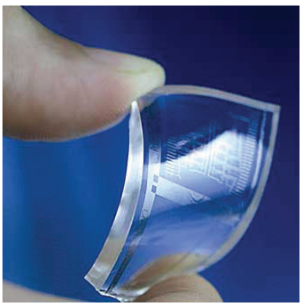
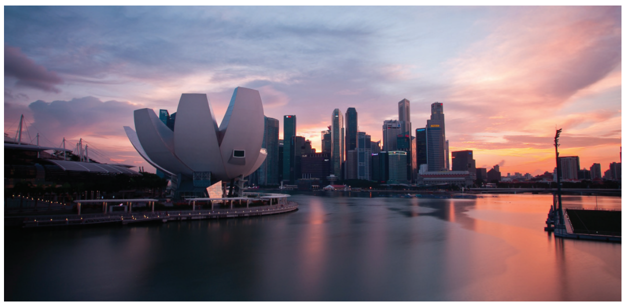
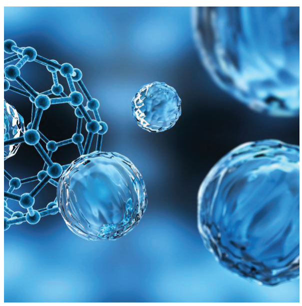
Keynote Forum
November 21, 2019

Smart Materials & Polymer Chemistry 2019

Joint event on

WORLD CONGRESS ON SMART MATERIALS AND STRUCTURES

&

3rd International Conference on

POLYMER CHEMISTRY AND MATERIALS ENGINEERING

November 21-22, 2019 | Singapore

Sidi A Bencherif

Northeastern University, USA

Engineering injectable polymeric cryogels for biomedical applications

For a number of biomedical applications, including cell therapy and tissue engineering, there is an increasing need to engineer advanced three-dimensional (3D) scaffolds to provide a structural and mechanical support for cells and guide tissue regeneration. Engineering injectable biomaterials have become a promising approach for scaffold implantation into the body while avoiding open surgery and post-surgery complications. To that end, we have recently unveiled a breakthrough technology for the delivery via conventional needle–syringe injection of large preformed macroporous hydrogels called cryogels with well-defined properties.

Our 2012 publication (Bencherif et al. PNAS) disclosing the first cryogel scaffold to be injected through a conventional small-bore needle while recapitulating aspects of the native cell niche has sparked massive interest in the field. These injectable cryogels in the form of elastic sponge-like matrices are prepared by environmentally friendly cryotropic gelation of water soluble polymers giving rise to 3D scaffolds with unique properties, including shape-memory properties and complete geometric restoration once delivered in the body. Cryogels displaying an interconnected macro porous structure can be molded to a variety of shapes and sizes, and may be optionally loaded with therapeutic agents or cells. These cryogels with unique features have created a new class of injectable materials applicable for a number of biomedical applications including tissue engineering, drug delivery, cell transplantation, cosmetics, and more recently cancer immunotherapy.

Biography

Sidi A Bencherif is the Director of the Laboratory for Advanced and Multifunctional Polymeric Biomaterials and an Assistant Professor in the Department of Chemical Engineering at Northeastern University. He is also appointed as an Associate at Harvard University. In 2009, he received a PhD in Chemistry from Carnegie Mellon University. Following his PhD, he was initially appointed as a postdoctoral researcher and then later as a researcher associate at Harvard University and the Wyss Institute for Biologically Inspired Engineering. He has authored and coauthored in top journals (Science, PNAS, Nature Materials, Nature Communications, etc.), international conference proceedings, reviews and patent applications, and he is the recipient of several fellowships, honors and awards, including the prestigious National Science Foundation CAREER award. He has over 50 publications that have been cited over 4000 times, and his H-index is 24 and has been serving as an editorial board member of reputed Journals.

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Bassem Andrawes

University of Illinois at Urbana-Champaign, USA

Application of shape memory technology in civil structures

The last few decades have clearly demonstrated the vulnerability of civil structures to problems related to aging and natural or man-made hazards. Conventional materials have proven to be limited in terms of their ability to withstand the extreme demands imposed on them by modern societies. Hence, there is growing interest in the application of innovative and smart materials to extend the service life of civil structures. This presentation will discuss one particular class of smart materials, namely shape memory alloys (SMAs) and their potential applications in civil structures. SMAs have recently emerged as a potential construction material with unique thermomechanical phenomena, namely shape memory effect and superelasticity. These phenomena are related to the ability of SMA to recover its original shape after being extremely deformed beyond its elastic range. Both phenomena have attracted the attention of researchers and practitioners in the structural engineering industry. This presentation will provide three examples of the recently studied applications of SMAs in civil structures. The first application involves the use of SMA in performing seismic retrofit and repair of bridge columns. In this application SMA is used in the form of thermally-prestressed spirals that can apply large active confinement pressure to the columns. The second application focuses on utilizing superelastic SMA as seismic dampers and restrainers for bridges. The recentering capability of SMA is sought to prevent failure during strong ground motions. Finally, the third application focuses on developing a new type of fiber reinforced polymer composite reinforced with superelastic SMA fibers. The newly developed composite material is studied as seismic reinforcing bars for buildings. In all three applications, the performance of the proposed SMA technology is compared with that of conventional and currently used technologies.

Biography

Bassem Andrawes is a professor and CEE excellence faculty fellow in the department of civil and environmental engineering at the University of Illinois at Urbana-Champaign (UIUC), USA. He received his Ph.D. degree from Georgia Institute of Technology in 2005. He has been on the faculty at UIUC since 2006. His research interests are primarily in the areas of application of smart materials in civil structures subjected to natural and man-made hazards, constitutive modeling and testing of shape memory alloys under extreme dynamic loads, and large-scale experimental testing. He has over 130 publications. He is a recipient of the prestigious US National Science Foundation (NSF) CAREER award. He has served or is currently serving as the chair of several technical committees associated with the American Society of Civil Engineers (ASCE) and the American Concrete Institute (ACI).

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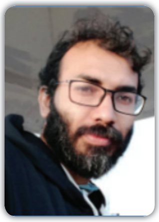

Arun D I

Indian Space Research Organisation, India

Smart materials: Evolution of intelligence

Stone Age, Bronze Age, Iron Age, and Silicon Age are the names given to the timeline of human civilization history which highlight the materials in use during each period. The mere naming process suggests that each of these periods evolved technologically and culturally to the next era, primarily through advancements in the field of materials science. The demand for lighter, stronger, and more reliable materials has resulted in the study of a new prospect called multifunctional materials. A specific subgroup of such materials with the capability to sense, process, and respond to external stimuli evolved as smart materials. Camouflage of a chameleon, shyness of the leaves of touch-me not plant, ink shooting of a squid are few of the popularized smartness exhibited by nature, which we humans have copied as ready made solutions during the various stages of our developments. More the challenges, more we looked for stable solutions from natural smart systems. The basic units of such smart systems are termed as smart materials that by function or properties respond intelligently. Shape memory systems or materials find a significant place among the synonyms used for smart materials in this modern era. Alloys, ceramics, gels, polymers and their combinations enrich the domain of shape memory materials, applications of which ranges from cardiovascular stents to deploy-able robotic arms for deep space missions. Today, technology's Cutting edge lustre portrays new manufacturing freedom of shape memory materials inducing multiple dimensions defining 4D printing and 5D materials. The lecture titled "Smart materials: Evolution of Intelligence" will take a journey through the natural smart systems, their influence, various shape memory materials and their mechanisms, applications that links us back to the nature.

Biography

Arun D I is a Scientist at Vikram Sarabhai Space Centre, ISRO and is responsible for design and realisation of composite overwrapped propellant tanks for electric propulsion spacecrafts for ISRO missions. His area of research focuses on smart materials and structures as replacement for the pyro-systems currently in use for deployment in spacecrafts and other space based applications. He has published a book titled SHAPE MEMORY MATERIALS with CRC press, Taylor & Francis group which addresses the basic principles, synthesis / fabrication and applications of smart materials, specifically shape memory materials. In addition to the book, he has generated many research articles about shape memory materials (both theoretical and experimental) which are published with popular refereed journals. His bachelor degree is in Civil Engineering, Masters in Project management and PhD is in the field of Aerospace Engineering.

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Marija Colovic
Jelena Vasiljević, Barbara Simončič, Nataša Čelan Korošin, Matic Šobak, Andrej Demšar, Ivan Jerman
National Institute of Chemistry, Slovenia

Novel fibre forming flame retardant polyamide 6

Wide application of polymers and derived products is causing additional demands in their safe usage, especially in the field of fire safety. Polyamide 6 (PA6) represents one of the most competent high-performance industrial polymers for the technical textile production. The main restrain to the end-use of textile products based on PA6 is their flammability. The strict regulation rules exclude bio-persistent and toxic halogenated flame retardants from the use and require application, of more environment-friendly and sustainable flame retardants. As a consequence, halogen-free flame retardant polyamide 6, FR-PA6 textile filaments are still not commercially available.

In our research, we presented a new approach for solving PA6 flammability in which flame retardant organophosphorus functionality is introduced into the polymer structure within copolymerisation process 1, 2. The first step in the preparation of flame retardant PA6 co-polymer was the synthesis of co-monomer based on 9,10-dihydro-9-oxa-phosphaphenanthrene-10-oxide, DOPO functionalized3 caprolactam. In the next step, the introduction of 15 wt% of synthesised co-monomer in the copolymerisation reaction with -caprolactam resulted in obtaining of co-polymer that exhibited V0 flame retardancy level according to UL94 vertical burning test. Co-polymer with 10 wt% of co-monomer was used for successful textile filament production in the melt-spinning process.

The new approach for FR-PA6 textile filaments production, where more environment-friendly and more sustainable flame retardant functionality is included into PA6 polymer structure by the copolymerisation reaction, was mentioned to be a solution for the flame retardant agglomeration and leaching problems present in the case when flame retardant additives are physically incorporated by melt-compounding. The advantage of the copolymerisation process is also the preservation of PA6 chain structure, which provides chemical FR-PA6 recycling. Furthermore, the possibility for obtaining co-polymer starting material from biomass recycling enables establishment of a circular economy.

Biography

Marija Colovic has completed her PhD at the Faculty of Chemistry and Chemical Technology in Ljubljana in 2012 at the National Institute of Chemistry, Department of Materials Chemistry, Ljubljana, Slovenia. She continued her research at the synthetic resin industry as head of the R&D analytical department. She has 11 publications that have been cited over 100 times. She is an author on the two European patent applications.

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Guangxin Wang

Henan University of Science and Technology, China

Improving anode utilization of Mg-air batteries

Due to the self-corrosion of Mg, a Mg-air battery has a rather low anode utilization rate. In order to improve the anode utilization, work was done to test different methods such as hot rolling, alloying with indium, as well as modifications of electrolyte and air cathode with reduced graphene oxide (RGO). For batteries with a commercial air cathode and a 3.5% NaCl electrolyte, utilization rates of hot-rolled Mg-6Al anode and Mg-6Al-1In anode are 39% and 52% at a current density of 10 mA cm^{-2}, respectively, higher than 36% of as-cast Mg-6Al anode. When electrolyte was modified with a water soluble poly (sodium 4-styrenesulfonate)/RGO, and air cathode was prepared with an RGO/Mn_3O_4 nanometer composite, an anode utilization of 82 % has been achieved with a Mg-6Al-1In anode. At the same time, an energy density of 1620 Wh kg^{-1} has been obtained, much higher than those achieved with a NaCl electrolyte and a commercial air cathode (1115 Wh kg^{-1} and 52%). These results were discussed together with SEM findings of anodes after discharge.

Biography

Guangxin Wang received his PhD from University of Bremen, Germany in 1990. Since then, he has been working as a materials scientist in Germany, USA and China. Right now, he is a professor of Henan University of Science and Technology, China. He has published a book and over 90 technical papers.

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Songye Zhu

The Hong Kong Polytechnic University, Hong Kong

Using superelastic shape memory alloys to achieve earthquake resilience

Modern seismic design philosophy allows buildings to experience significant plastic responses to dissipate energy at plastic hinge regions when subjected to moderate-to-strong earthquakes. Even though the performance target (e.g., Collapse Prevention) of these buildings can be successfully met, such a design philosophy may result in permanent damage concentrated in the selected "sacrificial" regions after earthquakes. The damaged buildings are often demolished because too large residual deformation makes the repair economically unviable. For example, approximately 60% of RC buildings after 2011 New Zealand Christchurch earthquake were demolished because of forbidden repair cost, although most of them did not collapse during the earthquake. The government estimated the total losses would be as much as NZ$40 billion. Furthermore, the central business district was closed for over 2 years and some tall buildings underwent a long-demolished period. A recent study concluded that residual drift ratio greater than 0.5% makes rebuilding a new structure more economical rather than retrofitting the damaged structure. For this reason, new seismic protection concepts, such as resilience-based design (RBD) have recently emerged to minimize structural damage through new technologies or high-performance materials.

As a high-performance metallic material, shape memory alloys (SMAs) can undergo large strains and recover their initial shape through heating (shape memory effect) or unloading (superelastic effect). The schematic of stress-strain responses of superelastic and shape memory behaviors. The stress-strain behavior of SMA is similar to the conventional steel with fat hysteresis loop and remarkable residual strain at a temperature below the martensite finish temperature $T < M_f$; however, residual strain can be recovered through temperature increase. When the temperature above the austenite finish temperature $T > A_f$, SMA exhibits superelastic behavior with little or no residual strain caused by a stress-induced phase transformation from austenite to martensite. Moreover, excellent corrosion resistance performance and high fatigue resistance of NiTi SMAs can overcome the aging, durability, and maintenance issues in a life-cycle design of civil infrastructures. The superelasticity of SMA is appealing to the earthquake engineering research community because flag-shaped hysteresis is associated with minimal residual deformation under cyclic loading.

The lecture highlights the research on seismic applications of superelastic SMAs, from material level, structural member level, to structural system level. The major content includes the thermomechanical constitutive model of SMA, SMA-based dampers and braces, self-centering reinforced concrete walls, high-performance steel rocking columns, shake table test study of a steel frame with SMA braces, and performance-based seismic design method. From the perspective of seismic design, SMA-based structural members and systems exhibit satisfactory and stable flag-shaped hysteretic loops with excellent self-centering capability and sufficient energy dissipation capability. Detailed experimental studies and numerical analyses show superelastic SMAs can provide a promising solution to high-performance structural systems to achieve modern resilient and sustainable civil infrastructure.

Biography

Songye Zhu received his B.Eng. and M.Sc. degrees in Structural Engineering from Tongji University, China in 2000 and 2003, respectively, and his Ph.D. degree in Civil Engineering from Lehigh University, USA in 2007. He is currently an Associate Professor in the Department of Civil and Environmental Engineering and the Hong Kong Branch of National Rail Transit Electrification and Automation Engineering Technology Research Center at The Hong Kong Polytechnic University. He also serves as Editor of Advances in Structural Engineering (an international journal), Associate Editor of International Journal of Nano and Smart Materials, and Immediate Past President of American Society of Civil Engineers – Hong Kong Section (2018-2019).

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Vincent Tan

National University of Singapore, Singapore

Bio-inspired composites

Comprising layers of aligned chitin filaments stacked together, the exoskeletons of many crustaceans are analogous to fibre reinforced composites. A unique feature of crustacean laminates is their helicoidal lay-up. Each layer is rotated a slight angle from the layer below like the steps of a spiral staircase – an unusual configuration that is never considered for structural composites. Carbon fibre reinforced epoxy with helicoidal lay-ups were fabricated and tested to determine if they offered any advantage. Under transverse loads, helicoidal laminates outperformed commonly used cross-ply and quasi-isotropic laminates in terms of peak load by up to 50%. Reasons for the improved performance are suggested and validated by further tests involving other composite material systems. Based on these investigations, ideas for helicoidal laminates that can be healed after sustaining damage will be presented.

Biography

Vincent Tan is an Associate Professor and Deputy Head at the Department of Mechanical Engineering, National University of Singapore. His current research projects cover multiscale modeling of heterogeneous materials, damage in composite materials and structures and ballistics. His research on concurrent multiscale methods and bioinspired composites have been presented in several invited seminars. He is currently a member of the General Council of the International Association for Computational Mechanics and Vice President and Fellow of the Association for Computational Mechanics, Singapore.

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Chengkuo Lee

National University of Singapore, Singapore

Textile based smart sensors and nanogenerators as platform technology for internet of things (IoT) applications

Wearable sensors have received extensive development across the world towards diverse applications in healthcare, sports monitoring, and smart home. Socks with sensing capabilities can reveal more direct sensory information on the body for longer duration in daily life. Textiles-based Triboelectric nanogenerator (T-TENG) not only could be an optimal option for scavenging low-frequency waste energy from body motions as a power source, but also can be used as self-powered sensors due to its soft, flexible, and thin characteristics. With the integration of a high-voltage diode and a mechanical switch, the T-TENG socks are able to generate a high closed-loop current which is used to harvest energy from normal walking to power a Bluetooth module for wireless sensory data transmission under Internet of Things (IoT) framework. In addition, leveraging personalized triboelectric output features, artificial intelligence (AI) based comprehensive gait analysis can tell us about the identification, health condition, and activity of the users. In general, the smart triboelectric socks offer a complete AIoT platform in the applications of foot-based energy harvesting and monitoring the diversified physiological signals for healthcare and smart homes.

Biography

Chengkuo Lee received his Ph.D. degree in precision engineering from The University of Tokyo, Tokyo, Japan, in 1996. Currently, he is the director of Center for Intelligent Sensors and MEMS at National University of Singapore, Singapore. He cofounded Asia Pacific Microsystems, Inc. (APM) in 2001, where he was Vice President of R&D from 2001 to 2005. From 2006 to 2009, he was a Senior Member of the Technical Staff at the Institute of Microelectronics (IME), A-STAR, Singapore. He has co-authored 300+ journal articles and 300+ conference papers. His google scholar citation is more than 9600+. He is Associate Editor of IEEE JMEMS. He is in the Executive Editor Board of J Micromechanics and Microeng. (IOP, UK). He is the Associate editor of Journal of Micro/Nanolithography, MEMS and MOEMS (JM3; SPIE). He is also the Editor of Scientific Reports, Sensors (MDPI), Micromachines (MDPI), and Journal of Sensors (Hindawi).

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Xian-Xu 'Frank' Bai

Hefei University of Technology, China

Hysteresis modeling and precise control of magnetorheological semi-active system

Precise hysteresis description and efficient control of smart materials and structures are the only way to the applications. Magnetorheological semi-active seat suspension system for an extreme application - mine-resistant ambush-protected vehicles, is taken as an example to show: (i) how hysteretic nonlinearity is efficiently modeled and (ii) how precise control is realized.

The impact caused by the detonation of landmines and improvised explosive devices may lead to spine fracture and injury of the seated occupants on mine-resistant ambush-protected vehicles. The vibration transmitted from the uneven road surface is another factor affecting ride comfort/health, on the other hand. Aiming at minimizing the injury to spine and "discomfort" due to the shock and vibration from the terrain or blast, a magnetorheological energy absorber-based semi-active seat suspension system for both shock and vibration mitigation is investigated. A resistor-capacitor operator, summarized from the electric circuit characteristics, is proposed to model the rate-independent memory effect of the magnetorheological energy absorber. A concept of integrated hybrid controller combining strategies for shock and vibration control is proposed for the specific application. The hybrid controller employs the skyhook control strategy to achieve vibration control and the "soft-landing" control strategy to achieve shock control, and it switches between the two control strategies according to the system dynamic states. As a result, precise output of the desired damping force of the hybrid controller is realized by the magnetorheological energy absorber from numerical simulation and experimental tests.

Biography

Xian-Xu 'Frank' Bai received his Ph.D. degree in Instrument Science and Technology from Chongqing University in 2013. He joined Hefei University of Technology in 2013 and founded Laboratory for Adaptive Structures and Intelligent Systems (LASIS) in 2016. His research interests are focused in two areas. (i) Design, optimization, dynamics, and control of smart structures based on smart materials, including magnetorheological fluids/elastomers and magnetostrictive materials, applied to automotive and aerospace systems, and (ii) New mechatronics-based vehicle dynamics and control in emphasis on intelligent/unmanned vehicles. He has authored over 50 international journal and conference articles. He is an inventor on 16 issued Chinese patents and 2 PCT US patents (pending). Currently, he serves as an Associate Editor of Journal of Intelligent Material Systems and Structures. He is a Committee Member of Adaptive Structures and Materials System Branch of Aerospace Division of ASME. He is a peer reviewer of over 30 international journals. He is a member of ASME, SAE-China and IEEE.

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Thomas J Webster

Northeastern University, USA

Revolutionizing medicine with implantable nano sensors

There is an acute shortage of organs due to disease, trauma, congenital defects, and most importantly, age related maladies. While tissue engineering (and nanotechnology) has made great strides towards improving tissue growth, infection control has been largely forgotten. Critically, as a consequence, the Centers for Disease Control have predicted more deaths from antibiotic- resistant bacteria than all cancers combined by 2050. Moreover, there has been a lack of translation to real commercial products. This talk will summarize how nanotechnology with FDA approval can be used to increase tissue growth and decrease implant infection without using antibiotics. Studies will also be highlighted using nano sensors (while getting regulatory approval). Our group has shown that nanofeatures, nano-modifications, nanoparticles, and most importantly, nanosensors can reduce bacterial growth without using antibiotics. This talk will summarize techniques and efforts to create nanosensors for a wide range of medical and tissue engineering applications, particularly those that have received FDA approval and are currently being implanted in humans.

Biography

Thomas J Webster's (H index: 88) degrees are in chemical engineering from the University of Pittsburgh (B.S., 1995) and in biomedical engineering from Rensselaer Polytechnic Institute (M.S., 1997; Ph.D., 2000). He has graduated/supervised over 189 visiting faculty, clinical fellows, post-doctoral students, and thesis completing B.S., M.S., and Ph.D. students. He is the founding editor-in-chief of the *International Journal of Nanomedicine* (pioneering the open- access format). He currently directs or co-directs several centers in the area of biomaterials: The Center for Natural and Tropical Biomaterials (Medellin, Colombia), The Center for Pico and Nanomedicine (Wenzhou China), and The International Materials Research Center (Soochow, China). He regularly appears on NBC, CNN, MSNBC, ABC News, National Geographic, Discovery Channel, and BBC News talking about science and medicine. He has received numerous honors and is currently a fellow of AANM, AIMBE, BMES, NAI, IJN, FSBE, and RSM.

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Masayuki Yamaguchi

Japan Advanced Institute of Science and Technology, Japan

Structure and properties for polymeric materials containing specific salts

The effect of the addition of a specific metal salt compound on the glass transition temperature Tg as well as the dynamic mechanical properties of polymers was investigated using conventional plastic glasses such as poly(methyl methacrylate) (PMMA) and polycarbonate (PC). Lithium trifluoromethanesulfonate (LiFMS) and lithium perchlorate ($LiClO4$) were found to be miscible with PMMA and PC and thus the blends show excellent transparency. Furthermore, the modulus enhancement in the rheological glassy region was clearly detected by the addition of the salts especially for PC. In the case of PMMA, Tg was greatly enhanced, leading to improved heat resistance, without losing its good flowability at melt-processing temperature. The ion-dipole interaction between oxygen atoms in the polymers and the lithium cations dissociated in a polymer is responsible for the phenomena, which becomes weak at high temperature. This technique is applicable to various polymers. For semicrystalline polymers, the crystallization rate tends to decrease and thus the degree of crystallization becomes low by the salt addition. Moreover, some specific salts enhance the miscibility for immiscible polymer pairs.

Biography

Masayuki Yamaguchi has joined in Japan Advanced Institute of Science and Technology after working in a chemical company in Japan for 17 years. He is a professor and a head of Materials Chemistry Area. He got his doctorate in engineering from Kyoto University, Japan.

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Notes:

Peter W Tse

City University of Hong Kong, Hong Kong

Novel design of a smart guided-wave-based sensor to enhance the ability in detecting defects occurred in pipes

Pipes are important infrastructures in modern cities. Carrying gas, water and sewage wastes, pipes are prone to defects as a result of aging and corrosive environment. Detecting such defects in their early stages is of vital importance so that any gas and water leakage and subsequently disastrous explosions can be avoided. Today, there is no commercially available system that can effectively detect defects occurred in building pipes especially when they are concealed in concrete wall. Guided wave (GW) is a popular NDT method for detecting corrosion occurred in pipes. Here, an innovative GW-based sensor that employed smart materials for emitting desired GW signals into a pipe and then receiving signals reflected from any pipe defects has been designed. Different than conventional piezoelectric transducers, which is time and labour intensive to be mounted on inspected objects, a new magnetostrictive sensor, which is embedded with our invented flexible printed coil and a thin patch of smart material, has been developed. Because the entire sensor is made out of thin sheets, it can be easily wrapped around any size of pipe. By employing smart material, which has stronger magnetostrictive property, the GW energy emitted by the sensor for detecting defects has been significantly enhanced. Moreover, the smart sensor can be applied to both metal and plastic pipes. Several field tests were conducted in buildings using in-service gas pipes that were partially covered by building walls. The results prove that the smart sensor can reveal pipe defects and corrosion even part of the pipe is covered by walls. Finally, the current market available transduction systems was found to be bulky and expensive. Hence a new, low-cost and portable transduction system has been implemented so that it can be workable on-site and inspects in-service gas pipes that are installed in modern buildings.

Biography

Peter W Tse is a Fellow of American Society of Mechanical Engineers and a Foundation Fellow of International Society of Engineering Asset Management. He is the Associate Director of the Centre for Systems and Informatics Engineering. He obtained his B.Eng. and M.Sc. from Canada and his Ph.D. from United Kingdom. He is a Chartered Engineer and a Professional Engineer registered in UK and Canada. He is the committee member of ISO's Technical Committees (TC): TC108, TC135 and TC199. As of today, his Scopus h-index 34 with 4,980 citations and Google Scholar h-index is 39 with 6,830 citations. He has published over 460 articles in various journals, proceedings, newspapers etc. Currently, his research outcomes have been applied to over 30 local and international companies. Recognized by the Council of Canadian Academies as the author of Top 1% most highly cited papers in the related research field worldwide in year 2016.

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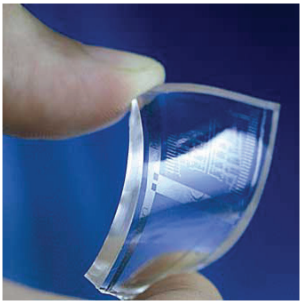

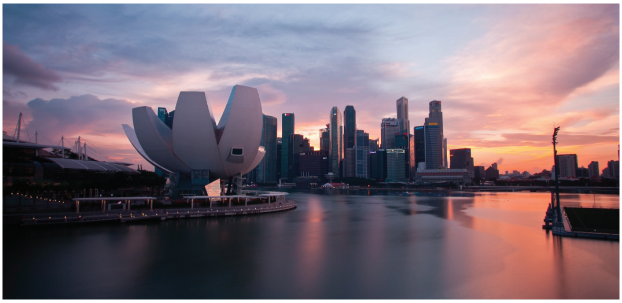

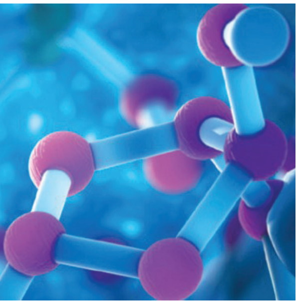

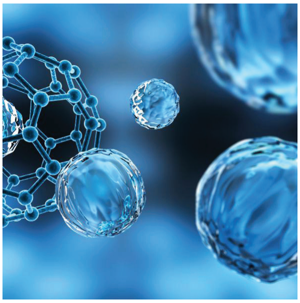

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Chulho Yang

Oklahoma State University, USA

Auxetic cell-structures applied to soft exoskeleton suits and protection garments

This research seeks to develop an innovative wearable garment that will be used as a structural member of an exoskeleton when it conducts its own tasks such as lifting heavy loads, walking and running, as well as protecting the human body from external blunt impact. In order to design a structure with elastic flexibilities in the soft wearable suit, it is important to develop an auxetic unit cell with adjustability of stiffness. This research proposes an enhanced auxetic structure and examining its mechanical behavior in static and impact load conditions. We focus on the nonlinearity and shock-absorption performance of the structures. FEA models were used to examine how the stiffness and Poisson's ratio are affected by static load conditions and also how the dynamic loads are transmitted through the auxetic structure. 3D printing techniques were used to build fixtures and prototypes of the auxetic structures and experiments of several specimens were conducted to verify mechanical characteristics of the proposed structures. Stiffness and Poisson's ratio were examined both in tensile and compression loading conditions and the measured values of mechanical properties were compared with the computational results. It was shown that the proposed auxetic structures had nonlinear behavior and excellent shock absorption performance, which could be useful properties for developing body protection pads and soft wearable suits.

Biography

Chulho Yang received a Ph.D. degree in Mechanical Engineering from Purdue University at West Lafayette, IN, USA as well as M.S. and B.S. degrees from Hanyang University in Korea. Before joining OSU in 2008, he acquired 11 years of industrial experience with ArvinMeritor technical center, IBM Korea, and KIA Motors R&D Center. Much of his work focused on structural design and optimization, vehicle NVH test, sensitivity analysis, structural health monitoring, human body protection, and design methodologies. He registered many patents in the USA, Europe, Japan, and Korea. He received an "Innovation and Achievement Award" from ArvinMeritor, Inc., a "Best Paper Award" from the International Symposium on Advanced Material and Mechanical Application, an "Outstanding Presenter Award" from the International Symposium on Green Manufacturing and Applications. He also served as a keynote speaker or a session chair for multiple international conferences.

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Notes:

Zhao-Dong Xu

Southeast University, China

Experimental and numerical study on magneto rheological intelligent materials and dampers

Magnetorheological (MR) fluids and MR dampers are the primary elements of MR intelligent control system. In the presentation, three kinds of MR fluids with different coating materials were prepared and the samples with both high sedimentation stability as well as adjustability through optimized selection were obtained. Meanwhile, the proposed microchain model was verified to be beneficial to the performance optimization of MR fluids. Correspondingly, different types of MR dampers, among which the maximum damper force could reach 48 tons, were fabricated and tested. The performance of MR dampers can be described precisely with the deduction of the mathematical model considering nonlinear hysteresis curves and temperature rise during vibration. Based on the combination of comprehensive theoretical derivation and experimental study of both materials and dampers, the MR intelligent earthquake mitigation technique was promoted.

Biography

Zhao-Dong Xu is Vice President of RC & PC Key Laboratory of Education Ministry, National Distinguished Youth Professor, Changjiang Scholar Distinguished Professor in China. He won the national prize of technical invention, the gold medal of international invention exposition in Geneva. He has published 279 journal papers and 5 monographs in Elsevier, John Welly etc. He has been granted 83 invention patents. He has been invited as the keynote speaker for 37 times.

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Asma Amleh

The American University in Cairo, Egypt

Nylon-coating improves the performance of UHMWPE bearing surfaces

In joint arthroplasty, Ultra High Molecular Weight Polyethylene (UHMWPE) is used as a bearing surface due to its excellent attributes, such as good wear resistance, high strength, bio compatibility, lightweight, chemical stability, and lubricity. We have shown in previous works, the ability of UHMWPE coated with nylon in enhancing both mechanical and biological performances of conventional UHMWPE, including superior tensile strength, higher impact resistance, reduced damage, and improved cell viability. The purpose of the current study is to assess the wound healing and the antimicrobial capabilities of this novel nylon-coated UHMWPE. A combination of biological/biochemical tests, including MTT viability, antibacterial activity (using E. coli and S. aureus), and wound healing assays were performed to assess the bio activity and the bio compatibility of the coated specimens. Additional tests, such as SBF absorption, alizarin staining, SEM, EDX, and FTIR techniques were conducted to evaluate the moisture uptake, osteogenic activity, and the morphology of the coated samples. Our results indicate that the viability of U2OS (osteosarcoma cell line) cells cultured in conditioned media for 48 hours was comparable for both coated (95%) and uncoated (93%) UHMWPE relative to the control. Interestingly, the antibacterial activity test results after 24 hours incubation exhibited that the nylon coated UHMWPE has significantly higher antibacterial activity compared to the uncoated UHMWPE. There was no bone mineralization detected in U2OS as no Alizarin red stain was observed, confirming the absence of any osteogenic induction. Such quality is a preferred characteristic of bearing surfaces. In agreement with Alizarin red staining results, the EDX demonstrated the absence of a hydroxyapatite layer, which is a required feature in the bearing surfaces. The uptake of the simulated body fluid (SBF) by both the coated and uncoated UHMWPE indicated that the nylon coating is of great advantage to the polymer as it prevents the increased absorption of the SBF and hence may decrease the risk of implant degradation. Moreover, our results demonstrate the superiority of the proposed coated biomaterial for wound healing applications with improved antibacterial capabilities.

Biography

Asma Amleh is an Associate Professor of Biology at The American University in Cairo and an Adjunct Professor, Department of Mechanical & Industrial Engineering at Ryerson University, Toronto, Canada. She received a BSc in biology and chemistry at The American University of Beirut, Lebanon, and a Ph.D. in biology from McGill University in Montreal, Canada (1997). She has been a research fellow at the laboratory of cellular and developmental biology, NIDDK, and a research associate at the National Institutes of Health, Bethesda, MD, USA. She has also been an instructor at the Department of Molecular Medicine, Institute of Biotechnology, at the University of Texas Health Science Center and a senior research scientist at the Developmental Biology Program, Memorial Sloan-Kettering Cancer Center in NY. Her research interests are focused on understanding the genetic control of normal and abnormal development in the mammalian system, including tissue compatibility of biomaterials and the incidence of cancer.

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Nguyen Quoc Hung

Vietnamese-German University, Vietnam

Development of bidirectional MRF based actuators for haptic application

This study focuses on review and proposal of new configurations of bidirectional magneto- rheological actuator (BMRA) for force feedback application. Firstly, an introduction to development of haptic systems based on MR brakes is presented. The disadvantages of MR brake based haptic systems are then analyzed and the necessity for development of BMRA for haptic systems is figured out. After that, several configurations of BMRA including the previously developed and new proposals are introduced. The optimal design of the considered configurations of the BMRA is then conducted and the optimal results are evaluated. Some applications of the BMRA in haptic systems are shown with updated experimental results. In addition, some existing limitations of developed BMRA based haptic systems are shown and future research directions on BMRA based haptic systems are presented.

Biography

Nguyen Quoc Hung was awarded with a PhD degree at Inha University, Korea in 2009, majored in Solid Mechanics and Manufacturing Engineering. He is currently the Dean of Faculty of Engineering at Vietnamese German University (VGU). Prior to this, he worked as the Dean of Mechanical Engineering, Industrial University of Ho Chi Minh. He has written over 100 journal papers (around 50 ISI papers) and thee book chapters, delivered more than 30 presentations at international conferences. He is a fellow of Vietnamese Society of Mechanics, Vietnamese Society of Computational Mechanics. He is currently the chairman of scientific committee of Mechanics-Engineering, NAFOSTED (National Foundation for Science and Technology Development, Vietnam). His main research directions include Smart materials and structures, Fluid Mechanics, Structure Optimization, Vibration control, Intelligent Control Systems. He has successfully chaired (principal investigator) 05 projects funded by state organizations.

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Kolluru V L Subramaniam

Indian Institute of Technology Hyderabad, India

Embedded-smart PZT sensors for combined local and distributed monitoring of concrete structures

Hydration process of concrete begins when concrete is mixed with water. Development of the early age properties of concrete are important in determining the load carrying capacity of concrete structures during construction and service. Early age monitoring of concrete is difficult due to the presence of moisture and the highly alkaline environment inside concrete. In-situ monitoring large volume of concrete in structures requires a large number of robust sensors. In this study, an embedded PZT sensor, which can be placed inside concrete and has protection from alkaline and moist environment of concrete is developed. An array of PZT sensors are placed inside a concrete structure at the time of casting for monitoring changes in the material over a 28-day period. The PZT sensors are used in localized and distributed sensing modes. The localized sensing is based on monitoring the changes in the electrical impedance (EI) of an embedded PZT sensor. Changes in EI measurements are shown to sensitively reflect the changes in hydrating concrete as it transforms from a fluid to a solid state and during the strength gain of the solid material. In the distributed measurement, PZT sensors are used as actuator-receiver (AR) pairs for global monitoring of concrete. The changes in the stress-waves propagating through the concrete produced by changes in the material medium are monitored. The changes in the hydrating concrete along the stress wave travelling path are sensitively reflected in AR measurements. The EI and the AR measurements techniques are combined to develop an effective methodology for monitoring the early age changes in large volumes of concrete with less number of PZT sensors. The EI measurements are used to assess the changes in vicinity of sensor and the AR measurements are used to assess the changes in bulk of concrete.

Biography

Kolluru V L Subramaniam is currently a Professor in the Department of Civil Engineering at Indian Institute of Technology Hyderabad (IITH). Prior to joining IITH, he was the Catell Fellow and Professor of Civil Engineering at the Grove School of Engineering, City College of New York. He received the James Instrument Award from the American Concrete Institute (ACI) in 1999 for his research on nondestructive evaluation of concrete. He is the recipient of the Early CAREER award from the National Science Foundation of U.S.A. for research on nondestructive evaluation of microstructure development in hydrating cement. He was the Chairman, committee 215 on Fatigue of Concrete of the ACI. In 2009, he was elected as a Fellow of the American Concrete Institute. He is an Associate Editor of the Journal of Materials in Civil Engineering (ASCE).

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Shutian Liu

Dalian University of Technology, China

Band-gap mechanical metamaterial design based on perforation layout optimization of low porosity perforated sheets

Perforated mechanical metamaterials providing unique physical properties, such as band gaps for wave propagation and negative poison ratio, have recently attracted significant interest. Despite numerous works on configuration optimization, however, relatively few studies have explored the role of perforation layout (holes arrangement) on the dynamic behavior of metamaterials. Here, we report two kinds of perforation layout based on regular configuration to investigate the effect of perforation layout on wave attenuation properties and mechanical behaviors. The proposed layouts are characterized by the redistribution of the construction material via pore rotation. Our analysis not only shows that the proposed layouts obtain broad and multiple band- gaps in low-frequency range and exhibit extreme Poisson's ratio and Young's modulus variations, but also reveals how the reduction of connector thickness and geometric symmetry contribute to the unusual response. Our numerical study provides a new perspective to design auxetic perforated metamaterials with low porosity and wide and low-frequency band gaps.

Biography

Shutian Liu completed his PhD from Dalian University of Technology, China in 1994. He is the professor of Dalian University of Technology. His research interests focused on the structural and multidisciplinary optimization, metamaterial design, and smart material and structures. He has over 150 publications that have been cited over 500 times.

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Ana Costa Conrado

University of Oslo, Norway

A piezoelectric travelling wave ultrasonic motor based on the shear effect

Ultrasonic motors have been adopted in high precision applications such as in the robotics, automotive industry, medical devices and autofocus of camera lenses. They are characterized by compact size, low speed with high torque and zero backlash. Since the shear piezoelectric coupling factor and the shear piezoelectric constant are higher than for the other piezoelectric effects, a relative higher torque and a better efficiency are also attained.

Special attention is paid to the kinematics and the geometry of the motor parts and to characteristics that influence efficiency and torque. The stator is of disc-type, made of piezoceramics and radially polarized. It is modelled as an annular Reissner-Mindlin plate with piezoelectric terms. Rayleigh-Ritz discretization is used to obtain eigenfrequencies and eigenmodes of the stator plate. In the laboratory, measured eigenfrequencies of the free vibrations of the plate corroborate the numerical method. Particularly, the generation of travelling waves requests the excitation of two degenerated vibration modes. This requires a specific electrode configuration.

A suitable vibration mode is chosen, so that the energy losses through friction in the radial direction are minimized. The transmission of load from stator to rotor occurs through a ring of teeth over the stator. The kinetic energy of the teeth set is formulated and taken into account in the equations of motion. Additionally, the conditions for the symmetry of the stator are stated with respect to the disposition and the number of teeth. In the contact model, point contact with a rigid rotor is assumed.

The present model, which is characterized by a few degrees of freedom, is able to deliver relevant characteristics of the motor. Performance parameters (at steady state) can be calculated. It allows a systematical optimization of the motor with respect to its geometry, its size, the number and disposition of the teeth, and the electric excitation.

Biography

Ana Costa Conrado has completed her PhD from the Technische Universität Darmstadt and worked in the industry. She returned to academia as master student. Currently, she is working as a research software engineer at the University of Oslo and teaches programming for researchers.

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Notes:

Jun Li

Curtin University, Australia

Structural damage localization and quantification using electromechanical impedance and sparse regularization

Electromechanical impedance (EMI)-based Structural Health Monitoring (SHM) methods have been rapidly developed in recent years for condition monitoring of civil structures. However, most of those methods are based on using various damage indices to monitor structural condition changes and locate structural damage. Using EMI based SHM techniques to quantify structural damage is still a challenging task, since a very fine finite element model is required and a large number of parameters are required to be identified. This will make the damage identification as a significantly under determined inverse problem. This talk will present a new damage index based on time frequency analysis of impedance responses to increase the sensitivity to detect minor damage, and will propose a novel approach based on model updating with impedance resonance frequency shifts and sparse regularization technique to provide damage quantification results for structural condition monitoring. The coupled finite element model of piezoelectric transducer and host structure is developed and calibrated for damage identification. Numerical and experimental investigations are conducted on beam and plate-like structures to demonstrate the accuracy and performance of the proposed approach for structural damage localization and quantification.

Biography

Jun Li received his PhD degree from Hong Kong Polytechnic University, China, in 2012. He is currently a senior lecturer in School of Civil and Mechanical Engineering at Curtin University, Australia. He has published over 115 technical papers including more than 65 journal papers, with a H-index of 16. He is currently an Associate Editor of International Journal of Lifecycle Performance Engineering, and has been serving as an editorial board member of several reputed international journals. He was a recipient of Australian Research Council Discovery, Early Career Researcher Award in 2014, and was one of the finalists of the prestigious Western Australia Premier's Science Awards, Early Career Scientist of the Year for 2016 and 2017.

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Notes:

Ardiyansyah Syahrom

Universiti Teknologi Malaysia, Malaysia

Biomimetic degradable porous scaffold for trabecular bone interlog

Biodegradable metals have been suggested for bone scaffold applications due to their mechanical properties that are better for load bearing applications. Among biodegradable metals, magnesium and its alloy are the most investigated materials due to their mechanical properties which are closer to the cancellous bone. The aim of this research is to analyse the degradation behaviour of porous magnesium under dynamic degradation test for bone scaffold applications. Interconnected holes of porous magnesium have been developed with various percentages of porosity (30%, 41% and 55%). Dynamic immersion test rigs are specifically designed to simulate environment of human cancellous bone. There are two types of tests that have been conducted in this study: (1) fluid flow with different flowrates and (2) fluid flow integrated cyclic loading. A dynamic immersion test has been conducted for 24, 48 and 72 hours. The results showed that the specimen with a higher percentage of porosity as well as the exposed surface area degrades faster compared to the others. The effects of different flow rates towards the mechanical integrity of porous magnesium have shown a huge drop of 95% from their original mechanical properties within 3 days, which have deteriorated in both functions; porosity and degradation time. The variation in flowrates used showed that degradation of the material is seven times higher compared to the static immersion test environment. Furthermore, the influenced of integrating fluid flow and cyclic loading have increased the relative weight loss and degradation rate as high as 61.56% and 93.67%, respectively. Additionally, the mechanical properties have improved and increased from 53% to 87% as compared to dynamic immersion test using the mechanical stimulus of fluid flow only. Therefore, the dynamic immersion test with integrated cyclic loading was more reliable compared to static immersion test for bone scaffold application.

Biography

Ardiyansyah Syahrom is Associate Professor at school of Mechanical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, UTM. Presently, he is the director of Medical Devices and Technology Centre (MEDiTEC), Institute Human Centred Engineeing (iHumEn). He is by profession a Mechanical Engineer with special interest in Biomechanics, Bone, Biomaterials and Sports Engineering. His previous administrative duties also include the Director of Sports Innovation and Technology Centre (SITC). He has published in reputed Journals and supervises many post-doctoral, doctoral and other post-graduate as well as undergraduate students. He sits in Innovation section in Malaysia Medical Devices Authority (MDA) committees, a member of many international societies, a reviewer to a number of academic journals and is the editor of the Jurnal Mekanikal.

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Yong Huang

Harbin Institute of Technology, China

Sparse Bayesian learning for system identification and damage assessment in structural health monitoring

System identification methods may be used to update a parameterized model of a structure based on features extracted from its measured data such as structural vibration responses or guided-wave/ultrasonic NDT signals. A common goal in applying system identification to structural health monitoring is to infer damage/flaw by updating structural model parameters. However, no structural model is an exact representation of a structure's behavior, because parameter estimation often gives non-unique results, raising the issue of model identifiability. A Bayesian framework has been developed that addresses this difficulty. The relative plausibility of all plausible values of the parameters based on the data is quantified by the posterior PDF (probability density function) coming from Bayes' Theorem. Another powerful feature of the Bayesian framework is that it implements an elegant and powerful version of Ockham's Razor, known as the Bayesian Ockham Razor. It trades off the fit to the data by the model against the amount of information extracted from the data and can automatically avoid over-fitting of the sensor data. Sparse Bayesian learning is a supervised learning framework that is very effective at implementing Bayesian Ockham Razor by achieving sparse representations in the context of regression and classification. We will give an overview of our recent progress of developing sparse Bayesian learning algorithms for performing sparse stiffness loss inference for vibration-based damage assessment and also for flaw detection using guided-wave/ultrasonic NDT signal processing. It will be shown that the incorporation of prior knowledge pertaining to the spatial sparseness of structural damage/flaw helps to suppress the possible occurrences of false and missed damage/flaw detections. Several nice features of our theory from both theoretical and computational perspectives will also be discussed. This research is a joint work with Prof. James L. Beck at the California Institute of Technology and Prof. Hui Li at the Harbin Institute of Technology.

Biography

Yong Huang has completed his Ph.D. in Engineering Mechanics at the age of 28 from Harbin Institute of Technology, China. He is the full professor of Civil Engineering at the Harbin Institute of Technology, China. He was a Postdoctoral Scholar and Visiting Associate in department of Mechanical and Civil Engineering at the California Institute of Technology during the periods of February 2012 until February 2013 and December 2014 until February 2017, respectively. He has over 50 technical publications that have been cited over 400 times, covering topics in structural health monitoring, signal processing, system identification, guided-wave testing, ultrasonic NDT, machine learning. In much of this research he uses a Bayesian probabilistic treatment of modeling uncertainty that is based on probability as a multi-valued conditional logic for quantitative plausible reasoning. He has been serving as an editorial board member of International Journal on Data Science and Technology.

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Zhishen WU[1] and Huang HUANG[2]

[1]Southeast University, China
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Self-sensing FRP composites for infrastructure intelligence

Intelligent infrastructure has become increasing attractive for civil engineering structures. On the other hand, fiber-reinforced-polymer (FRP) composites are increasingly used as structural materials and reinforcements, especially in the aircraft industries and civil engineering, due to their light weight, high strength, high stiffness and good environmental compatibility with concrete. This work highlights the health monitoring and smart material technologies to ensure the safety and longevity of civil infrastructure structures, as well as the latest developments and research achievements. It is concerned with the presentations of following: 1)- Background and Overall Considerations: the necessity of achieving structural safety and long-life maintenance and the requests of precise monitoring technology are introduced. 2)-Advancements of Sensing Technology: Base on the effect of global and local sensing, the progress and current status of structural health monitoring and damage identification technology are discussed. Aiming at the bottleneck problem of structural health monitoring technology, this section introduces the concept of area-wise distributed sensing technology, and advanced optical /carbon fiber based long-gauge strain sensing technology. 3)-Advanced FRP Technology: this section presents a look at some of the novel research application of FRP composites. Latest study works and practical engineering application are present.4) Challenge of Infrastructure Intelligence and Self-sensing FRP Composites: this section focuses on how to establish an effective intelligence system and specific solutions for various types of self-sensing FRP composites, such as self-sensing FRP rods, sheets, cables, and grids. Finally, the presentation concludes with brief comments on future directions and opportunities of self-sensing FRP composites for infrastructure intelligence.

Biography

Huang HUANG is serving at the Ibaraki University, Japan. This presentation is part of a collaboration he continued with Zhishen WU, a professor of civil engineering and the founding dean of the International Institute for Urban Systems Engineering, an interdisciplinary and major center of excellence, as well as a Special Assistant to the President at Southeast University, China. He is also a professor of civil engineering at Ibaraki University in Japan and the Director of the Center for Disaster Prevention and Security. He has published 8 books and over 1,000 international journals and conference's papers including over 60 keynote or invited papers. His total citation is over 11,000 times, and his publication H-index is 53. He was awarded the JSCE Research Price, the JSCM Technology Award, and 2009 SHM person of the year Award from SHM, National Prize for Progress in Science and Technology of China in 2012, and IIFC medal in 2016. He is the chairman or board member of numerous national and int. societies, such as China chemical fibers association committee on basalt fibers as chairman, ISHMII as a president.

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Hong Hu

The Hong Kong Polytechnic University, Hong Kong

Textile structures with negative Poisson's ratio

Textile structures with negative Poisson's ratio are a special class of textile materials. Known as auxetic textiles, they transversally expand when axially stretched or transversally contract when compressed. This nonconventional deformation behavior leads to a series of special properties of textile structures such as formation of dome shape under out of plane bending, increase of pore opening effect under extension, enhancement of energy absorption ability and indentation effect under impact force, etc. In this talk, different types of textile structures with negative Poisson's ratio which have been recently developed at PolyU will be presented, including auxetic plied and braided yarns, 2D and 3D auxetic weft and warp knitted fabrics, uni-stretch and bi-stretch auxetic woven fabrics, and 3D auxetic textile structure and composites. Auxetic behavior and mechanical properties of these textile structures obtained from both experimental and theoretical analyses will be discussed. In addition, potential applications of auxetic textiles in different areas will be demonstrated.

Biography

Hong Hu is currently a full Professor at The Hong Kong Polytechnic University and Research Committee Chair of Institute of Textiles and Clothing. He is internationally known for his leading research work on 3D textile structures for composite reinforcement and auxetic textile materials for technical applications. He has over 250 publications that have been cited over 3900, and his publication H-index is 35 (Scopus). He has been serving as an editorial board member of various journals.

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