Yongliang Qi, Yake Wu, Tinghui Cao, Lin He, Feng Jiang* and Jun Sun
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Aims: Face-centered cubic (FCC) high-entropy alloys (HEAs) strengthened by coherent $L1_2$-nanoparticles exhibit an excellent strength-ductility balance. However, the strength of previously studied HEAs remains inadequate for the requirements of high-performance structural applications, due to their emphasis on coherency strengthening and the suppression of the formation of incoherent precipitates, which could substantially increase the alloy strength but also leads to significant brittleness. In this study, we propose to employ incoherent precipitates as additional strengthening phases to further improve the mechanical performance of conventional $L1_2$-strengthened FCC HEAs without dramatic loss of their ductility.

Methods: We achieve this using a prototypical $(FeCoNiCr)_{89}Ti_6Al_5$ (at.%) HEA, in which high-density, fine, and incoherent $L2_1$ precipitates were introduced and uniformly distributed at the recrystallized grain boundaries through proper thermomechanical processes, including large cold deformation, full recrystallization, and aging heat treatment.

Results: A superb combination of strength and ductility in the alloy is confirmed by the uniaxial tensile tests, with a yield strength of 1136 MPa, an ultimate tensile strength of 1597 MPa, and a ductility of 25.3%.

Conclusions: This superior mechanical response is caused by the synergistic contribution of the fine and uniformly distributed $L2_1$ particles and the ultra-ductile and damage-tolerant FeCoNiCr matrix, which are responsible for increasing strength and maintaining ductility, respectively. These findings demonstrate the viability of a new method of using incoherent precipitates to strengthen other FCC HEAs by properly tuning their particle size and distribution.

Acknowledgements: This research was supported by the National Natural Science Foundation of China (NSFC) under Grant Nos. 51621063.

MS1557

Experimental and Numerical Studies on Free Vibration of Laminated Composite Shallow Shells in Hygrothermal Environment

S K SAHU[1*] and M BISWAL[2]

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[2]*Department of Civil Engineering, CAPGS, BPUT, Rourkela, India*

Aims: The present study deals with free vibration analyses of bidirectional laminated composite shell panels subjected to harmonic in-plane loading in hygrothermal environment. The effects of various parameters like curvature, number of layers, stacking sequence, temperature, moisture, boundary conditions on the free vibration, behaviour of woven fiber glass/epoxy composite shell panels are investigated in the present study.

Methods: Numerical dynamic analysis is carried out using finite element method (FEM) and experimental modal testing are conducted using B&K FFT Analyzer for free vibration of bidirectional laminated composite shell panels under hygrothermal loading. A composite doubly curved shell model based on first order shear deformation theory (FSDT) is considered for free vibration analyses of shells subjected to elevated temperatures and moisture concentrations.

Results: The numerical and experimental results show that there is a reduction in natural frequency of laminated composite shells with the increase in temperature and moisture concentrations. A good matching is observed between the numerical and experimental results for free vibration of laminated composite curved panels in hygrothermal field.

Conclusions: Significant impact of temperature and moisture concentrations is observed on the vibration characteristics of laminated woven fiber glass/epoxy composite curved panels. The free vibration results can be used as a technique for structural health monitoring or testing of structural integrity, performance and safety.

MS1568

Three-Dimensional Analysis of Dislocation Structure at Grain Boundary Pop-ins in Tungsten

Farhan Javaid
School of Chemical & Materials Engineering, National University of Sciences and Technology, Pakistan

Abstract. Berkovich nanoindentation experiments were performed in the vicinity of a grain boundary (GB) in coarse-grained tungsten. In addition to the first pop-in (which depicts the elastic to the plastic transition of the material), a secondary pop-in event was observed in the load-displacement curve. The GB pop-in load was strongly influenced by the distance of the indenter to the GB and indenter orientation with respect to the GB. Moreover, a significant hardness increase was observed before the GB pop-in events. Furthermore, the dislocation structure at the GB pop-in event was studied using electron channeling contrast imaging (ECCI) on sequentially polished cross-sections below the surface at – 300 nm and – 1000 nm polishing depths. The ECCI images clearly show the dislocation pile-up in the vicinity of the GB along with transmitted dislocations in the adjacent grain. The transmitted dislocations were also found to be influenced by the indenter orientation with respect to the GB.

MS1565

In-Plane Biaxial Stress Distribution along GFRP Cruciform Geometry

Abdul Mateen Mohammed[1,*], D.V. Ravi Shankar [1] and M. Manzoor Hussain [2]
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[2]*JNTU Hyderabad, India*

Aims: The synchronous formulation to utilize the test data acquired during the uni-axial loading of the test coupon to predict the failure of fiber reinforced composite materials which are anisotropic in nature have observed to be deficient in actual loading synories. Correspondingly, multi-axial test has been materialized to enhance the discriminating astir of these materials which are complex in nature. The present study is concentrated on assortment of a appropriate coupon geometry required to improve the understanding the materials behaviour under bi-axial loading.

Methods: Three different cruciform specimens where subjected to the study in-view of finalizing a geometry which could obtain a uni-from bi-axial stress field and the final failure along the gauge section.

Results: The stress distribution along the gauge section for one of the three geometries was along the gauge section under all the four possible stress ratios.

Conclusions: Finite element analysis (FEA) was effectively enforced on the cruciform specimen with various undercuts and holes and the specimen which was suitable under the biaxail stress was proposed for a coupon geometry.

Acknowledgements: The authors would like to acknowledge the support rendered by SVS Hydraulics, Hyderabad in preparation of Test bench. The authors would also like to thank Mr. K. Vidya Sagar, Managing Director and Proprietor, Sri Venkateswara Associates, Hyderabad for providing the strain smart data acquisition system during the test.

MS1543 To avoid repeatability issue, this abstract will be available after the full paper is published in the conference proceedings.

MS1585

Fracture and Fatigue Resistance of Different CAD/CAM Occlusal Veneers Restorations

Eman H. Albelasy*
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Aim: The purpose of this systematic review was to summarize scientific evidence that evaluates in vitro fracture and fatigue strength of occlusal veneers in different thicknesses, CAD/CAM materials, and under different aging methodologies.

Materials and methods: An electronic search of 3 English databases (The National Library of Medicine (MEDLINE/ PubMed), ScienceDirect, and EBSCOhost) was conducted. Laboratory studies published between September 2009 and October 2019 that evaluated fracture or fatigue strength of CAD/CAM occlusal veneers and used human teeth were selected. The included studies were individually evaluated for the risk of bias following a predetermined criterion. The outcomes assessed included the types of the restorative material, the thickness of the veneers, and aging methods.

Results: A total of 12 studies fulfilled the inclusion criteria. Most of the included studies (86%) evaluated the fracture strength of occlusal veneers. Two studies evaluated fatigue resistance. There was a significant relationship between the choice of materials and fracture strength. Polymeric materials performed better in fatigue testing in comparison to ceramics. Lithium silicate-based glass ceramics showed more favorable outcomes in a thickness of 0.7–1.0 mm. Fracture resistance values in all the included studies exceeded maximum bite forces in the posterior region.

Conclusions: The outcomes of this systematic review suggest that occlusal veneers can withstand bite forces in the posterior region, whereas the measurement of thickness should be standardized in order to have a fair comparison. Further research needs to be conducted to evaluate the longevity of this type of restorations clinically.

MS1525

CFRP New Small-Diameter Material for Strengthening of Steel Bridge Girders

HAMID KAZEM*
North Carolina *State University, USA*

Aims: This study summarizes the findings of a comprehensive research program, including experimental and analytical studies undertaken to examine the use of small-diameter Carbon Fiber Reinforced Polymer (CFRP) strands for shear strengthening of steel structures and bridges.

Methods: The experimental program examined the proposed strengthening system to increase the buckling capacity of total 32 steel plates subjected to uniaxial compressive stresses. The research then continued to examine the same strengthening system for increasing the shear capacity of steel plate by subjecting nine steel plates to pure shear loading conditions. The research extended to testing large scale bridge girder using the same strengthening system to verify the performance. Nonlinear finite element (FE) models calibrated by the experimental results were used to study different parameters that were not included in the experimental program.

Results: Research findings indicated that the proposed system is effective for shear strengthening of steel structures and the material used eliminated the typical debonding failure, commonly observed for strengthening systems using CFRP laminates.

Conclusions: Based on the research finding, design guidelines are recommended for the field application.

Acknowledgements: The authors would like to acknowledge The National Science Foundation (NSF) Center of Integration of Composites into Infrastructure (CICI) at North Carolina State University, the faculty and staff of the Constructed Facilities Laboratory (CFL) at North Carolina State University, and Nippon Steel & Sumikin Material Co., Ltd, Composites Company for their great contribution in this research.

Oral Session 3: Applied Mechanics

Time: 14:00-17:30, December 8, 2020. China Standard Time (GMT+8)
Session Chair: Dr. Salvatore Magazù, University of Messina, Italy
Please Click Paper ID to Access the Video Presentation.
Session Room Link: http://www.academicconf.com/teamslink?confname=msam2020

14:00-14:15	**MS1537**	Effect of Five versus Two Axle Moving Trucks on Structural Dynamic Performance of Frame Bridges *Dr. Amina Mohammed, National Research Council Canada, Canada*
14:15-14:30	**MS1538**	Empirical Correlation of Heat Generation in Hybrid Ball Bearings Depending on the Operational Conditions in the Supports of Aero-Engine Rotor *Mr. Yury Lavrentyev, Central Institute of Aviation Motors (CIAM), Russia*
14:30-14:45	**MS1532**	Estimating Al 1230 Clad Thicknesses over Al 2024 Alloys Using AECC Measurements *Dr. Bassam Abu-Nabah, American University of Sharjah, United Arab Emirates*
14:45-15:00	**MS1469**	A 3D/2D Mixed-Dimensional Structural Model for General Laminated Composites Including REBCO Coated Conductors *Dr. Peifeng Gao, Lanzhou University, China*
15:00-15:15	**MS1569**	Dynamics of Magnetic Dipoles in Low-Dimensional Systems *Dr. Mikhail Kucherov, Siberian Federal University, Russia*
15:15-15:30	**MS1558**	Ballistic Assessment of Multilayer Cross-Ply UHMWPE Laminated Plate *Dr. Rui Zhang, Xi'an Jiaotong university, China*
15:30-15:55	**MS1575 (Invited)**	New Approach for Testing Mechanical Properties of Innovative *Dr. Salvatore Magazù, University of Messina, Italy*
15:55-16:10	**MS1504 (Invited)**	Wave Attenuation and Waveguiding in 3D Phononic Meta-Structures *Dr. Anastasiia Krushynska, University of Groningen, the Netherlands*
16:10-16:20		**BREAK**
16:20-16:45	**MS1488 (Invited)**	Physical Only Modes Identification Using the Stochastic Modal Appropriation Algorithm (SMA) *Dr. Maher Abdelghani, University of Sousse, Tunisia*
16:45-17:00	**MS1478**	Crashworthiness Design for Ultralight Foam Filled Truncated Conical Sandwich Shells with Corrugated Cores *Mr. Mao Yang, Xi'an Jiaotong University, China*
17:00-17:15	**MS1559**	Waste Management by Using Plasma *Dr. Emilio A. Figueroa, Universidad Tecnológica Metropolitana, Chile*
17:15-17:30	**MS1580**	Topological Reface of Continuum Mechanics *Dr. Ryabov Valeriy, National Research Centre "Kurchatov Institute", Russia*

Abstracts of Session 3

MS1537 To avoid repeatability issue, this abstract will be available after the full paper is published in the conference proceedings.

MS1538 To avoid repeatability issue, this abstract will be available after the full paper is published in the conference proceedings.

MS1532 To avoid repeatability issue, this abstract will be available after the full paper is published in the conference proceedings.

MS1469

A 3D/2D Mixed-Dimensional Structural Model for General Laminated Composites Including REBCO Coated Conductors

Peifeng Gao[1,*], Wan-Kan Chan[2*], Xingzhe Wang[1], Youhe Zhou[1] and Justin Schwartz[3]
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[2]*Department of Materials Science & Engineering, North Carolina State University, Raleigh, NC, 27695, USA*
[3]*Department of Engineering Science & Mechanics, College of Engineering, The Pennsylvania State University, University Park, PA 16802, USA*

Aims: Modelling high precision, efficient numerical finite element (FE) models for general laminated composites containing high-aspect-ratio (HAR) thin film interlayers with vastly different material properties for elastic-plastic behavior and delamination failure analyses.

Methods: The three-dimensional/two-dimensional (3D/2D) mixed-dimensional modeling method is adopted to build a novel elastic-plastic structural mechanics model, which realizes the entire simulation of fabrication and cooling processes and subsequently under tensile loading with multi-step modeling. Based on the cohesive zone model (CZM) and 3D/2D mixed-dimensional modeling methodology, the delamination model is further generated. The models include all the major constituent layers of a typical REBCO conductor.

Results: Simulation results show that the 3D/2D mixed-dimensional model performs simulations with much higher computational efficiency than the full-3D counterpart while maintaining sufficient accuracy. Multi-step modeling is an effective method for elastic-plastic stress and strain analyses of REBCO conductors during the fabrication and cooling processes and under and tensile loads. The 3D/2D mixed-dimensional elastic-plastic delamination FE model based on CZM can be used to study the delamination behaviors in REBCO conductors.

Conclusions: The 3D/2D mixed-dimensional method models any number of laminated HAR thin layers in a composite as stacked 2D surfaces, thus, resolving the thickness-dependent meshing and computational problems in modeling such composites with full 3D FE approaches.

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MS1569
Dynamics of Magnetic Dipoles in Low-Dimensional Systems

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Abstract. This work is a study of coherent superposition of magnetic dipoles, $P_i^m S_i^+$ in the high-temperature approximation and rigid limit that form changing magnetic environment of the tagged spin-bearing atom. The projector P_i^m is the tensor product of single spin ½ projectors at sites $\boldsymbol{r}_j$ ($\neq \boldsymbol{r}_i$). The interactions within the cluster have been considered in detail based on the effective Hamiltonian obtained from the truncated dipolar one. By using a symmetry-adapted basis operator set, the overall density matrix equation was decoupled into finite number of equations for the time-resolved isochromat components, the sum of which yields the observed signal. The appropriate Liouville equation is solved by an eigenfunction expansion. A full range of spectra from classic Engelsberg and Lowe one-dimensional patterns to two-dimensional spectrum in portlandite, $Ca(OH)_2$, is recovered. As an extension of the above approach, the solid-echo experiment is described in terms of the ensemble-averaged isochromats.

Following the direct-product formalism for calculating magnetic resonance signals in many-body systems of interacting spins, the line shape expression in the thermodynamic limit is obtained. The method is extended to describe the behavior of the many-body system in a solid-echo sequence. As expected, only a relatively small number of atoms, the nearest and next-nearest neighbors of a tagged atom, are involved in creating the correlation functions in diamagnetic crystals. It constitutes a useful approach for treating multi-quantum statistical systems.

MS1558
Ballistic Assessment of Multilayer Cross-ply UHMWPE Laminated Plate

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Abstract. The ballistic performance of multilayer cross-ply ultra-high molecular weight polyethylene (UHMWPE) laminated plate was explored both experimentally and numerically. High velocity impacts were performed on the monolithic and multilayer targets with the same weight. Ballistic data of the different targets was obtained, with dynamic deformation features captured and failure modes examined. A finite element model was built to simulate the responses of target plate and further investigate the mechanisms. Good agreement was obtained between numerical simulations and experimental measurements. The results indicated that multi layering the target could help relieve the fiber tensile stress on the rear face and lead to a more significant boundary pull-in effect, causing a larger back face deflection and an enhancement in ballistic performance.

Keywords: Polymeric Composites, Ballistic Resistance, Multilayer Plates, Experiment.

MS1575

New Approach for Testing Mechanical Properties of Innovative Materials Submitted to Stress Conditions

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Aims: The aim of this work is to propose an innovative approach for characterizing, in the nanoscopic range, the mechanical properties, as well as their temperature dependence, of innovative materials, submitted to stress conditions, by means of different spectroscopic techniques. In particular, the proposed approach allows to measure a pseudo force constant, *k*, in order to quantify the mechanical resilience of materials used in the aerospatial field.

Methods: In order to calculate the pseudo force constant, EINS measurements can be performed. Furthermore a comparison with other techniques, i.e., Infrared Absorption and Raman Scattering, is also proposed.

Results: The evaluation of the pseudo force constant allows to characterize the mechanical properties, as well as their temperature dependence, for a wide class of systems.

Conclusions: The mechanical rigidity of a material system is characterized by means of pseudo-force constant. The approach also allows characterizing the temperature dependence of mechanical properties. This approach can be applied to innovative materials, submitted to stress conditions.

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MS1504

Wave Attenuation and Waveguiding in 3D Phononic Meta-Structures

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Aims: Manipulation of low-frequency mechanical waves and vibrations is challenging, yet highly desirable for multiple applications in different engineering fields. This work proposes several three-dimensional configurations of architected materials capable of strongly attenuating or waveguiding waves in broadband low-frequency ranges.

Methods: The design principle of the wave-attenuating meta-materials implies activation of one or several wave scattering mechanisms by changing structural parameters of cellular configurations. The latter are composed of periodic identical cubic blocks and beams. Variations in the beams thickness and inclination angles enables generating extremely broadband band gaps estimated by means of the finite-element method. The wave-guiding meta-materials are obtained by creating an arbitrary curved wave-path represented by unit cells of one of the developed designs inside the other meta-structure.

Results: The proposed approach provides a reliable way to achieve strong omnidirectional mechanical wave attenuation or path-independent waveguiding by means of compact meta-structures. The numerical results are corroborated by a good agreement with experimental measurements on additively manufactures meta-material samples.

Conclusions: The developed approach opens a way to a more general concept to design compact, easy-to-manufacture cellular materials capable of excellently controlling low-frequency waves in broadband regimes. These meta-structures can act as acoustic or mechanical filters, sensors, be used in non-destructive evaluation or other engineering devices.

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MS1488

Physical Only Modes Identification using the Stochastic Modal Appropriation Algorithm (SMA)

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Abstract. Recently the author proposed a new In-Operation modal identification algorithm, namely the Stochastic Modal Appropriation algorithm (SMA) which identifies the frequency and the damping ratio simultaneously in a single step. The key idea is to rotate parametrically the outputs correlation sequence so as it looks like the system impulse response.

We show in this work that SMA rejects automatically harmonics as well as spurious/numerical modes leading therefore to physical-only modes identification. After a mathematical proof, the method is validated on a simulated example.

MS1478

Crashworthiness Design for Ultralight Foam Filled Truncated Conical Sandwich Shells with Corrugated Cores

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Aim: The quasi-static and dynamic crushing and energy absorption behaviors of a novel ultralight foam filled truncated conical sandwich shells (FFTCSS) with corrugated cores were investigated and optimized.

Methods: Three different forms of FFTCSS, i.e. foam filled (i) inner cavity, (ii) corrugated channel, (iii) inner cavity and corrugated channel, were fabricated and experimentally studied. Detailed parametric study with three-dimensional finite element simulations was subsequently carried out. Finally, multi-objective optimization design was performed based on response surface model.

Results: The foam filled structure had higher energy absorption (*EA*) than the unfilled structure, and the foam filled in the corrugated channel had the highest specific energy absorption (*SEA*). Increasing the taper angle in a certain range could improve the energy absorption ability of the structure. The value of *SEA* and peak force (*PF*) raised with increasing the impact velocity.

Conclusions: The foam could improve the energy absorption ability of the structure, especially the foam filled corrugated channel structure had obvious coupling effect. This was the advantage of the FFTCSS compared to other foam filled structures.

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MS1559
Waste Management by Using Plasma

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Abstract. The amount of garbage per capita produced daily has reached unmanageable levels that explains the need to implement new technologies for its management and treatment. By using plasma can handle all types of solid urban waste, residential as well as industrial waste. The technologies involved in waste management should focus on maximizing material recovery, improving processes that allow us to obtain usable energy from the same waste and above all minimizing environmental impact. The process behind plasma waste treatment is the gasification, where enough energy is transferred to a substance such that it is transformed into partly in gas and another partly in molten lava. The lava cools to become an inert vitreous and hot gases can be used for electricity production and this can be used both to energize the same treatment plant and to deliver electricity to the external power grid. It is a study dedicated to evaluating the feasibility of implementing urban waste treatment by a plasma system.

MS1580
Topological Reface of Continuum Mechanics

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Abstract. Topological reface of continuum mechanics allowing an atomistic treatment is given. It suggests a body as a surface immersed into ambient space. Four kinds of surfaces inherent to basic deformations determine classical dynamics of the atoms alongside their spatial coordinates. For uniaxial stretch, this surface is isomorphic to the cylinder. For a simple shear, it is the twisted cylinder, for a bending a cone, and for a torsion a helicoid. Scalar parameters of the metric of these surfaces that are stretch ratios, shear, cone and torsion angles used instead of the strain tensor constitute extra coordinates of the particles in hypersurface. Correspondingly, vector valued tensions and moments are used instead of stress. In the case of pure deformation, the normal and extra coordinates of atoms obey classical equation of motion admitting periodic boundary conditions. In boundary problems, the system of governing equations unambiguously reproduce the stress-strain-displacement relations in normal space using the tension boundary theorem instead of Cauchy traction principle. The derived direct method of elastostatic makes the system of governing equations closed and the compatibility condition unnecessary. Examples of the solution of beam cantilever problem normally following from the Airy stress function illustrate the method. Validation of principle of the minimum of action instead of the principle of the minimum of energy gives a single valued solution of boundary problem for any boundary condition as it must be for many particle system. Its dynamics generates an analog of the molecular dynamics method in terms of extra orders of freedom.

Part VI 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.

Reviews on Advanced Materials Science (IF: 1.197)
ISSN: 1605-8127
Indexed by: SCIE, EI Compendex, Scopus, etc.

Mechanika (IF: 0.458)
ISSN: 2029-6983
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.

Part VII Acknowledgements

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Technical Program Committee