Spectrum
Conferences & Expos

INTERNATIONAL SUMMIT ON APPLIED SCIENCE, ENGINEERING AND TECHNOLOGY

March 18, 2024 | Florence, Italy

FOREWORD

Dear Colleagues,

It is our pleasure to invite all scientists, academicians, young researchers, business delegates and students from all over the world to attend the International Summit on Applied Science, Engineering and Technology will be held in Florence, Italy during March 18, 2024.

ISASET2024 shares an insight into the recent research and cutting edge technologies, which gains immense interest with the colossal and exuberant presence of young and brilliant researchers, business, delegates and talented student communities.

ISASET2024 goal is to bring together, a multi-disciplinary group of scientists and Professors from all over the world to present and exchange break-through ideas relating to the Applied Science, Engineering and Technology. It promotes top level research and to globalize the quality research in general, thus makes discussions, presentations more internationally competitive and focusing attention on the recent outstanding achievements in the field of Applied Science, Engineering and Technology.

We're looking forward to an excellent meeting with scientists from different countries around the world and sharing new and exciting results in Applied Science, Engineering and Technology.

COMMITTEE

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Knowledge-Based and Machine Leaning Manufacturing System for the Injection Molding to Achieve Intelligent Mold Trial and Self-Adjustment During Production

Shia Chung Chen
Chuang Yuan Christian University, Taiwan

Abstract:

Injection molding is a cost-effective technology for the mass production of plastics part. During the three stages of melt-filling packing and cooling, the melt is subjected to different pressure, temperature, shear stress at various cavity location resulting in differential orientation and uneven shrinkage that affect part dimension accuracies and warpage most significantly. In addition to the molding parameters, part geometry and mold design such as gate and cooling channel also attribute to the final qualities. Traditionally, the mold trial and production are mastered by experienced molders. This study demonstrates using knowledge-based data to guide the mold trial with a reasonable molding condition first and combined with AI to further optimize the molding parameters. To achieve high part qualities, particularly the precision control, the guiding system can further utilize the acquisition data from cavity embedded pressure and temperature sensors. Multi-stage packing pressure algorithm was employed in line to adjust the P(pressure)-T(Temperature) pathswhich are displayed real time in the P(pressure)v(Specific Volume) T(Temperature) diagram so that even melt shrinkage can be guaranteed. To solve the fluctuation of machine operation and production instability, the tolerance of quality index derived from shrinkage can be defined and machine learning is continuously going on. In case the quality index is out of range, the system will immediately interact with machine controller to adjust the machining setting until the quality index back to the allowable values. This manufacture system intimately integrates with the injection machine makes it smart and “cruise”-like operation.

Biography:

Professor Shia-Chung Chen is currently the Chair Professor of Mechanical Engineering and Director of R&D Center for Smart Manufacturing at Chuang Yuan Christian University, as well as the Honorary Director for Society of Advanced Molding Technology. He used to serve as the Vice Chancellor and Dean of Research and Development at CYCU, and President of Society of Advanced Molding Technology in the past years. He received a Ph.D. degree in Materials Science from Northwestern University, USA in 1984. After graduation, he worked as a Product Manager at Application Engineering Corp., during 1985 to 1987 and Cisigraph Corp., in 1988 in USA. In 1989, he decided to return to his home town, Taiwan, and started his research life at Chung Yuan Christian University till now. He was pointed by Ministry of Education Affairs as the director of Mold Automation Education Resource Center in promoting research/education related mold/molding technology since 2001. He receives many awards such as Outstanding Technology Transfer Award and Distinguished Research Award from NSC, National Invention and Creation Award and Industrial Technology Advancement Award from Ministry of Economic Affairs, and Outstanding Engineering Professor Award from Chinese Institute of Engineers. He is a Fellow of Society of Plastics Engineers.

An Analytical Homogenization Framework for Dynamic Behaviour of Heterogeneous Materials

Jianxiang Wang
Peking University, China

Abstract:

The macroscopic governing equations of heterogeneous materials predicted by conventional micromechanical schemes usually have the same form as those of the constituents, that is, if the latter obey the principle of spatial location action, the former also exhibits the same behavior. While this simple up-scaling transmission of the governing equations is successful in most cases, it cannot describe some fundamental dynamic behaviour of heterogeneous materials, such as the dispersion and bandgaps of elastic waves. With the development of heterogeneous materials, especially metamaterials, researchers have reached a consensus that the macroscopic governing equations of heterogenous materials should be temporal nonlocal or even spatiotemporal nonlocal. On the other hand, since the 1960s, various nonlocal theories have been proposed, and most of them are phenomenological theories, whose physical connections to the properties of heterogeneous materials are largely absent, and the involved parameters are difficult to determine. In order to solve these problems, we propose a bottom-up dynamic homogenization framework for dynamic mechanical behaviour and transient heat conduction of heterogeneous materials. The analytical macroscopic governing equations derived through the homogenization framework are spatiotemporal nonlocal, and all parameters and operators in the macroscopic governing equations are analytically determined by the material and geometrical parameters of the constituents. The origin of nonlocality comes from the homogenization that treats the heterogeneous materials as a single equivalent continuum medium. In addition, the analytical macroscopic governing equations can degenerate into a series of nonlocal thermomechanical models. For example, in the mechanics sense, the macroscopic governing equation can correspond to the Mindlin equation, the Willis formalism, the spatial nonlocal Eringen constitutive relation, and the peridynamic formulation. In the thermal sense, the macroscopic governing equation of the average temperature can degenerate into the Jeffreys-type equation, Nunziato equation, Gurtin and Pipkin equation, peridynamic formulation, and dual-phase- lag (DPL) equation. The parameters and operators in the previous nonlocal theories in the literature can be related to the microscopic parameters through our macroscopic governing equations. Furthermore, the fundamental solutions of the analytical spatiotemporal nonlocal macroscopic governing equations are derived, which have two different Green's functions for initial conditions and body forces. This "double Green's function phenomena" is first reported, which is due to the spatiotemporal nonlocality of the inertia terms. The analytical solutions of our models agree well with those of direct numerical simulations of dynamic responses of heterogeneous materials. The framework provides an alternative to computational homogenization of heterogeneous materials with much less cost of computation.

Keywords: Dynamic homogenization; spatiotemporal nonlocality; Elastic waves; Heat conduction

Biography:

Jianxiang Wang is currently Changjiang Scholar Professor of mechanics in Department of Mechanics and Engineering Science of Peking University. He received his PhD from The University of Sydney in 1995. He joined Peking University in 1998, after doing post-doctoral research in Imperial College in 1996 and Aalborg University in 1997. Jianxiang Wang's research interests cover fracture/failure analyses of composite materials, constitutive relations and transport properties of heterogeneous materials and nano-structured materials, surface effects in heterogeneous materials and nanomaterials, and the Eshel by formalism. He is Associate Editor of Act a Mechanica Sinica, and served as secretary-general of the 23rd International Congress of Theoretical and Applied Mechanics of the International Union of Theoretical and Applied Mechanics, and member of Congress Committee of the IUTAM. Jianxiang Wang was awarded Excellent Teacher of Beijing and Honorary Visiting Professor of Cardiff University.

VAWTs Beyond 40 MW

Friedrich Grimm
University of Stuttgart, Germany

Abstract:

The presentation of the RES-institute relates to a fusion reactor for which quantum effective geometry conditions are described to achieve permanent electromagnetic plasma confinement. Symmetry conditions within a double helix are identified for charged particles with spin quantum number 1/2 to return precisely to their original spin state within one orbit through the double helix, allowing electromagnetically induced fluid dynamics of the plasma to be understood as a harmonic ring oscillation. This harmonic oscillation achieves dynamic equilibrium within the high-energy state of fusion plasma. The proposal for a novel fusion reactor also encompasses the technical principles for assembling the fusion reactor with the quantum-mechanically effective double helix, designed as an integrated system composed of modular components and functional elements. This integrated system facilitates continuous plasma confinement within the fusion reactor's plasma vessel for an unlimited period of time.

The fusion reactor in question is centered at the intersection of a space defined by longitudinal, transverse, and vertical axes. It's designed to achieve stable electromagnetic confinement of a plasma volume within a plasma vessel surrounded by multiple Helmholtz coils. The plasma volume possesses a flow direction and a central magnetic field line composed of four identical arcs with four vertices and four connection points arranged at a radius around a center point. This central magnetic field line is encircled by concentric helix surfaces providing space for encompassing off center magnetic field lines in multiple layers. Helmholtz coils, positioned at regular intervals transverse to the central magnetic field line are inducting electromagnetic flow in the plasma and in conjunction with a chiasmus of the looped magnetic field lines, enforce a fourfold reversal of the spin of charged particles with a quantum number of 1/2, each change being 180 degrees. This occurs at least once along a zero line of the ring oscillations, spanning two periods of harmonic ring oscillations. Within the concentric layers of the plasma volume and between the tubular surfaces, Deuterium and Tritium nuclei and electrons are guided along spiraling eccentric magnetic field lines, covering equal lengths of path for electrons and ions. The fusion reactor's operational capability is enabled by a cooling system for the coils, by a plasma heating system, by a heat transfer system of the plasma vessel, by a support structure for the plasma vessel, and by a fuel injection system. The reactor facilitates continuous operation by enabling nuclei of Deuterium and Tritium to collide at temperatures ranging from 100 to 400 million degrees Celsius and speeds exceeding 1000 km/s. This collision triggers a chain reaction, resulting in the nuclei's fusion to form Helium by releasing a million times more thermal energy than it would be possible with any exothermic chemical reaction. This is why fusion is so fascinating and holds the promise to solve mankind's pressing energy problems in an elegant way.

Biography:

Prof. Friedrich Grimm was born in Stuttgart in 1954. He studied architecture at the University of Stuttgart and at the Illinois Institute of Technology in Chicago in 1980. After having finished his studies in 1981, he worked as an employed architect and later on temporarily joined the scientific staff of the Institute for Building Construction at the University of Stuttgart. During his practice as a freelanced architect, since 1989 he took part in competitions and completed several multifamily houses in southern Germany. Due to a series of books, which he has written in the field of steel construction, edited by Ernst & Sohn in Berlin (2003), and one the subject of one family homes, edited by Callwey in Munich (2006), he was nominated a professor honorary in 2009 by the faculty one, for architecture and urban design at the university of Stuttgart. In 2016, he founded the RES- Institute as a completely independent think tank in the field of renewable energies. Since then he works with passion and endurance on projects matching the RES-Institutes obligation to provide blueprints for a friendly climate on earth. Several patents in the field of concentrated solar thermal systems led him into the field of optics where he invented a wide angel sensor, recording light signals with infinite depth of field in real time. Among his inventions there is also a new achromatic lens focusing light of different wave lengths, even x-rays. His latest invention relates to a quantum mechanical device which, making use of the electronic spin of quantum particles with spin number 1/2, to create a fluid dynamic equilibrium within electromagnetically enclosed plasma of a fusion reactor, by a regular change of the spin's angular momentum.

Retrieving Injection Molding Knowledge Graph Based on Transformer

Wen Ren Jong
Chuang Yuan Christian University, Taiwan

Abstract:

Injection molding is a production process with high knowledge content. In our previous research, we have established an injection molding industrial knowledge graph to express its intricate knowledge. However, the current knowledge graph is mostly searched through programming language, which makes it difficult for personnel without relevant backgrounds to retrieve knowledge. Furthermore, the current way of searching the knowledge graph also makes it difficult to identify potential relationships between nodes, which limits the usability of the knowledge graph. This study will utilize the previously established injection molding industrial knowledge graph and employ a BERT (Bidirectional Encoder Representations from Transformers) fi-ne-tuning model to analyse the semantic of user questions. Knowledge graph will be retrieved through a search engine built on Transformer Encoder, which can reason based on the structure of the graph to find relevant knowledge that satisfies the user's questions. Experimental results show that both the BERT fi-ne-tuned model and the search engine achieve excellent performance. This approach can help engineers who do not have knowledge graph background to retrieve information from the graph by inputting natural language queries, thereby improving the usability of the graph.

Biography:

Professor Wen Ren Jong is currently the Distinguished Professor of Department of Mechanical Engineering, and Deputy Director of R&D Center for Smart Manufacturing in Chuang Yuan Christian University. He received a Ph.D. from Mechanical Engineering from Cornell University, US in 1989. He used to serve as the Chairman of the Department of Mechanical Engineering, Chief of Student Affairs and Information Technology in Chung Yuan Christian University. He has authored several books, such as IC Packaging Process and CAE Application, and Computer Aided Mold Design. He has been working on integrating CAD/CAM/CAE software for many years. Since 2001, he has developed a knowledge-oriented customized mold design/manufacturing navigating system. He uses the network platform to combine CAD secondary development tools and knowledge management and CAE simulation in order to realize standardized and knowledge-based design process. In the past ten years, it has successively carried out industry-academic cooperation with many well-known companies such as Green Point High-tech, Qisda Tech., Chimei Electronics, Hiwin Tech., Inventec and Walsin Lihwa Cor. etc. Recently his research focus on developing a knowledge-based system with AI learning for plastic mold manufacturing and molding. From design, manufacturing to molding, it will effectively integrate and communicate with various departments, and integrate different systems such as ERP, PDM, MES, etc. at each stage to achieve alliance synchronization. The concept makes information and data transparent and improves the quality of products.

Edge and On-Device Artificial Intelligence Engineering and Technology

Sergio Duarte Correia
Head-Electronics and Instrumentation Laboratory Portalegre Polytechnic University, Portugal

Abstract:

Stochastic methods have gained some popularity in global optimization in that most of them do not assume the cost functions to be differentiable. They have capabilities to avoid being trapped by local optima, and may converge even faster than gradient-based optimization methods on some problems. The present paper proposes an optimization method, which reduces the search space by means of densification curves, coupled with the dynamic canonical descent algorithm. The performances of the new method are shown on several known problems classically used for testing optimization algorithms, and proved to outperform competitive algorithms such as simulated annealing and genetic algorithms.

Biography:

Prof. Sergio D. Correia received his Diploma in Electrical and Computer Engineering from the University of Coimbra, Portugal, in 2000, his Master's Degree in Industrial Control and Maintenance Systems from Beira Interior University, CovilhÃ£, Portugal, in 2010, and the Ph.D. in Electrical and Computer Engineering from the University of Coimbra, Portugal, in 2020. Currently, he is an Associate Professor at the Portalegre Polytechnic University, Portugal. He is also a Researcher at COPELABS - Cognitive and People-centric Computing Research Center, Lusofona University of Humanities and Technologies, Lisbon, Portugal, and VALORIZA - Research Center for Endogenous Resource Valorization, Portalegre Polytechnic University, Portalegre, Portugal, and has worked with several private companies for more than 20 years. His current research interests are Embedded Artificial Intelligence, Soft Computing, Signal Processing, Embedded Systems, and Computer Architecture, topics on which he is an editor of several scientific journals, collaborator at several International Conferences, and guest professor at several European universities.

Realization of Giant Flexoelectric Effect at Macroscale and The Applications as Sensors and Energy Harvesters

Li-Hua Shao
Beihang University, China

Abstract:

Dielectric materials have the property of flexoelectricity, i.e., polarization under non-uniform strains, which has wide applications in sensing, actuating and energy harvesting. However, the research and applications of this effect have been largely restricted to micro- to nano-scales, for producing large strain gradients at the macroscale inevitably results in large strains so as to cause failure of the materials. Thus, achieving significant and practical flexoelectricity of solids at the macroscopic scale has been a challenging issue. Micro- and nano-porous structured materials own a significant number of randomly distributed microscopic pores and ligamentous structures, which can deform non-uniformly under arbitrary forms of macroscopic loading. Moreover, due to the size effect of flexoelectricity, the entire flexoelectricity of the micro- and nano-porous materials will be much more significant than that of the solid counterpart. We develop a theoretical framework of porous structures to predict the flexoelectric electric output, and a quantitative analysis to reveal the major governing parameters is performed. Based on the theory, a stacked-and-twisted porous composite is fabricated to improve the flexoelectric coefficient of ligaments, combining with the optimized aspect ratio, and compression-torsion coupling deformation mode to increase the flexoelectric output. The mass- and deformability-specific flexoelectric current of the porous composite exceeds that of the matrix material by four orders of magnitude. Besides, other natural porous structured materials also have flexoelectric effect. Because of the omnidirectional electromechanical coupling, the porous materials exhibit an effective piezoelectric property. We find the highest density specific equivalent piezoelectric coefficient known for any piezoelectric material. Therefore, porous structured light-weight materials with highly sensitive omnidirectional electromechanical coupling properties enabled by flexoelectricity have fresh possibilities and applications in mechanical sensing and energy harvesting.

Keywords: Flexoelectricity; Porous material; Equivalent piezoelectric coefficient; Strain gradient electric generator; Energy harvesting

Biography:

Prof. Dr.-Ing Li-Hua Shao is currently a full Professor in the Institute of Solid Mechanics, and Vice Dean of School of Aeronautic Science and Engineering of Beihang University. She received her B.Eng degree in mechanical engineering from Dalian University of Technology, and MSc degree in solid mechanics from Peking University. She once studied in Karlsruhe Institute of Technology and received her Ph.D. degree from Hamburg University of Technology in 2012. Her research interests include flexoelectric effect, electro-mechanical deformation of porous media, surface and interface mechanics. She was awarded the first Chou Pei-Yuan Young Investigator Award in Mechanics by the Chinese Society of Theoretical and Applied Mechanics (CSTAM) and the Natural Science Fund for Distinguished Young Scholars of Beijing Municipal. She serves as a Junior Editorial Advisory Board member of Engineering Fracture Mechanics, and Secretary General of Working Committee of Female Scientists of the CSTAM.

Directional Direct Search Strategies within Global and Local Optimisation

Jose Firmino Aguilar Madeira
Instituto Politecnico de Lisboa, Portugal

Abstract:

In optimization applications, it is common to encounter situations in which it is impossible to use derivative-based methods, numerical approximations of derivatives, or automatic differentiation tools. Typically, computer simulations are used to evaluate the functions. This evaluation may be black-box (given a point, the function value is returned with no additional information) and/or numerically noisy, preventing the application of derivative-based techniques. This encourages the implementation of Derivative-Free Optimization (DFO). In this presentation, directional direct search methods in Global and Local Optimization as well as some applications will be discussed.

Keywords: direct-search methods, positive spanning sets, Pareto dominance, non-smooth calculus

Biography:

Jose Firmino Aguilar Madeira completed his Habilitation in Mathematics in 2021 at the Universidade de Ãvora, PhD in Mathematics in 2019 at the Universidade de Lisboa, Instituto Superior Tacnico, PhD in Mechanical Engineering in 2004 at the Universidade de Lisboa, Instituto Superior Tacnico, MSc in Mathematics in 1995 at the Universidade de Lisboa, Faculdade de CiÃªncias and BSc in the Scientific Area of Pure Mathematics in 1991 at the Universidade de Lisboa, Faculdade de CiÃªncias. He is Associate Professor with habilitation at the Instituto Superior de Engenharia de Lisboa, Instituto PolitÃ©cnico de Lisboa and Integrated Scientific Researcher. He was professor and lecturer of 9 curricular units. Currently he is a teacher of 3 curricular units:" Optimization"," Complementary Mathematics" and" Operational Research". Optimization", "Complements of Operational Research" and "Numerical Calculus".

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Computational Simulations of Fast Marine Vehicle with Aerodynamic Support

Konstantin Matveev
Washington State University, USA

Abstract:

Fast catamaran-type marine vehicles with tunnel hulls can benefit from aerodynamic lift which becomes significant at very high speeds of forward motion. The aerodynamic support helps elevate the boat, which decreases its contact with water, considerably reducing water drag. This effect can be further augmented by using front air-based propellers or even jet engines that direct air or exhaust streams under the boat platform to create an air cushion even at relatively low or even zero forward speed. This allows the boat to become amphibious and move over beach or ice at low speeds, whereas it can carry much heavier payloads at high speeds. Aero-hydrodynamics of air-supported marine craft with propulsors used for both lift and thrust is rather complex and difficult to analyze.

However, with increasing availability of computing power, physics-based high-fidelity numerical tools can be useful in providing detailed information about air and water flows that can be used for design, optimization, and control of such marine vehicles. In this study, computational fluid dynamics simulations are conducted using the state-of-the-art software to determine force and moment characteristics for an air-supported vehicle with front air-based propulsors steadily moving at a high speed over water. Lift and drag forces are calculated by integrating aero-hydrodynamic pressure and shear stress applied on the vehicle surface. The mesh-verification studies are conducted to assess numerical uncertainties of these forces. The main variable parameter in subsequent simulations is a deflection of the flap located at the stern of the platform between two hulls.

The flap can be used to regulate pressure in the air cushion under the platform to control the distribution between aerodynamic lift and thrust. The lift and drag coefficients are found to grow with increasing blockage of the tunnel by deflecting the stern flap downward. At the same time, the center of lift gradually shifts rearward, and the thrust-to-weight ratio shows non-monotonic behavior. Pressure distributions on the vehicle surface, velocity field in the tunnel, and surrounding water surface elevations are reported for two specific conditions. Force estimates for the tunnel portion of the craft are also obtained using the ideal quasi-one-dimensional jet theory based on the potential-flow analysis. It produces values for the tunnel-based lift and drag coefficients, which demonstrate the same trend as computational fluid dynamics results. There is a reasonable quantitative agreement between low- and high-fidelity models at lower flap deflections, but the deviation becomes large at significant tunnel blockage as three-dimensional and nonlinear features of the flow are much more pronounced. Results presented in this paper can benefit developers of aerodynamically supported marine vehicles with amphibious capabilities.

Keywords: Fast amphibious boats; Aero-hydrodynamics; Computational fluid dynamics

Biography:

Konstantin Matveev earned a PhD in Mechanical Engineering from Caltech in 2003 and prior to that BS/MS degrees in Applied Physics from Moscow Institute of Physics and Technology. He carried out post-doctoral research at Los Alamos National Lab and worked as Senior Hydrodynamicist for a naval architecture company. Currently, Dr. Matveev is a professor in the School of Mechanical and Materials Engineering at Washington State University. His main research interests include advanced marine craft, unmanned aerial vehicles, and liquid hydrogen systems. Dr. Matveev co-authored a book on Small Waterplane Ships and was recently elected as ASME Fellow.

PVDF Ultrafiltration Polymeric Membranes Production from Lab to a Pilot Scale: Uses and Results

Liana Padilha
Federal University of Rio Grande do Norte, Brazil

Abstract:

Preparation of polymeric membranes by non-solvent induced phase separation technique (NIPS) was evaluated with the aim to obtain MF and UF suitable characteristics. The influence of the polymer concentration, solvent type and additives addition were investigated on PVC and PVDF hollow fiber membranes. NIPS process parameters as gap exposure, spinneret type, polymeric and bore solution flow rate and precipitation bore solution composition on the membrane morphologies and transport properties were also evaluated. Conditions with high permeability were adjusted to obtain hollow fibers. It was verified that all the variable conditions significantly change the membrane morphology. The additive presence improves the transport properties and allows to obtain membranes with permeability higher than 100 L/h.m2.bar and about of 80% of BSA rejection. The morphologic control throw precipitation rates and thermodynamics conditions of the solution were reached, and it was possible to obtain porous membrane superficies with permeability higher than 1.000 L/h.m2.bar, suitable to MF process. Besides, hollow fibers with minor defects, permeability and rejection in the range of UF processes also could be prepared from the same conditions.

Biography:

Liana Padilha is an Adjunct Professor and Coordinator of Food engineering at the Department of Chemical Engineering at UFRN since 2019. She received her Chemical Engineer graduated from UFSM and PhD in Separation Processes with Membranes from COPPE/UFRJ. She has 15 years of experience in research projects developing laboratory products, pilot plant and industrial stages. She has extensive knowledge in the field of Chemical Engineering, with an emphasis on Separation Processes with Polymeric Membranes, acting on the following topics: synthesis and characterization of membranes, research projects with new separation routes and basic engineering of effluent treatment plants. She teaches classes in Momentum, Heat and Mass Transfer and Chemical Industry Projects and Processes at graduated level. In addition, she collaborates with the Alternative Energies and Transport PhenomenaResearch Laboratory and actively participates in the project to develop ultrafiltration modules in Brazil in partnership with INMETRO and SENAI. Research interests arechemical and food engineering, membrane separation processes, microchannel reactors, protein purification andwaste and wastewater treatment.Liana Padilha is anAdjunct Professor and Coordinator of Food Engineering at the Department of Chemical Engineering at UFRN since 2019. She received her Chemical Engineer graduated from UFSM and PhD in Separation Processes with

Membranes from COPPE/UFRJ. She has 15 years of experience in research projects developing laboratory products, pilot plant and industrial stages. She has extensive knowledge in the field of Chemical Engineering, with an emphasis on Separation Processes with Polymeric Membranes, acting on the following topics: synthesis and characterization of membranes, research projects with new separation routes and basic engineering of effluent treatment plants. She teaches classes in Momentum, Heat and Mass Transfer and Chemical Industry Projects and Processes at graduated level. In addition, she collaborates with the Alternative Energies and Transport Phenomena Research Laboratory and actively participates in the project to develop ultrafiltration modules in Brazil in partnership with INMETRO and SENAI. Her research interests are chemical and food engineering, membrane separation processes, microchannel reactors, protein purification and waste and wastewater treatment.

Simulation for Applied Science and Engineering

Prakash Manandhar
MIT System Design and Management, USA

Abstract:

Numerical models were established to correlate with the experimentally measured properties of mesh conductors previously developed through a combined process of dip coating carbon nanotubes and inkjet printing poly 3, 4-ethylenedioxythiophene: poly styrene sulfonate. The electroluminescent (EL) devices assembled with such mesh conductors as front electrodes were modeled by commercially available finite element method software COMSOL Multiphysics. The modeling results are in agreement with those from the experiments and suggest that an optimized fiber arrangement is the key for further improving the performance of EL devices based on mesh conductors.

Biography:

He has held part-time teaching appointments teaching programming, theory of computing (discrete math) and programming languages, image and signal processing, remote-sensing, and biomechanics. While working in the industry, I have advised multiple student projects on biomechanics and computational ultrasonics, including some that generated patents and an MIT MS degree in Computer Science. With my degree in System Design and Management from MIT, and extensive experience in leading engineering teams, He can teach engineering management and senior design/capstone classes. He currently advise senior design projects at Wentworth Institute of Technology in Boston, MA

Morphological and Chemical Characterization of Natural Asbestos Fibers in Artifical Stone from Historically Significant Contexts and Road Pavements

Elena Marrocchino
University of Ferrara, Italy

Abstract:

Asbestos is a naturally occurring collection of silicate minerals characterized by their fibrous or asbestiform structure. These minerals have been widely employed in various industries due to their exceptional properties, such as high heat resistance, strength, and insulation.

During the process of construction rationalization in the early 19th century, a new industrial material known as "artificial stone" emerged. This cost-effective alternative to luxurious ornamental natural stone gained popularity in European architecture from the late 19th to the early 20th centuries, representing the cultural evolution of the middle class. Italy, in particular, witnessed the rise of artificial stone production during the early 20th century, closely associated with the Italian Monumental Rationalist Architecture movement. Patents from that era described the utilization of natural asbestos fibers as fillers to enhance the physical-mechanical properties, polishability, and durability of decorative concrete elements, primarily for improving molds in the construction of artificial stone blocks.

The extensive use of artificial stone in Italian rationalist monumental architecture has recently attracted attention. In a specific study conducted in Codigoro, a small town near Ferrara in Northeast Italy, the mineralogy and petrography of the building materials employed in the former Casa del Fascio were characterized. The objective was to assess potential degradation and determine the presence of asbestos minerals. Detecting asbestos is crucial due to the associated health risks, ensuring the safety of individuals interacting with these structures.

Furthermore, in the past, natural asbestos fibers were occasionally incorporated into asphalt mixtures for roads, bridges, and infrastructure projects. This addition aimed to enhance the strength and durability of the asphalt, improving its resistance to cracking, rutting, and wear and tear. Identifying the presence of natural asbestos fibers in road materials is of utmost importance to prevent the dispersion of hazardous solid particles into the atmosphere. Inhaling these particles poses a significant risk, particularly for road maintenance personnel. The text also provides a description of the morphological and chemical characterization of asphalt samples utilized in road paving.

The purpose of this study is to conduct a comprehensive morphological and chemical analysis of natural asbestos fibers found in two distinct contexts: artificial stone from historically significant sites and road pavements. By examining the morphological characteristics and chemical composition of these fibers in artificial stone, we aim to gain a deeper understanding of their role in enhancing material properties and determine any potential risks associated with

their presence. Additionally, by analyzing asphalt samples, we seek to identify the presence of natural asbestos fibers in road pavements, taking necessary measures to prevent the dispersion of hazardous particles and ensure the safety of road maintenance personnel.

In summary, this study encompasses a thorough examination of natural asbestos fibers in both artificial stone from historically significant contexts and road pavements. Through morphological and chemical analyses, we can acquire valuable insights into the influence of these fibers on material properties and identify any associated health risks. Ultimately, this research contributes to the safety and preservation of structures and road infrastructures.

Keywords: Natural Asbesto fibers, Rationalist Architecture, material decay

Biography:

Elena Marrocchino is a Researcher at the Department of Environmental and Prevention Sciences of the University of Ferrara. She has a degree in Geological Sciences and a Ph.D. in Mineralogy, Petrology, and Crystallography. Her areas of expertise include: i) Traceability, enhancement, and protection of the quality of agri-food products using geochemical and isotopic approaches for quality certification and sustainable agronomic practices. This ensures the safety of the soil, water resources, and consumers. ii) Petrographic, mineralogical, and geochemical characterization of mining waste and alluvial sediments, with a specific focus on environmentally friendly mineral treatment methods. She explores potential alternative uses for these materials and promotes their utilization in the ceramic and glass industries. iii) Petrographic, mineralogical, and geochemical characterization of building aggregates to facilitate their reuse after appropriate recycling processes. iv) Analysis of environmental aspects and the geochemical, petrographic, mineralogical, and isotopic characterization of sediments, biota, and plastics in harbor and seaside environments in the Upper Adriatic region. v) Petro-archaeometric characterization and classification of archaeological materials such as ceramics, gems, coins, and marbles, as well as architectural materials like lithoid building materials, mortars, concretes, and plasters used in Cultural Heritage. This research aims to determine their origin and assist in restoration efforts.

Elena has published numerous scientific papers in international journals and actively participates in Third Mission and Public Engagement initiatives. She collaborates with local authorities and schools to conduct training activities, develop transversal skills, and raise awareness about environmental issues.

Roses, Robotic System for Endovascular Surgery

Guido Danieli
University of Calabria, Italy

Abstract:

Roses, an innovative Robotic System for Endovascular Surgery, features a unique mechanism that continuously measures the resistance encountered by catheters and guide wires as they advance within the body. This feature operates seamlessly without the need for additional specialized components. The system is comprised of a series of robotic actuators (up to three) arranged linearly on slides running along a rail, inclined towards the patient. Another slide, housing a pair of step motors, facilitates the adjustment of relative positions between the actuators, with the proximal actuator affixed to the motor slide by a lateral bar.

A force transducer, linked to the motor slide via a wire, is responsive to the gravitational component of any object on the rail. Importantly, this force remains constant even as the actuators move. However, the force dynamically changes if an external obstruction hinders the progress of catheters and guide wires, serving as an alert to the attending physician.

The system, uniquely, is also capable of guiding the introduction of the first catheter, even if it is pre-curved. This capability facilitates the complete separation of the doctor from the patient throughout the entire surgical procedure.

The system employs compact, purely mechanical disposables designed for a wide range of interventions utilizing commercially available catheters and guide wires, including angioplasty, brain and carotid surgery (for aneurysms or thrombi), TAVI, and various lower and upper limb procedures. Future developments include the incorporation of animated catheters capable of altering their shape configuration under console control.

As the system also records the penetration length of each device and transmits this data to a workstation along with X-ray images, it effectively becomes the "black box" of endovascular surgeries. This functionality allows for a complete separation between physicians and patients throughout the entire surgical procedure. The system is safeguarded by multiple pending international patent applications.

Biography:

Guido Danieli, M.S. in M.E. University of Naples (1971). Graduate student (1971) at M.I.T., Research Assistant (1972) of the M. E. Dept., M.S. in M.E. (1973), and a Ph.D. in M.E. (1976) in the field of Combustion Engines. December 1974 Assistant Professor, 1984 Associate Professor, 2003 Full Professor, Faculty of Engineering of Calabria University.

Part-time Professor from 1984 to 1994, he gained a wide knowledge in the Bioengineering field. Research contracts with Fiat Research Centre on Combustion in S.I.E., and with several national and regional research calls.

Retired (age limits) from the University, very active in research with his firm, Calabrian High Tech, of which is CEO.

Author of over 180 technical papers and 80 patents, 20 of which reached the international level, one (on a fixation device) purchased by Biomet for 300k dollars, two by Tecnologica Srl for 224k euro on a device for mouth model determination, two by Bosch und Siemens Haugeraete Gmbh for 26k euro on a washing machine.

His research interests include Classical Mechanics, with particular emphasis on the analysis and synthesis of mechanisms and gears designed to realize given motion laws, biomechanics, robotics, and Virtual Reality Applied to Orthopedics. Presently ROSES, a robotic system for endovascular surgery, is in the registration process to reach the market.

Spin Polarisation in Chiral Molecules/Magnetic Thin Film Hybrid Nanostructure

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Abstract:

In ferromagnets magnetization reversal can be realized either by the external magnetic field or by the spin-polarized current. The manipulation of magnetization by spin-current occurs through the spin-transfer torque (STT) effect. This effect serves, for example, in modern magnetoresistive random access memory (MRAM). However, the current density required for inducing STT is of the order of 1×106 A·cm-2, or about 1x1025 electrons·sec-1·cm-2. This relatively high current density significantly affects the devices' structure and performance. In his study a new effect is discovered: magnetization switching of ferromagnetic (FM) thin layers induced solely by adsorption of chiral molecules (magnetism induced by a proximity of adsorbed chiral molecules - MIPAC). The local magnetization switching is achieved by adsorbing the chiral molecules as a self-assembled monolayer (SAM) on a gold-coated FM layer with perpendicular magnetic anisotropy. The direction of the magnetization depends on the handedness of the adsorbed chiral molecules. Owing to spin-selective electron transfer, the FM layer underneath the SAM molecules becomes spin polarized, and hence magnetization direction is determined. In the present work we combined the two effects, the electron transfer due to SAM formation and the chiral-induced spin selectivity (CISS) effect (where the spin is polarized either parallel or anti-parallel to the electrons' velocity vector according to the handedness of the molecules) in order to demonstrate the ability to control magnetization direction in a FM layer, by adsorption of SAM made from chiral molecules. This concept was demonstrated in optically and electrically induced spin transport experiments in a sandwich type epitaxial nanostructures: Al2O3/Pt/Au/Co (1.5-2.2 nm)/Au (5 nm) with the easy magnetization axis in the out-of-plane direction. The SAMs were made with two enantiomers of the oligopeptide, which are based on α-helix polyalanine L and D. The oligopeptides were adsorbed on predetermined areas on the top gold layer. Enantio-separation of chiral molecules adsorbed on a magnetic nanostructure with perpendicular anisotropy was also demonstrated what is an extremely important process in the pharmaceutical and chemical industries.

Keywords: Nanomagnetism, Chiral Molecules, Spin Polarization, Chiral-Induced Spin Selectivity

Biography:

Prof. Lech T. Baczewski is a Head of the Magnetic Heterostructures Laboratory in the Institute of Physics Polish Academy of Sciences in Warsaw, Poland. He is involved in studying the metallic magnetic thin films and nanostructures grown by Molecular Beam Epitaxy (MBE). Topics of interest: exchange interactions in rare-earths- transition metals thin films and multilayers, spin reorientation transition in magnetic Co based nanostructures – tailoring of magnetic properties, interface related magnetic phenomena studied by Polarized Neutron Reflectivity and Xray Magnetic Circular Dichroism – induced magnetic moment, magnetic and structural studies of Co nanotubes grown on ZnTe nanowires template, nanomagnetism – magnetic anisotropy in ultra-thin Co nanostructures depending on type of buffer and/or cover layer such as Co/Au, Co/Pt, Co/Mo, Co/V, anisotropy origin in Fe/Pt and FeNi L10 nanostructures, the chiral-induced spin selectivity, magnetism induced by a proximity of adsorbed chiral molecules. Invited professor at University of Nancy, University of Grenoble and Laboratoire Louis Neel, CNRS, University Paris-Sud, Orsay in France, Kyoto University and Tohoku University in Sendai, Japan. President of the Management Board of the Polish Academy of Sciences Scientific Centre "Nanophysics and Spintronics - SPINLAB". Author and co-author of more than 200 publications in international scientific journals.

Digital Twins for Image Analysis of Granular Media

Johan Debayle
Ecole des Mines de Saint-Étienne, France

Abstract:

Granular media are widely used in many industrial applications and fields of science from physics to chemistry, biology or agronomy. In energy, power and chemical engineering systems, in particular, it is generally desired to extract information on geometrical characteristics and on spatial distribution from 2D images of the population of particles/grains involved in the process. For example in pharmaceutics, the size and the shape of crystals of active ingredients are known to have a considerable impact on the final quality of products, such as drugs. As another example, the performance of fuel cells is mainly related to the electrode microstructure (size and spatial distribution of the solid and porous phase). The purpose of this talk is then to show different ways (deterministic and stochastic methods using digital twins) of image processing, analysis and modeling to geometrically characterize such granular media from 2-D or 3-D images/videos. The developed methods will be presented by addressing different issues: overlapping, projection, blur... The methods are mainly based on image enhancement, restoration, segmentation, tracking, modeling, feature detection, stereology, stochastic geometry, pattern recognition and machine learning. The methods will be particularly illustrated on real applications of crystallization processes (for pharmaceutics industry), multiphase flow processes (for nuclear industry) and fuel cell power systems (for energy industry).

Biography:

Johan Debayle received his M.Sc., Ph.D. and Habilitation degrees in the field of image processing and analysis, in 2002, 2005 and 2012 respectively. Currently, he is a Full Professor at the Ecole Nationale Supérieure des Mines de Saint-Etienne (MINES Saint-Etienne) in France, within the SPIN Center and the LGF Laboratory, UMR CNRS 5307, where he leads the PMDM Department interested in image analysis of granular media. He is also the Deputy Director of the MORPHEA CNRS GDR 2021 Research Group. He is the Head of the Master of Science in Mathematical Imaging and Spatial Pattern Analysis (MISPA) at MINES Saint-Etienne.

His research interests include image processing and analysis, pattern recognition and stochastic geometry. He published more than 170 international papers in international journals and conference proceedings. He has been invited to give a keynote talk in several international conferences.

He is the General Chair/Co-Chair of the international conferences and served as Program committee member in several international conferences. He is Associate Editor for 7 international journals: Pattern Recognition Letters, Pattern Analysis and Applications, Journal of Electronic Imaging, Journal of Imaging, IET Image Processing, Springer Nature Computer Science and Image Analysis and Stereology.

Security Holographic Labels with Hyperfine Structures Imprinted via Biodegradable Polymeric Plates

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Abstract:

Holographic labels (HLs) are aluminium foils including nanometric details that give them the advantage of being difficult to counterfeit. They combine several complex scientific knowledge in their design and fabrication processes, as well as expensive equipment for manufacturing and detection. HLs are smart elements designed and produced to secure important documents, credit cards, banknotes, passports, deluxe products. From this reason, thousands of millions of HL are produced annually, each series containing different security elements. Their security level increases if HL contains many submicronic or hidden structures revealed only with sophisticated instruments like microscopes, lasers or ellipsometers.

Our purpose is to enhance HLs technological fabrication processes by introducing transparent, re-usable, eco-friendly biodegradable polymer plates, ensuring the faithful transfer of the submicrometric structures for the correct formation of the optical images and effects. The submicrometric structures are of the type of diffraction gratings with different constants and orientations to ensure visual effects in white light (solar light, artificial illumination).

HL fabrication process starts with a master produced by laser modulation in a photoresist on glass plate and ends with the biodegradable polymeric plate which contains the microrelief to be finally embossed on an aluminium foil, i.e., the commercial product. To establish the optimal technological parameters for biodegradable polymers (temperature, pressure, duty cycles) we have tested several variants in the laboratory using dynamic mechanical and thermal analyses.

For the characterisation of submicrometric structures on biodegradable polymers, we choose quantitative phase imaging technique, based on the Mach-Zehnder interferometer, configuration in transmission; it gives us the depth of the submicrometric structures with nanometres resolution. We used hyperspectral imaging under enhanced darkfield microscopy for transversal characterization of nanometric details.

To increase the security level of HL, we introduced a new security element as diffractive cylindrical Fresnel lenses divided in hyperfine structures. An ensemble of cylindrical Fresnel lenses designed to exhibit the same focal length at three distinct wavelengths will be presented. The optical effect that forms focal lines at desired distances is part of the "hidden image" category and is only visible using a laser that illuminates the structures. In the design process, we divide the quasiperiodic structures resulted from Fresnel lenses equation into fine structures with submicronic dimensions.

In conclusion, we introduced submicrometric details designed as fine structures to increase the security level of HL, and we have greened the manufacturing technology by introducing biodegradable polymeric plates that can be reused, ensuring the reliable transfer of submicrometric structures to accurately generate the optical images and effects.

Keywords: Holographic labels; diffraction gratings; biodegradable polymers; security

Biography:

Dr. Mihailescu studied Physics at the Bucharest University, Romania, graduated as MS in 1991, received her PhD degree in 2007 at Politehnica University Bucharest and now she is Professor at the National University for Science and Technology Politehnica Bucharest. She developed the first laboratory from Romania in digital holographic microscopy with two main branches: 1/ computer generated holograms with applications in free space optical communications and security elements, and 2/ to investigate cultured cells and compute specific parameters like refractive index, dry mass, dry mass density at cellular level. Now, the laboratory is equipped with a hyperspectral microscope to characterize nanostructures, to detect nanoparticles densities inside cells, NPs uptake efficiency. Now, she is involved in many projects aiming at the development of systems and methods based on optical techniques with different applications. She has published more than 110 research articles.


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