IUTAM-SMM2023

2023 IUTAM Symposium on Soft Matter Mechanics

Handbook

Co-organizers: Ningbo University | Zhejiang University

Dec. 5-8, 2023 Ningbo, China

Conference Organization

IUTAM Symposium on Soft Matter Mechanics

Conference Hosts

- International Union of Theoretical and Applied Mechanics (IUTAM)
- The Chinese Society of Theoretical and Applied Mechanics (CSTAM), China
- Beijing International Center for Theoretical and Applied Mechanics (BICTAM), China

Conference Co-organizers

- Ningbo University, China
- Zhejiang University, China

Supporting Organizers

- Zhejiang Society of Theoretical and Applied Mechanics, China
- Working Group of Soft Materials Mechanics, CSTAM, China

Welcome Message

IUTAM Symposium on Soft Matter Mechanics

Dear Colleagues and Friends,

It is our great pleasure and privilege to welcome you to the 2023 IUTAM Symposium on Soft Matter Mechanics (IUTAM-SMM2023) being held from December 5th to 8th 2023 at Ningbo, China.

Soft Matter is a subfield of Condensed Matter differing considerably from ordinary solids and fluids. It includes the objects such as rubber, elastomers, polymers, colloids, liquid crystals, foams, gels, granular matter, biological tissues, cells, and proteins. Obviously, Soft Matter spans a wide complexity of physical states and softness, which are sensitive to tiny perturbations from the environment, including mechanical forces, thermal fluctuations, electrical stimuli, light exposure, magnetic field and chemistry processes. This variety of responses enables diverse significant technologies related to soft matter to emerge in industry and engineering, often inspired by examples found in nature. Examples range from soft robotics, displays, functional films, smart fluids and flexible electronics to biomedical devices, tissue engineering, drug delivery, etc. In addition, as all vital movements in the human body involve soft tissues and are accompanied by various physical, chemical and biological processes, a deeper understanding of their mechanics (including multi-physics coupling) could, if properly manipulated, ultimately change human life.

The varied responses of soft matter to external stimuli feature nonlinearity, self-assembly, and coexistence of thermal fluctuations with solid phase constraints. This diversity results in new phenomena that are much more complex to model than for ordinary solids and fluids, and thus pose significant challenges to the manipulation of soft matter in both industrial technologies and biological processes. Mechanics plays a key role in these processes by revealing the underlying deformation and possible failure mechanisms, and by generating fundamental insights and establishing optimal criteria for proper design, manufacture, and services related to soft matter devices. This symposium aims to forge fruitful and needed interactions among active researchers from both academia and industries working in the area of soft matter mechanics.

We greatly appreciate the strong support from our participants and our organizing committee, and do hope each of you enjoy your stay in Ningbo, China.

Prof. Yonggang Huang

Northwestern University, USA

Prof. Chaofeng Lü

Ningbo University, China

Prof. Shaoxing Qu

Zhejiang University, China

General Information

IUTAM Symposium on Soft Matter Mechanics

Catering

Date	Time		Venue
Dec 5, Tuesday	Dinner	17:30 – 20:30	Yi Café 2F
Dec 6, Wednesday	Lunch	11:55 – 13:30	Yi Café 2F
	Banquet	17:30 – 20:30	Ningbo Grand Ballroom I 2F
Dec 7, Thursday	Lunch	12:10 – 13:40	Yi Café 2F
	Dinner	17:30 – 20:00	Yi Café 2F
Dec 8, Friday	Lunch	12:10 – 13:40	Yi Café 2F
	Dinner	17:30 – 20:30	Yi Café 2F

Climate

Dec 5	Dec 6	Dec 7	Dec 8
6°C/17°C	4°C/18°C	6°C/20°C	8°C/22°C

Liability

The Organizing Committee and/or Conference Organizers shall not be held liable for personal accidents of losses or damage to private property of registered delegates of the Conference. Delegates should make their own arrangements for purchasing personal insurance.

Navigation: Junior Ballroom, 1st Floor

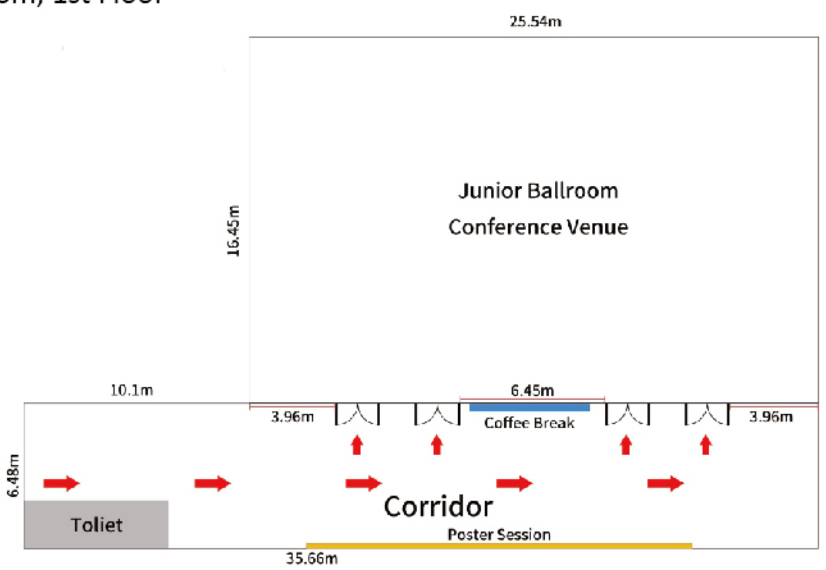


Table of Contents

IUTAM Symposium on Soft Matter Mechanics

Organization Committees

IUTAM Symposium on Soft Matter Mechanics

Symposium Chairman

Yonggang Huang, Northwestern University, USA

Symposium Co-Chairman

Chaofeng Lü, Ningbo University, China

Scientific Committee

Chairman

Yonggang Huang, Northwestern University, USA

Members

Ray W. Ogden, University of Glasgow, UK
Huajian Gao, Nanyang Technological University, Singapore
Huiling Duan, Peking University, China
Michel Destrade, NUI Galway, Ireland
Xiqiao Feng, Tsinghua University, China
Xue Feng, Tsinghua University, China
Pradeep Sharma, University of Houston, USA

IUTAM Representative

Huajian Gao, Nanyang Technological University, Singapore

Scientific Advisors

Wei Yang, Zhejiang University, China
Weiqiu Chen, Zhejiang University, China

Local Organizing Committee Chairmen

Chaofeng Lü, Ningbo University, China
Shaoxing Qu, Zhejiang University, China

Conference Secretaires

Haifei Zhan, Zhejiang University, China
Guannan Wang, Zhejiang University, China
Hui Chen, Ningbo University, China
Yangyang Zhang, Ningbo University, China

Program Overview

IUTAM Symposium on Soft Matter Mechanics

Date	Time	Event
Dec. 5 Tuesday	14:00 – 22:00	Registration
	17:30 – 20:30	Dinner
Dec. 6 Wednesday	08:30 – 09:00	Opening Ceremony
	09:00 – 09:45	Invited Talks
	09:45 – 10:10	Coffee Break
	10:10 – 11:55	Invited Talks
	11:55 – 13:30	Lunch
	13:30 – 15:15	Invited Talks
	15:15 – 15:40	Coffee Break
	15:40 – 16:50	Invited Talks
	16:50 – 17:20	Poster Session
	17:30 – 20:00	Conference Banquet
Dec. 7 Thursday	08:30 – 10:00	Invited Talks
	10:00 – 10:25	Coffee Break
	10:25 – 12:10	Invited Talks
	12:10 – 13:40	Lunch
	13:40 – 15:25	Invited Talks
	15:25 – 15:50	Coffee Break
	15:50 – 17:00	Invited Talks
	17:00 – 17:20	Poster Session
	17:30 – 20:00	Dinner
Dec. 8 Friday	08:30 – 10:00	Invited Talks
	10:00 – 10:25	Coffee Break
	10:25 – 12:10	Invited Talks
	12:10 – 13:40	Lunch
	13:40 – 15:25	Invited Talks
	15:25 – 15:50	Closing Ceremony
	15:50 – 16:20	Coffee Break
	16:20 – 17:30	Free Discussions
	17:30 – 20:30	Dinner

Scientific Program

IUTAM Symposium on Soft Matter Mechanics

Day 1: Wednesday, December 6, 2023 **Venue:** Junior Ballroom 1F

Time	Speaker & Title	Chair
08:30-09:00	**Opening Ceremony**	**Chaofeng Lü**
09:00-09:45	Engineer Peptide-based Materials and Structures through Synthetic Biology **Huajian Gao (Nanyang Technological University, Singapore)**	**Yonggang Huang**
09:45-10:10	**Coffee Break**	
10:10-10:45	Multiscale Dynamics of Biological Tissues **Xiqiao Feng (Tsinghua University, China)**	**Marco Amabili**
10:45-11:20	Conformal Mapping and Finite-elasticity of Growing Leaves **Martine Ben Amar (Ecole Normale Supérieure, France)**	
11:20-11:55	Climbing-inspired Twining Electrodes: from Mechanics to Bioelectronics Applications in Neuroscience **Xue Feng (Tsinghua University, China)**	
11:55-13:30	**Lunch**	
13:30-14:05	Toughening and fatigue-resistant strategies for hydrogels **Shaoxing Qu (Zhejiang University, China)**	**Jizhou Song**
14:05-14:40	Mechanics of Hydrogel-Some Paradoxes in the Description of Mechanical Properties and Fracture Toughness of Hydrogels **Zishun Liu (Xi'an Jiaotong University, China)**	
14:40-15:15	Advances in Confinement Free Energy Modeling for Wormlike Chains within Nanotubes: A Comprehensive Framework for Arbitrary Dimensions and Geometries **Jizeng Wang (Lanzhou University, China)**	
15:15-15:40	**Coffee Break**	
15:40-16:15	Recent Advances in the Modeling of Magnetorheological Elastomers and Their Instabilities **Kostas Danas (Ecole Polytechnique, France)**	**Bo Li**
16:15-16:50	How do Different Active Cellular Forces Co-regulate Wound Shapes - Cellular Mechanics of Gap Closure **Baohua Ji (Zhejiang University, China)**	
16:50-17:20	**Poster Session**	
17:30-20:00	**Conference Banquet**	

Scientific Program

IUTAM Symposium on Soft Matter Mechanics

Day 2: Thursday, December 7, 2023 **Venue:** Junior Ballroom 1F

Time	Speaker & Title	Chair
08:30-09:15	Extreme Mechanics of Metallic Materials with Irradiation and High Temperature **Huiling Duan (Peking University, China)**	**Davide Bigoni**
09:15-10:00	Effect of Vascular Smooth Muscle Activation on the Static and Dynamic Mechanical Response of Human Aortas **Marco Amabili (McGill University, Canada)**	
10:00-10:25	**Coffee Break**	
10:25-11:00	Instability of a Circular Electrodes-coated Dielectric Membrane: Axisymmetric Necking as an Alternative Route to Electric Breakdown **Yibin Fu (Keele University, UK)**	**Michel Destrade**
11:00-11:35	Combining Detection of Molecular Damage with Fast Detection of Nanoscale Motion to Predict Crack Propagation in Soft Elastomers **Costantino Creton (ESPCI Paris – PSL University, France)**	
11:35-12:10	Directional Transport and Fixed-point Transfer of Droplets on Functionalized Surfaces **Shaohua Chen (Beijing Institute of Technology, China)**	
12:10-13:40	**Lunch**	
13:40-14:15	Soft Materials and Origami-based Structures for Robotics and the Metaverse **Hanqing Jiang (Westlake University, China)**	**Yuli Chen**
14:15-14:50	Multifunctional Wearable Electronics with Stretching, Self-healing, Recycling and Reconfiguring Capabilities **Jianliang Xiao (University of Colorado Boulder, USA)**	
14:50-15:25	Mechanomedicine: From Biomechanics and Mechanobiology to Mechanodiagnosis and Mechanotherapy **Feng Xu (Xi'an Jiaotong University, China)**	
15:25-15:45	**Coffee Break**	
15:45-16:20	Mechanics-guided 3D Assembly of Electronic Devices and Microsystems **Yihui Zhang (Tsinghua University, China)**	**Kostas Danas**
16:20-16:55	Scaling Laws and Network Structures of Hydrogels **Wei Hong (Southern University of Science and Technology, China)**	
16:55-17:30	Morphomechanics of Soft Films: Growth, Shrinkage and Curvature **Fan Xu (Fudan University, China)**	
17:30-20:00	**Dinner**	

Scientific Program

IUTAM Symposium on Soft Matter Mechanics

Day 3: Friday, December 8, 2023 **Venue:** Junior Ballroom 1F

Time	Speaker & Title	Chair
08:30-09:15	A Dynamically Reprogrammable Surface with Self-evolving Shape Morphing **Yonggang Huang (Northwestern University, USA)**	**Martine Ben Amar**
09:15-10:00	Architected Instabilities in Solids Obtained from Structures **Davide Bigoni (University of Trento, Italy)**	
10:00-10:25	**Coffee Break**	
10:25-11:00	Acoustic Evaluation of Material Parameters, Stresses, and Strains in Soft Solids **Michel Destrade (University of Galway, Ireland)**	**Costantino Creton**
11:00-11:35	Flexoelectric Vector Sensor for Sound Pressure Gradient **Shengping Shen (Xi'an Jiaotong University, China)**	
11:35-12:10	A perturbation Force based Approach to Creasing Instability in Soft Materials under General Loading Conditions **Bin Liu (Tsinghua University, China)**	
12:10-13:40	**Lunch**	
13:40-14:15	Growth of 2-D Materials on Curved Surfaces **Zhuhua Zhang (Nanjing University of Aeronautics and Astronautics, China)**	**Jianliang Xiao**
14:15-14:50	The Mechanobiological Investigation on Cell Volume Regulation and Cell Division **Hongyuan Jiang (University of Science and Technology of China, China)**	
14:50-15:25	Tunable Waves in Dielectric Elastomer Structures and Their Manipulations **Weiqiu Chen (Zhejiang University, China)**	
15:25-15:50	**Closing Ceremony**	**Yonggang Huang**
15:50-16:20	**Coffee Break**	
16:20-17:30	**Free Discussions**	
17:30-20:30	**Dinner**	

Distinguished Speakers

A Dynamically Reprogrammable Surface with Self-evolving Shape Morphing

Yonggang Huang
Northwestern University, USA
Email: y-huang@northwestern.edu

Dynamic shape-morphing soft materials systems are ubiquitous in living organisms; they are also of rapidly increasing relevance to emerging technologies in soft machines, flexible electronics and smart medicines. Soft matter equipped with responsive components can switch between designed shapes or structures, but cannot support the types of dynamic morphing capabilities needed to reproduce natural, continuous processes of interest for many applications. Challenges lie in the development of schemes to reprogram target shapes after fabrication, especially when complexities associated with the operating physics and disturbances from the environment can stop the use of deterministic theoretical models to guide inverse design and control strategies. Here we present a mechanical metasurface constructed from a matrix of filamentary metal traces, driven by reprogrammable, distributed Lorentz forces that follow from the passage of electrical currents in the presence of a static magnetic field. The resulting system demonstrates complex, dynamic morphing capabilities with response times within 0.1 second. Implementing an in situ stereo-imaging feedback strategy with a digitally controlled actuation scheme guided by an optimization algorithm yields surfaces that can follow a self-evolving inverse design to morph into a wide range of three-dimensional target shapes with high precision, including an ability to morph against extrinsic or intrinsic perturbations. These concepts support a data-driven approach to the design of dynamic soft matter, with many unique characteristics.

Biography: *Yonggang Huang is the Achenbach Professor of Mechanical Engineering (50%), Civil and Environmental Engineering (50%), and Materials Science and Engineering (0%) at Northwestern University. He is interested in mechanics of stretchable and flexible electronics, and mechanically guided deterministic 3D assembly. He has published >700 papers in journal, including 14 in Science and 7 in Nature. He has been a highly cited researcher in Engineering (2009), in materials science (since 2014) and in physics (2018). He is a member of the US National Academy of Engineering, US National Academy of Sciences, and a fellow of American Academy of Arts and Sciences. He is also a foreign member of the Royal Society (London), Royal Society of Canada, Chinese Academy of Sciences. He has received awards for undergraduate teaching and advising at every university he has taught.*

Engineer Peptide-based Materials and Structures through Synthetic Biology

Huajian Gao
Nanyang Technological University, Singapore
Email: huajian.gao@ntu.edu.sg

Synthetic biology combining engineering principles with existing biotechnology techniques are being used to fabricate new peptide-based materials and structures. Here we discuss two recent examples to demonstrate the potential as well as some of the open challenges in this field. The first example involves a study of strong underwater pH sensitive peptide-based adhesives that mimic adhesive mussel foot proteins (Mfps) [1]. We focus on GK-16*, a peptide that mimics the primary adhesive mussel foot protein Mfp-5 but only comprises 3 distinct amino acids. Molecular dynamics simulations combined with point mutation experiments reveals the molecular design principles for the development of mussel-inspired peptide adhesives. In another example, we explore gradient-mediated self-assembly as a general mechanism of structure synthesis and fabrication of peptide-based materials. Here, we focus on fabricating insect cuticle peptide (ICP)-based nanocapsules for drug delivery, cancer therapy and precision medicine. ICPs are self-assembled into nanocapsules in local concentration gradients created through a solvent mixing procedure. We show that the ICP self-assembly is tunable by controlling the peptide sequences and free energy well depth. The proposed gradient-mediated self-assembly mechanism, as demonstrated by the ICP nanocapsule formation, lays a foundation for synthesis and fabrication of peptide-based nanostructures.

Selected Publication:

[1] Q. Guo, G.J. Zou, X.L. Qian, S.J. Chen, H. Gao and J. Yu*, "Hydrogen-Bonds Mediate Liquid-Liquid Phase Separation of Mussel Derived Adhesive Peptides," 2022, Nature Communications, Vol. 13, Art. No. 5771. DOI:10.1038/s41467-022-33545-w*

Biography: *Huajian Gao received his B.S. degree from Xian Jiaotong University in 1982, and his M.S. and Ph.D. degrees in Engineering Science from Harvard in 1984 and 1988, respectively. He served on the faculty of Stanford from 1988-2002, as Director at the Max Planck Institute for Metals Research from 2001-2006 and as Walter H. Annenberg Professor of Engineering at Brown from 2006-2019. At present, he is one of only 8 Distinguished University Professors at Nanyang Technological University and Scientific Director of the Institute of High Performance Computing in Singapore. Professor Gao's research has been focused on the understanding of basic principles that control mechanical properties and behaviors of materials in both engineering and biological systems. He is Editor-in-Chief of Journal of the Mechanics and Physics of Solids. His list of honors includes the Timoshenko Medal and Rodney Hill Prize, the two highest lifetime achievement awards in his field, and elections to US National Academy of Sciences, US National Academy of Engineering, UK Royal Society, German National Academy of Sciences and Chinese Academy of Sciences.*

Extreme Mechanics of Metallic Materials with Irradiation and High Temperature

Huiling Duan

Peking University, China

Email: hlduan@pku.edu.cn

In recent years, we have been dedicated, employing a combination of experiments, simulations, and theoretical modeling, to comprehensively studying the mechanical properties of metallic materials under extreme conditions, specifically those involving irradiation and high temperature. A physically-based constitutive model was proposed to predict the thermo-mechanical properties of irradiated structural materials by incorporating the micro-mechanisms involved, and the microstructural effects, particularly irradiation hardening, have been analyzed systematically for a variety of metals. Furthermore, we have established a probabilistic model that integrates with the constitutive model to elucidate the competition between the cleavage and ductile void failure of structural materials with irradiation effects. Moreover, we revealed the emergence of kinetic hardening behavior from the complex distribution of grain boundaries (GBs), and developed a dislocation-level back stress model based on the dislocation-GB interactions, enabling analyses on the cyclic plasticity and fatigue crack nucleation at GBs. We have also explored the coupled size effects and irradiation effects on strength, toughness, and creep, thereby providing theoretical fundamentals for enhancing the efficiency of studying irradiation damage through the utilization of small-scale samples.

Biography: *Dr. Huiling Duan is Chang Jiang Chair Professor and Dean of the College of Engineering at Peking University. Her area of expertise lies in the interface mechanics of complex media, including the mechanics of heterogeneous and complex materials, and interfacial interaction between fluids and solids with bio-inspired functional surface microstructures. She published more than 200 peer-reviewed papers in PNAS, Phys. Rev. Lett., J. Mech. Phys. Solids, Nature Comm., Science Advances, Advances in Applied Mechanics, Applied Mechanics Review, and J. Fluid Mechanics, etc. She received the National Nature Science Prize of China (2020), the National Outstanding Young Scholar of China (2015), the National Outstanding Young Female Scientist of China (2014), the Distinguished Young Scholars Award of the National Natural Science Foundation of China (2012), ASME Fellow (2020) and Humboldt Research Award (2023), etc.*

Effect of Vascular Smooth Muscle Activation on the Static and Dynamic Mechanical Response of Human Aortas

Giulio Franchini[1], Ivan D. Breslavsky[1], Francesco Giovanniello[1], Ali Kassab[1,2], Gerhard A. Holzapfel[3], Marco Amabili[1]

[1]Department of Mechanical Engineering, McGill University, Montreal, Canada

[2]Research Center, Centre Hospitalier Universitaire de Montréal (CHUM), Université de Montréal, Montreal, Canada

[3]Institute of Biomechanics, Graz University of Technology, Austria

Marco Amabili

McGill University, Canada

Email: marco.amabili@mcgill.ca

Experimental data and a suitable material model for human aortas with smooth muscle activation are not available in the literature despite the need for developing advanced grafts; the present study closes this gap. Mechanical characterization of human descending thoracic aortas was performed with and without vascular smooth muscle (VSM) activation. Specimens were taken from 13 heart-beating donors. The aortic segments were cooled in Belzer UW solution during transport and tested within a few hours after explantation. VSM activation was achieved through the use of potassium depolarization and noradrenaline as vasoactive agents. In addition to isometric activation experiments, the quasi-static passive and active stress-strain curves were obtained for circumferential and longitudinal strips of the aortic material. This characterization made it possible to create an original mechanical model of the active aortic material that accurately fits the experimental data. The dynamic mechanical characterization was executed using cyclic strain at different frequencies of physiological interest. An initial pre-stretch, which corresponded to the physiological conditions, was applied before cyclic loading. Dynamic tests made it possible to identify the differences in the viscoelastic behavior of the passive and active tissue. This work illustrates the importance of VSM activation for the static and dynamic mechanical response of human aortas. Most importantly, this study provides material data and a material model for the development of a future generation of active aortic grafts that mimic natural behavior and help regulate blood pressure.

Biography: *Born in Italy, Marco Amabili received his PhD in Bologna. Professor Amabili is a Distinguished James McGill professor at the Department of Mechanical Engineering, McGill University, Montreal, Canada. He received the Worcester Reed Warner Medal of the ASME (American Society of Mechanical Engineers) in 2020, the 2021 Raymond D. Mindlin Medal of the American Society of Civil Engineers, the 2021 International Gili-Agostinelli Prize of the "Lincei" National Academy of Sciences of Italy, the 2022 Rayleigh Lecture award of the ASME, the 2022 Blaise Pascal Medal of the European Academy of Sciences and the Guggenheim Fellowship in Engineering in 2022. He is the author of two monographs published by Cambridge University press and a plethora of scientific papers. Dr. Amabili is an elected Fellow of the Royal Society of Canada (Academy of Sciences), the Canadian Academy of Engineering, Foreign Member of Academia Europaea, Vice-Dean of the European Academy of Sciences and Arts, Member of the European Academy of Sciences and Fellow of the Engineering Institute of Canada. He is the chair of the Executive Committee of Applied Mechanics Division of the ASME. Amabili is also the chair of the Canadian National Committee for IUTAM (International Union of Theoretical and Applied Mechanics) and of the conference series ICoNSoM (Int. Conf. on Nonlinear Solid Mechanics).*

Architected Instabilities in Solids Obtained from Structures

Davide Bigoni
University of Trento, Italy
Email: bigoni@ing.unitn.it

Homogenization theory provides the framework for the design of metamaterials from grids of elastic structures, in which instabilities can be 'architected' to occur at given load thresholds and with pre-determined features. Homogenization of periodic grids of elastic rods, prestressed with axial forces and deformed incrementally under bending lead to prestressed elastic solids, which may show the emergence of material instabilities such as shear band formation [1]. The design of structural elements, including sliders leads to ellipticity loss in both tension and compression at the elliptic/parabolic boundary, thus showing stress channeling [2]. A design paradigm is established for artificial materials where follower micro-forces, so far ignored in homogenization schemes, are introduced as loads prestressing an elastic two-dimensional grid made up of linear elastic rods (reacting to elongation, flexure and shear). A rigorous application of Floquet-Bloch wave asymptotics yields an unsymmetric acoustic tensor governing the incremental dynamics of the effective material [3]. The latter is therefore the incremental response of a hypo-elastic solid, which does not follow from a strain potential and thus does not belong to hyper-elasticity. The solid is shown to display flutter, a material instability corresponding to a Hopf bifurcation, which was advocated as possible in plastic solids, but never experimentally found and so far believed to be impossible in elasticity [3]. In elastic structures flutter can be originated from different loading systems [4], which can be used to architect new discrete materials. The discovery of elastic materials capable of sucking up or delivering energy in closed strain cycles through interaction with the environment paves the way to realizations involving micro and nano technologies and finds definite applications in the field of energy harvesting.

Acknowledgements Financial support from ERC-ADG-2021-101052956-BEYOND is gratefully acknowledged.

References

[1] Bordiga, G., Cabras, L., Piccolroaz, A., Bigoni, D. "Dynamics of prestressed lattices: Homogenization, instabilities, and strain localization" J. Mech. Phys. Solids, 146, 104198 (2021).

[2] Bordiga, G., Bigoni, D., Piccolroaz, A. "Tensile material instabilities in elastic beam lattices lead to a closed stability domain" Phil. Trans. Royal Soc. A, 380, 20210388 (2022).

[3] Bordiga, G., Piccolroaz, A., Bigoni, D., "A way to hypo-elastic artificial materials without a strain potential and displaying flutter instability" J. Mech. Phys. Solids, 158, 104665 (2022).

[4] Rossi, M., Piccolroaz, A., Bigoni, D., "Fusion of two stable elastic structures resulting in an unstable system" J. Mech. Phys. Solids, 173, 105201 (2023).

Biography: *From 2001 Davide Bigoni holds a full professor position at the University of Trento (Italy), where he is leading a very active group in the field of Solid ad Structural Mechanics. He has authored or co-authored more than 150 journal papers and has published a book published by CUP. He was elected in 2009 Euromech Fellow (of the European Mechanics Society), received in 2012 the Ceramic Technology Transfer Day Award (of the ACIMAC and ISTEC-CNR), and in 2014 he was awarded the Doctor Honoris Causa degree at the Ovidius University of Constanta. He has received the Panetti and Ferrari Award for Applied Mechanics (from the Accademia delle Scienze di Torino), in 2018 he was Guest Lecturer for the Midwest Mechanics Seminars, in 2019 he was nominated Fellow of the Istituto Lombardo, Accademia di Scienze e Lettere, he was awarded a 60th Anniversary Issue of the Journal of the Mechanics and Physics of Solids. His research has been featured on 7 covers of International Journals. He has coordinated and has been involved in 3 European grants between academia and industry. He has been awarded 2 ERC advanced grants awarded by the European Research Council, the first in 2013 and the second in 2021. He is co-editor of the Journal of Mechanics of Materials and Structures, is associate Editor of Mechanics Research Communications and member of the editorial boards of: Archives of Mechanics, International Journal of Solids and Structures, Journal of Elasticity, Journal of the Mechanical Behavior of Materials, Acta Mechanica Sinica, and International Journal of Applied Mechanics. He is reviewer for more than 150 international journals. He was vice chair of the panel PE8 for the European Research Council Starting Grants.*

Multiscale Dynamics of Biological Tissues

Xi-Qiao Feng
Tsinghua University, China
Email: fengxq@tsinghua.edu.cn

Physiological and pathological processes, such as embryonic development and tumor growth, and modern biological techniques, such as biorobots and organs-on-chips, all involve multiscale spatiotemporal correlations, mechano-chemo-biological coupling, and other highly complicated mechanisms, posing a challenge for developing quantitative theories of biological tissues. In this talk, some recent advances in the field of multiscale dynamic theories and methods of biological tissues and cells will be presented. They mainly include (1) the mechano-chemo-biological theory for the growth and development of tissues, (2) the multiscale dynamic theory and numerical methods of cells, (3) dynamic instability of cells, and (4) dynamics of collective cells.

Biography: *Xiqiao Feng is a Chang Jiang Chair Professor at Tsinghua University. Currently, he serves as a vice president of CSTAM, an editor-in-chief of Engineering Fracture Mechanics, and an executive member of International Council of Fracture (ICF). His current interests include mechanics and biomimetics of biological materials, and biomechanics of cells and tissues. He has co-authored three monographs and about 400 international journal papers. Selected Feng's honors include the National Prize of Science and Technology of China (2019), the Award of Science and Technology for Young Scientists of China (2007), etc.*

2023 IUTAM Symposium on
Soft Matter Mechanics

Conformal Mapping and Finite-elasticity of Growing Leaves

Anna Dai and Martine Ben Amar
Laboratoire de Physique de l'ENS (LPENS), Ecole Normale Supérieure and Sorbonne Université

Martine Ben Amar

Laboratoire de Physique de l'ENS (LPENS), Ecole Normale Supérieure and Sorbonne Université, France

Email: martine.benamar@phys.ens.fr

Thin structures are ubiquitous in life mostly in botanic (flowers, leaves) but not only. In mammals or insects, they concern epithelia or the couple epithelium-extracellular matrix joined in a thin bilayer. When samples grow freely, as fresh leaves, a conformal map connects continuously in time the outer boundaries. If this mapping is chosen to describe the deformation tensor of each point inside the sample, we can prove that this specific mapping corresponds to an elastic mapping free of stress and so can be chosen during the slow growth of the samples. Examples will be given.

References

Anna Dai and Martine Ben Amar, Minimizing the elastic energy of growing leaves by conformal mapping. Phys. Rev.Lett. , 129.21 (2022): 218101.

Biography: *Martine Ben Amar holds a doctorate in atomic physics. She taught physics at UPMC since 1993, and received "Prix Huy Duong Bui of Academy of Sciences, section Mechanics" in 2018. Her preferred themes are the modeling of the cancer, the physics of cell morphogenesis and of soft tissue growth. With PhD students and postdocs, Martine Ben Amar is interested in "Dynamics of Complex Systems", bringing together 200 researchers and professors at UPMC, Université Paris-Diderot, the ENS and of ESCPI.*

Climbing-inspired Twining Electrodes: from Mechanics to Bioelectronics Applications in Neuroscience

Xue Feng

Tsinghua University, China

Email: fengxue@tsinghua.edu.cn

This presentation explores the seamless integration of applied mechanics and bioelectronics in the development and application of climbing-inspired twining electrodes for neuroscience. Beginning with a comprehensive finite deformation theory elucidating the climbing habits of twining plants in nature, we establish fundamental insights into the climbing habits and attachments of twining plants. Leveraging this understanding, we propose a 3D twining electrode by using shape memory effect. Similar to the climbing process of twining plants, the temporarily flattened 2D stiff twining electrode can naturally self-climb onto nerves driven by 37 degrees Celsius normal saline, and form 3D flexible neural interfaces with minimal constraint on the deforming nerves. We also conduct in vivo animal experiments to demonstrate the potential clinical utility for peripheral nerve stimulation and recording in neuroscience. Extending these principles, we further propose twining-inspired in-ear bioelectronics, named as SpiralE. Employing electrothermal actuation, SpiralE adaptively expands and spirals along the auditory meatus, ensuring conformal contact while facilitating communication with the outside world. Through visual and auditory BCI paradigms, we confirm that the proposed SpiralE can achieve reliable EEG sensing, thus supporting wearable and discreet BCI control. This interdisciplinary narrative showcases the synergy between applied mechanics and bioelectronics, offering transformative potential for future advancements in the field of bioelectronics for neuroscience.

Biography: *Professor Xue Feng received PhD degree in solid mechanics from Tsinghua University in 2003 and then worked as a postdoc at University of Illinois at Urbana Champaign from 2004 to 2007. He also worked as a postdoc at California Institute of Technology during 2005 to 2006. He joined Tsinghua University in 2007, and is now a tenured professor in the School of Aerospace Engineering. He is the Dean of both the Laboratory of Flexible Electronics Technology at Tsinghua University, and the Institute of Flexible Electronics Technology of Tsinghua, Zhejiang. He is a SES Fellow, he served or is currently serving as an (assoc.) editor/ an editorial board member of several journals, including Applied Mechanics Review, Acta Mechanica Sinica, npj Flexible Electronics, et al. Feng's research focuses on the design, fabrication and mass manufacturing of flexible integrated devices, as well as the wearable and implantable electronics with emphasis on medicine and health applications. He has published more than 270 papers, and is an inventor on over 200 patents. Prof. Feng's list of honors and academic awards includes ASME Ted Belytschko Applied Mechanics Division Award (2024), ASME Melville Medal (2023), Ho Leung Ho Lee Foundation Science and Technology Innovation Award (2022), etc.*

Toughening and fatigue-resistant strategies for hydrogels

Shaoxing Qu

Zhejiang University, China

Email: squ@zju.edu.cn

Soft materials are key components for stretchable electronics, soft machines, biomedical devices. Superior mechanical properties, multifunctionality, and simple integration are challenging topics in design and manufacture of these materials. This talk presents current research on toughening and anti-fatigue strategies for hydrogels in my group.

Biography: *Dr. Shaoxing Qu, Qiushi Distinguished Professor of Zhejiang University, and Distinguished Professor of Changjiang Scholars, Ministry of Education, China. He got his bachelor degree from university of Science and Technology of China in 1997, Master of Engineering from Tsinghua University in 2000, and Ph.D. from UIUC in 2004. After spending two years at Brown University as postdoc, he joined Zhejiang University in 2006 and was promoted to full professor in 2011. In 2015, he was awarded Distinguished Young Scholar grant from National Natural Science Foundation of China. His primary research interests include Soft Materials & Soft Machines, Insect-scale Robots, Mechanics of Composites, and Micro/Nano Mechanics. He has published more than 200 journal papers. He is serving as board member of Society of Engineering Sciences, and editorial board members of International Journal of Solids and Structures, International Journal of Fracture, Proceedings of the Royal Society A, Research etc.*

2023 IUTAM Symposium on
Soft Matter Mechanics

Mechanics of Hydrogel-Some Paradoxes in the Description of Mechanical Properties and Fracture Toughness of Hydrogels

Zishun Liu

Xi'an Jiaotong University, China

Email: zishunliu@mail.xjtu.edu.cn

Hydrogels are widely used in flexible electronics and biomedicine fields because of their excellent large deformation characteristics and very good biocompatibility. Recently, we carried out a series of experiments on polyacrylamide hydrogels with a wide range of water content and reveal that the physical adhesion properties of hydrogels are related to the water content. We find that with a variation of water content, the adhesion energy-water content relationship can be divided into four regions. For double-network (DN) hydrogels, we developed a quantitative framework to decompose the fracture toughness and feature size of the crack-tip field. Through extensive tearing tests, we propose an exponential function to describe the relationship between the apparent fracture energy and free width. The study reveals the physical inconsistencies in some opinions about DN gel fracture and resolves some paradoxes on the toughness of DN gels. Furthermore, through extensive experiments on polyacrylamide gel, we discover scaling-laws that differ significantly in the swollen and dehydrated state in addition to contradicting F-R model. Finally, the recent advances about hydrogel will be discussed in this talk.

Biography: *Dr. Zishun Liu is a Professor of Xi'an Jiaotong University (XJTU) and Executive Director of International Center for Applied Mechanics. He holed the director of the Academic Committee of the School of Aerospace Engineering at XJTU. He is also the General Secretary of Int. Association of Applied Mechanics and the Honorary President of Singapore Association of Computational Mechanics. He is Fellow of Int. Association of Applied Mechanics, Fellow of International Association of Advanced Materials and SACM fellow. He served on the faculty of XJTU between 1986 and 1994, and as Senior Scientist, Capability Group Manager at Institute of High Performance Computing, Singapore (IHPC), and Associate Professor of NUS at various points from 1999 to 2012. His recent research interests are mainly in the areas of Mechanics of Soft Materials, Computational Solid Mechanics. He has published more than 220 SCI referred research papers and many of his research articles were awarded Most Cited Author Award.*

Dr Liu is an active member of various leadership roles in editorial boards and professional communities as follow: Dr. Liu is an Editor-In-Chief of Int. Journal of Applied Mechanics and Int. Journal of Computational Materials Science and Engineering, and Editor of Journal of Mechanics of Material and Structures, Associate Editor of Journal of Applied and Computational Mechanics. He also serves on the editorial boards of IJCM, IJSSD, AMS, AMSS etc.. As a Chairman, Dr. Liu has organized more than 20 Int. Conferences in the field of computational mechanics & applied mechanics.

Acoustic evaluation of Material Parameters, Stresses, and Strains in Soft Solids

Michel Destrade

University of Galway, Ireland

Email: michel.destrade@nuigalway.ie

This talk discusses two non-destructive evaluation aims that can be achieved with elastic waves travelling in soft materials. First, we see how tracking the changes in wave speed with stress or strain gives access to linear and nonlinear material parameters. These can then be used to design biomaterials or to create meaningful Finite Element simulations. Examples include brain matter, muscles, and stretched soft plates. Then, we find that the states of stress and strain existing in a loaded material can be accessed directly from wave speed measurements, without having to determine, or even know, its material properties. These techniques are expected to have important applications in health monitoring of loaded structures. Examples include stressed rail steel, muscle, and thin membranes such as a stretched rubber sheet, a piece of cling film (~10 μm thick) and the animal skin of a bodhrán, a traditional Irish drum.

References

Z. Zhang, G.-Y. Li, Y. Jiang, Y. Zheng, A.L. Gower, M. Destrade, Y. Cao. Non-invasive measurement of local stress inside soft materials with programmed shear waves. Science Advances, 9 (2023) p.eadd4082.

G.-Y. Li, A.L. Gower, M. Destrade, S.-H. Yun. Non-destructive mapping of stress and strain in soft thin films through sound waves. Communications Physics. 5 (2022) 231.

G.-Y. Li, A.L. Gower, M. Destrade. An ultrasonic method to measure stress without calibration: The angled shear wave identity. Journal of the Acoustical Society of America, 148 (2020) 3963-3970.

Biography: *Michel Destrade is Chair of Applied Mathematics at the University of Galway, Adjunct Professor of Engineering Mechanics at Zhejiang University, Adjunct Professor of Mechanical Engineering at University College Dublin, and a member of the International Brain Mechanics and Trauma Lab. He is the Reviews Editor of Proceedings of the Royal Society A, and an Associate Editor of several international journals. His research interests are in nonlinear elasticity, in the mechanics of elastomers, soft dielectrics and biological soft tissues, and in linear, linearised, and non-linear waves and wrinkles in soft matter. In those fields, he has authored or co- authored 5 invited book chapters and more than 160 publications in refereed international journals. maths.nuigalway.ie/~destrade*

Instability of a Circular Electrodes-coated Dielectric Membrane: Axisymmetric Necking as an Alternative Route to Electric Breakdown

Yibin Fu

Keele University, UK

Email: y.fu@keele.ac.uk

We investigate the stability of a circular electrodes-coated dielectric membrane under the combined action of an electric field and an all-round in-plane tension. It is known that such a membrane is susceptible to the limiting point instability (also known as pull-in instability) which is widely believed to be a precursor to electric breakdown. However, there is experimental evidence showing that the limiting point instability may not necessarily be responsible for the rapid thinning and electric breakdown. We explore the possibility that the latter is due to a new instability mechanism, namely localized axisymmetric necking. The bifurcation condition for axisymmetric necking is first derived and used to show that this instability may occur before the Treloar-Kearsley instability or the limiting point instability for a class of free energy functions. A weakly nonlinear analysis is then conducted, and it is shown that the near-critical behaviour is described by a fourth order nonlinear ordinary differential equation with variable coefficients. This amplitude equation is solved using the finite difference method and it is demonstrated that a localized solution does indeed bifurcate from the homogeneous solution. We also present Abaqus simulations for the purely mechanical case and show that the necking evolution follows the same three stages of initiation, growth and propagation as other similar localization problems. Fully nonlinear numerical simulations for the electric case and experimental verifications are underway and will be reported if relevant results become available.

References

[1] Mi Wang, Lishuai Jin, and Yibin Fu, Axisymmetric necking versus Treloar-Kearsley instability in a hyperelastic sheet under equibiaxial stretching. Mathematics and Mechanics of Solids 27 (2022), 1610-1631.

[2] Yibin Fu and Xiang Yu, Axisymmetric necking of a circular electrodes-coated dielectric membrane. Mechanics of Materials. 181 (2023), 104645

Biography: *Yibin Fu is a professor and mathematics research director at Keele University. He was one of the first cohorts of students selected by the Chinese government to study abroad after the opening-up in the 1980s. After obtaining a PhD (1988) in Theoretical Mechanics from the University of East Anglia, he spent three years in Exeter University as a post-doctoral research fellow. He was appointed to a Lectureship in 1991 at the University of Manchester. Six year later, he moved to Keele University as a Senior Lecturer. He was promoted to Reader in 1999 and became Professor of Applied Mathematics in 2001. His early research focused on shock waves, multi-phase deformations, Stroh formalism and nonlinear surface waves. His more recent research has been concerned with reduced models, pattern formation in coated half-spaces, and elastic localizations such as those occurring in inflated rubber tubes, soft cylinders/tubes subjected to surface tension, and electrodes-coated membranes subject to an all-round tension and an electric field.*

Tunable Waves in Dielectric Elastomer Structures and their Manipulations

Weiqiu Chen
Zhejiang University, China
Email: chenwq@zju.edu.cn

Hyperelastic materials can repeatedly withstand large deformation, indicating a superior elastic behavior. The theory of hyperelasticity has already been established in the 1950s, and soon it has been applied to investigate the effect of large pre-deformation on the propagation behavior of elastic waves. This report will summarize our studies on waves in dielectric elastomer structures, including linear and nonlinear waves in dielectric elastomer bar, tuning of band structures in soft periodic structures, strain engineering of acoustic topological states, etc. Due to the large deformation induced in hyperelastic materials, material nonlinearity as well as geometric nonlinearity should be both taken into consideration. Furthermore, the characteristic of electromechanical coupling in dielectric elastomers should also be considered. These factors complicate the analysis, and hence except for a few special cases for which analytical solutions may be obtained, we have to resort to numerical simulations.

Biography: *Weiqiu Chen is the Qiushi Distinguished Professor at the Department of Engineering Mechanics, Zhejiang University. He has engaged himself in mechanics of smart materials/structures, mechanics of soft materials and structures, and vibration/waves in structures for more than thirty years, with 400+ peer-reviewed journal papers published. He now serves as the editorial member (or associate editor or associate editor-in-chief) of more than a dozen of academic journals including International Journal of Mechanical Sciences, Mechanics of Advanced Materials and Structures, Journal of Thermal Stresses, Journal of Zhejiang University – SCIENCE A, Science Bulletin, Composite Structures, Engineering Structures, Acta Mechanica Solida Sinica, and Applied Mathematics and Mechanics (English Edition).*

2023 IUTAM Symposium on
Soft Matter Mechanics

Combining Detection of Molecular Damage with Fast Detection of Nanoscale Motion to Predict Crack Propagation in Soft Elastomers

Costantino Creton
ESPCI Paris – PSL University, France
Email: costantino.creton@espci.psl.eu

Fracture of soft materials can take place below the critical failure condition via slow accumulation of internal damage followed by fast crack propagation[1]. While failure due to subcritical fracture accounts for most of the structural failures in use, it is challenging to predict fracture in time, due to the lack of current non-destructive detection methods with suitable spatial and time resolution to detect precursor events. Here we use simultaneous space and time-resolved multispeckle diffusing wave spectroscopy (MSDWS)[2] and molecular damage mapping by fluoresecent mechanophores[1, 3] to investigate the onset of crack propagation of polydimethylsiloxane (PDMS) elastomers. While the bulk of the elastomer remains elastic and intact, we detect a clear acceleration of strain rate over a large area of the order of a cm2, up to thousands of seconds the propagation of a crack occurs[4]. Combining dynamics/damage mapping and finite element (FEM) simulations, we attribute this dynamic elastic response to the highly localized molecular damage, occurring over 0.01 mm2 around the crack tip. This novel mechanism where molecular damage over a micron-size volume triggers readily observable changes in the elastic deformation field over a much larger volume of several mm3 shows the potential of MSDWS, using ordinary imaging and simple image processing, as a flexible tool to characterize and predict the occurrence of highly localized microscopic or molecular damage is soft materials by only examining the change in elastic response at a very early stage.

References

[1] G. E. Sanoja, X. P. Morelle, J. Comtet, C. J. Yeh, M. Ciccotti and C. Creton, Science Advances 2021, 7, eabg9410.
[2] M.-Y. Nagazi, G. Brambilla, G. Meunier, P. Marguerès, J.-N. Périé and L. Cipelletti, Optics and Lasers in Engineering 2017, 88, 5-12.
[3] J. Slootman, V. Waltz, C. J. Yeh, C. Baumann, R. Göstl, J. Comtet and C. Creton, Physical Review X 2020, 10, 041045.
[4] J. Ju, G. E. Sanoja, M. Y. Nagazi, L. Cipelletti, Z. Liu, C. Y. Hui, M. Ciccotti, T. Narita and C. Creton, Physical Review X 2023, 13, 021030.

Biography: *Costantino Creton graduated in Materials Science from the EPFL (Switzerland) in 1985. He then moved on to the MS& E Department of Cornell University (USA) where he obtained his Ph.D in 1991. After a post-doc at the IBM Almaden Research Center (USA), he joined ESPCI Paris first as a post-doctoral associate in 1993 and, since 1994 as a CNRS permanent researcher. He was promoted CNRS research director (equivalent to Professor) in 2001 in the Laboratory of Soft Matter Science and Engineering. Since 2009, he is coordinating the research activities of the Soft Polymer Networks research group of the laboratory. He also holds since 2011 the position of scientific chair of the Performance Polymers technology area of the Dutch Polymer Institute and has been appointed in 2016, Distinguished Professor at the Global Station for Soft Matter of Hokkaido University. Since may 2019 he is also the vice-president research of the ESPCI Paris-PSL.*

He has published more than 220 articles in peer-reviewed journals, 13 book chapters and has given more than 120 invited and plenary lectures at international conferences. His research interests focus on the mechanical properties of polymers at interfaces and on deformation and fracture of soft polymer networks. He has received several prizes and awards: the Adhesion Society's prize for Excellence in Adhesion Science in 2013, an ERC Advanced Grant in 2016 to work on fracture of soft materials and more recently the grand Prix Fondation Michelin - Académie des Sciences in 2021 and the Grand Prix Champetier from the French Polymer Society in 2023.

Flexoelectric Vector Sensor for Sound Pressure Gradient

Zhaoqi Li, and Shengping Shen
State Key Laboratory for Strength and Vibration of Mechanical Structures, School of Aerospace, Xi'an Jiaotong University, Xi'an, Shaanxi, 710049, China

Shengping Shen
Xi'an Jiaotong University, China
Email: sshen@mail.xjtu.edu.cn

In this work, we propose the design of a flexoelectric sensor which can measure sound pressure gradient directly. It is found that the sensitivity of sound pressure gradient of the flexoelectric sensor has a wide band for low working frequencies. Our theoretical and experimental results indicate that the position of sound sources can be predicted based on the measured sound pressure gradients of three flexoelectric sensors which are perpendicular to each other. Moreover, different from previous design for piezoelectric sensors array, only three flexoelectric sensors are needed to determine the orientation of sound sources. The flexoelectric sensor proposed here may provide a new way for the pressure gradient measurement.

Biography: *Prof. Shen's research interests mainly include chemomechanics, and flexoelectricity. He has coauthored 2 monographs, and is an author of over 200 journal articles. Through the years, his research work has received supports from governmental agencies such as NSFC etc. He serves as Associate Editors for some journals, such as ASME Journal of Applied Mechanics, Acta Mechanica Solida Sinica, etc. He has been in the organization/scientific commottee for a number of international conferences, and been invited to give lectures to a large audience with diverse backgrounds by a number of international conferences.*

2023 IUTAM Symposium on
Soft Matter Mechanics

How do Different Active Cellular Forces Co-regulate Wound Shapes - Cellular Mechanics of Gap Closure

Baohua Ji
Zhejiang University, China
Email: bhji@zju.edu.cn

Wound closure is a fundamental procedure in many physiological and pathological processes, driven by multiple active cellular forces. By developing a physical model, we elucidate that the different active cellular forces together co-regulate the wound closure process via directing the cell polarization and migration around the wounds, and determining the wound patterns (e.g., circle, oval and slit wound shapes). This study reveals a critical mechanism by which living organisms actively control complex processes via the coordination of multiple cellular forces in tissue repair and development.

Biography: *Dr. Baohua Ji is professor of biomechanics of Zhejiang University. He earned his B.S and Ph.D degrees from Xi'an Jiaotong University of China in 1993 and 1998, respectively. He did his postdoc research at Institute of Mechanics of Chinese Academy of Science during 1998-2001, and at Max-Planck Institute for Metal Research during 2001-2004. His research is currently focused on collective cell behaviors, cellular mechanics of tissue morphogenesis and mechanomedicine (mechanobiology based medicine). The objective of the research is to achieve a quantitative understanding of how forces and deformation affect human health and disease from molecular, cellular and tissue levels. Dr. Ji has published over 150 peer-reviewed Journal papers. And he has received several awards including the Outstanding Young Scientist Award of the Chinese Society of Theoretical and Applied Mechanics (2009), the NSFC Outstanding Young Scientists Award (2010), and National 10-Thousand program for leading talents (2017).*

2023 IUTAM Symposium on
Soft Matter Mechanics

Directional Transport and Fixed-point Transfer of Droplets on Functionalized Surfaces

Ming Liu, Zhilong Peng, Yin Yao, Shaohua Chen
Institute of Advanced Structure and Technology, Beijing Institute of Technology, Beijing, 100081, China

Shaohua Chen
Beijing Institute of Technology, China
Email: shchen@bit.edu.cn

Directional transport or transfer of micro-objects, including solid particles and liquid droplets, exhibits a high potential in various applications, including heat dissipation, water collection, microfluidics, drug transport without pollution, targeted therapy, etc. A variety of methods have been designed to achieve efficient transport functions. However, some challenges still exist, including the directional and rapid transport of solid particles, the non-destructive and non-polluting transfer of droplets, and the precise manipulation of droplets, etc. In this work, we mainly focused on the directional transport and fixed-point transfer of droplets. Firstly, the dynamic behavior of a droplet across the boundary of different wettability regions was studied experimentally1, which would be the mechanism for directional transport of droplets. Then, surfaces consisting of regions of different wettability were designed, on which droplets can spread or slide directionally2, 3. A magnetic sensitive flat surface was further prepared based on soft polymer materials. Under the action of magnetic field, the flat surface will partially become a rough surface. A droplet can be driven to move with a moving magnetic field due to the induced boundary between the flat and rough surface areas4. Finally, a magnetically responsive micro-plate-arrayed surface was designed, different secondary microstructures were further introduced on two lateral sides of each microplate, based on which droplets can be firmly grasped and easily released spontaneously under a rotating magnetic field5. All the experimental phenomena were reasonably explained. The above techniques are simple and easy to implement, which should provide new concepts or technologies for the related fields of droplet manipulation and directional transport or transfer.

References

1. M. Liu, L.Y. Huang, Y. Yao, Z.L. Peng, S.H. Chen. The Journal of Physical Chemistry C, 2019, 123, 23505−23510.
2. M. Liu, Y. Yao, Y.Z. Yang, Z.L. Peng, S.H. Chen. The Journal of Physical Chemistry C, 2019, 123, 12736-12743.
3. M. Liu, Y. Yao, J.J. Li, Z.L. Peng, S.H. Chen. The Journal of Physical Chemistry B, 2020, 124, 6905-6912.
4. M. Liu, C.H. Li, Z.L. Peng, S.H. Chen, B. Zhang. Langmuir, 2022, 38, 3917-3924.
5. M. Liu, C.H. Li, Z.L. Peng, Y. Yao, S.H. Chen. Chem. Engineering. J., 2022, 430, 132749.

Biography: *Shaohua Chen is a Professor of Solid Mechanics at Beijing Institute of Technology. He received his bachelor's and master's degrees from Harbin Engineering University in 1994 and 1996 respectively, and doctor's degree from Beijing Jiaotong University in 1999. After postcodtoral research at the Institute of Mechanics, Chinese Academy of Sciences, he joined the Institute of Mechanics and worked there till 2016. During the period of time, he ever worked as a post-doctor at Max Planck Institute for Metals Researh in Germany from 2003 to 2005 and a visiting scholar at the University of Hong Kong for six months. He works on the multi-scale mechanics of advanced materials and structures, mechanics of functional surface and interface, biomimetic mechanics. His reserch interests include developing multi-scale theories to explain size effect in micro-scale and nano-scale materials, finding novel and easy techniques to measure the interfacial strength and toughness, revealing the mechanism of some special functions of typical organisms and bionic designing functional surface and multifunctional integrated materials, structures and coatings. He has published over 190 SCI papers and has won several awards including the First Prize of Natural Science Award of CSTAM in 2022, Second Prize of National Natural Science Award in 2008, Distinguished Outstanding Youth of NSFC in 2011, Leading Talents of the 10000 Person Plan in 2018.*

A Perturbation Force based Approach to Creasing Instability in Soft Materials under General Loading Conditions

Bin Liu[a], Pengfei Yang[a], Yaopeng Fang[a], Huajian Gao[b]
[a] AML, CNMM, Department of Engineering Mechanics, Tsinghua University, Beijing 100084, China
[b] School of Mechanical and Aerospace Engineering, College of Engineering, Nanyang Technological University, 70 Nanyang Drive, Singapore 639798, Singapore

Bin Liu
Tsinghua University, China
Email: liubin@tsinghua.edu.cn

The formation and control of surface creases in soft materials under compression have intrigued the mechanics community for decades and recently found many applications in tissue biomechanics, soft robotics and tunable devices. In spite of a rapidly growing literature in this field, existing methods of analysis often rely on a presumed crease configuration and consequently there is still a lack of profound theoretical understanding on crease nucleation. In this study, we propose a force based perturbation approach to predicting the occurrence of crease nucleation without assuming a post-instability configuration. In a set of carefully controlled FEM simulations, by considering the relative magnitudes among the element size, perturbation displacement and sample size, we find that beyond a critical strain around -0.36, a flat surface under uniform deformation becomes metastable, while the creased configuration becomes stable, with energy barrier for creasing proportional to the square of the FEM element size and therefore vanishing in the continuum limit. Beyond the Biot critical strain of -0.46, the uniformly deformed configuration of a flat surface becomes unstable. Our force-based instability criterion also enabled us to determine the critical conditions of crease formation for different materials under general loading conditions, leading to a set of crease diagrams. Interestingly, it is shown theoretically and validated experimentally that some highly compressible soft materials do not undergo creasing under loading conditions close to equibiaxial compression.

Biography: *Dr. Bin Liu is currently a professor at Tsinghua University in China. He got his bachelor and PhD degrees majored in mechanics from Tsinghua University in 1996 and 2001, respectively. He spent three years, from 2001 to 2004, working as a postdoctoral research associate in Prof. Yonggang Huang's group at University of Illinois at Urbana-Champaign, the United States. He then visited Germany as a Humboldt research fellow and worked with Prof. Huajian Gao in Max-Plank institute from 2004 to 2005. He returned to China and joined the faculty of Department of Engineering Mechanics, Tsinghua University in 2005. His research interests include multiple scales and multiple physics simulation method, fracture mechanics, and composite mechanics. He is the editor in chief of Forces in Mechanics, and serves as the editorial board member of International Journal of Plasticity and Journal of Computational and Theoretical Nanoscience. He has published more than 140 journal articles and 3 book chapters.*

Advances in Confinement Free Energy Modeling for Wormlike Chains within Nanotubes: A Comprehensive Framework for Arbitrary Dimensions and Geometries

Jizeng Wang, Yihan Zhao, Kai Li
The Gansu Province Basic Discipline Research Center for Nonlinear Mechanics, College of Civil Engineering and Mechanics, Lanzhou University, China

Jizeng Wang
Lanzhou University, China
Email: jzwang@lzu.edu.cn

The confinement free energy of polymer chains within finite-sized spaces is a focal topic in polymer physics, presenting the complex challenge of identifying a singular length scale that captures the essence of confinement across diverse nanotube dimensions and geometries. This paper pioneers a breakthrough in this domain by meticulously dissecting the Fokker-Planck equation governing such systems, from which we extract a universal length scale in a definitive closed-form expression. This innovative length scale adeptly delineates the confinement free energy for wormlike chains enveloped by varying degrees of confinement, seamlessly transitioning from strong to weak entrapment. Our research culminates decades of inquiry, offering a robust resolution to a perennial conundrum that has intrigued scholars for over fifty years. Through extensive Monte Carlo simulations, we scrutinize wormlike chains within channels of assorted cross-sectional shapes, and our empirical findings robustly corroborate the proposed unified length scale, demonstrating an impeccable congruence with our theoretical free energy predictions. This stride in understanding holds profound implications for both theoretical exploration and practical applications pertaining to the statistical mechanical behavior of confined polymers, thereby illuminating a broad spectrum of enigmas in the sphere of polymer physics.

Biography: *Jizeng Wang is the Changjiang Scholar Distinguished Professor (2018-2023, 2023-2028) at Lanzhou University in China. He is also the Director of the Gansu Province Basic Discipline Research Center for Nonlinear Mechanics, Chairman of the Gansu Province Mechanics Society, and Associate Editor for journals such as Applied Mathematics and Mechanics (in Chinese), and Frontiers in Physics, etc. After earning his PhD from Lanzhou University in 2001, he gained experience as a visiting researcher at the Max Planck Institute in Germany and Brown University in the United States from 2002 to 2009. In 2009, he returned to Lanzhou University and was appointed as a Distinguished Professor of the Cuiying Scholar Program. Professor Wang's research is centered on the development of fundamental algorithms and their applications in nonlinear mechanics problems, as well as theoretical and experimental studies of cell mechanics. His research has been recognized with numerous awards, including the First Prize of the Ministry of Education Natural Science Award and support from the National Science Fund for Distinguished Young Scholars in 2019.*

Soft Materials and Origami-based Structures for Robotics and the Metaverse

Hanqing Jiang
Westlake University, China
Email: jianghanqing@westlake.edu.cn

Three basic deformation modes of an object (bending, twisting, and contraction/extension) along with their various combinations and delicate controls lead to diverse locomotion. As a result, seeking mechanisms to achieve simple to complex deformation modes in a controllable manner is a focal point in related engineering fields. Here, in this talk, I will share some thoughts of achieving multi-mode robotics arms, using different methods, including fabric-based pneumatic-driven origami-based actuators, liquid crystal elastomer-based untethered actuators, and a pneumatic-driven, origami-based deformation unit that offers all-purpose deformation modes. Beyond origami-based robotic arms, curved origami patterns that enable in-situ stiffness manipulation covering negative, zero, and positive stiffness have been adopted to achieve mechanical haptics with application in the metaverse. These studies open ways to design smart structures for variable applications.

Biography: *Hanqing Jiang is a Chair Professor of Mechanical Engineering at Westlake University in China. Before joining Westlake University in June 2021, he was a faculty member of Mechanical Engineering at Arizona State University from 2006 to 2021. He received his Ph.D. from Tsinghua University in 2001, majoring in Solid Mechanics. His current research interests include the origami and kirigami based mechanical metamaterials and robotics, mechanics of lithium-metal batteries, and unconventional electronics. He has published 5 book chapters and more than 150 peer-reviewed journal papers. He was elected to an ASME Fellow in 2016. He is a member of the executive committee of the Materials Division of ASME and is the President of the Society of Engineering Science in 2022. Selected honors include an NSF CAREER Award (2009), ASME Worcester Reed Warner Medal (2021), etc.*

2023 IUTAM Symposium on
Soft Matter Mechanics

The Mechanobiological Investigation on Cell Volume Regulation and Cell Division

Hongyuan Jiang
University of Science and Technology of China, China
Email: jianghy@ustc.edu.cn

Cell volume is an underestimated important parameter in cells. The recent studies showed that changes in cell volume not only affect the mechanical properties of cells, but also affect their gene expression and differentiation. The talk will first discuss the regulatory mechanisms of cell volume and pressure from both theoretical and experimental perspectives, as well as their important effects on cell mechanical properties, cell adhesion, and cell migration. The second part of the talk will introduce the mechanobiological investigation on the mitotic spindle and cell division, focusing on a series of basic scientific problems related to mechanics, such as how the external forces, shapea and size of cells affect the positioning, orientation and size of mitotic spindles, and how mechanical confinement regulates multipolar cell division via pole-cortex interaction.

Biography: *Prof. Jiang received the BS and MS degrees in Solid Mechanics from University of Science and Technology of China in 2001 and 2004. He then obtained a MS degree in Applied Mathematics and a Ph.D. degree in Solid Mechanics from Brown University in 2009. Prof. Jiang served as a post-doctoral research associate in Johns Hopkins University after he finished his PhD. degree, and he joined the Department of Modern Mechanics in University of Science and Technology of China in 2013. Prof. Jiang's research mainly focuses on theoretical, computational and experimental study on mechanobiology and biomechanics at multiple scales. Motivated by basic scientific questions and engineering applications, Prof. Jiang works on a wide range of problems at the interface of engineering, physics and biology, such as cell motility, cell volume regulation, mechanobiology of mitotic spindles and cell division, mechanics of growth and development of organs and tissues. Prof. Jiang's work has been published in Cell, Physical Review Letters, Physical Review X, Nature Communications, Biophysical Journal, JMPS and many other top journals. Prof. Jiang was supported by the "National Science Fund for Distinguished Young Scholars" and "National Science Fund for Excellent Young Scholars", and won "Outstanding Advisor Award of the Chinese Academy of Science", "Outstanding Scholar Award of Tang Lixin" and other awards.*

Growth of 2-D Materials on Curved Surfaces

Zhuhua Zhang
Nanjing University of Aeronautics and Astronautics, China
Email: chuwazhang@nuaa.edu.cn

Chemical growth of two-dimensional (2D) materials with controlled morphology is critical to bring their tantalizing properties into fruition. The growth is usually on a non-ideal substrate, which, however, involves either discrete curved features or continuous undulation, at a scale significantly larger than the materials thickness. Using a newly developed method based on the Metropolis algorithm and taking graphene as a prototype, we find that either isolated curved features or periodical undulations on substrates can cause lattice stress in 2D materials, which interacts with the growth chemistry and results in a variety of morphs in 2D materials. More specifically, the growth morphology on a curved feature on substrates mainly manifests as topological defects. As the feature's size increases by just nanometers, the defects can vary from adatoms, dislocation pairs, and grain boundary scars to long-range grain boundaries, in contrast to previously reported defect-free modes of rigid colloidal crystals growing on spheres. On the other hand, 2D materials growing on periodically undulated substrates with nonzero Gaussian curvature of practical relevance follow three distinct modes: defect-free conformal, defect-free suspension and defective conformal modes. The curvature induced stress gradually lifts the materials from substrate and progressively turns the conformal mode into a suspension mode with increasing the undulation amplitude. Further enhancing the undulation can trigger Asaro–Tiller–Grinfield growth instability in the materials, manifested as discretely distributed topological defects due to strong stress concentration. In particular, the undulation-induced suspension of 2D materials can help to understand the formation of overlapping grain boundaries, spotted quite often in experiments. We further rationalize the above results by model analyses and establish 'phase diagrams' for guiding the control of growth morphology via substrate patterning.

Biography: *Zhuhua Zhang, Professor of Nanjing University of Aeronautics and Astronautics, Deputy Director of National Key Laboratory of Aerospace Structural Mechanics and Control, Deputy Director of International Frontier Science Research Institute, and Deputy Director of Senior Talent Office. He is mainly working on the physical mechanics of low-dimensional functional materials and structural materials and has published more than 130 academic papers and authorized 4 invention patents. His papers have been cited by SCI more than 8,000 times, and he has stayed in the list of China's highly cited scholars in 2020-2022. He presided over the National Outstanding Youth Science Fund project, and the international (regional) cooperation and exchange project of the Foundation Committee. He was selected as the Youth Project of the National High-level Talent Program (2017), Jiangsu Distinguished Professor and Jiangsu "Double and Creative Talent" (2019). He has won the Chinese Mechanics Society Youth Science and Technology Award (2021), the Fok Yingdong Education Foundation Young Teachers Award (2020), the National Outstanding Doctoral Dissertation Nomination Award (2013), and the First Prize of Natural Science of the Ministry of Education (2011, 2022). He is deputy editor of Int. J. Smart Nano Mater, Young Editor of Acta Mech. Sinica et al. He also serves as the Member of the Physics and Mechanics Committee of Chinese Mechanics Society, and the Member of micro and nano mechanics working group of Chinese Mechanics Society.*

Mechanics-guided 3D Assembly of Electronic Devices and Microsystems

Yihui Zhang
Tsinghua University, China
Email: yihuizhang@tsinghua.edu.cn

3D micro-/nano-structures have widespread applications in a broad spectrum of cutting-edge areas, such as bio-integrated electronics, microrobots, among others. Existing approaches of 3D assembly/fabrication to form such micro-/nano-structures, however, can only be used directly with a narrow range of materials and/or 3D geometries. A grand challenge in the field is in the development of schemes that allow construction of 3D structures in device-grade crystalline inorganic materials essential for high-quality electronic systems and MEMS. In this talk, I will introduce a mechanics-guided assembly approach that exploits controlled buckling to construct complex 3D micro/nanostructures rapidly from patterned 2D micro/nanoscale precursors. This approach applies to a broad set of materials (e.g., semiconductors, polymers, metals, and ceramics) and even their heterogeneous integration, over a wide range of length scales (e.g., from 100 nm to 10 cm). Development of a rational microlattice design allows transformation of 2D films into programmable 3D curved mesosurfaces through this assembly approach. Analytical modeling and a machine learning–based computational approach serve as the basis for shape programming and determine the heterogeneous 2D microlattice patterns required for target 3D curved surfaces. The compatibility of the approach with the state-of-the-art fabrication/processing techniques available in semiconductor industries, allow transformation of diverse existing 2D microsystems into 3D configurations, providing unusual design options in the development of fundamentally new devices. I will introduce a few examples of unusual bioelectronic devices and bioinspired microrobots enabled by the mechanics-guided 3D assembly.

Biography: *Yihui Zhang is a Professor of Engineering Mechanics at Tsinghua University. His group (http://yihuizhang.org/) is dedicated to addressing the grand challenges in the frontiers of science and technologies through creative uses of mechanics principles and cross-fertilization among diverse disciplines, which drives the development of new mechanics theories and computational models of advanced materials/structures, as well as novel designs and fabrication approaches of materials/devices/systems with unprecedented properties and functionalities. His current research interests include mechanically guided 3D assembly, soft architected materials, and mechanics of flexible structures. He has published > 170 peer-reviewed journal papers, including, 4 in Science, 1 in Nature, 11 in Science sister journals, 15 in Nature sister journals, 1 in NSR, 8 in PNAS, 15 in JMPS, 13 in Advanced Materials, among others, as of November 2023. He is an inventor on 9 China patents and 3 US patents. Dr. Zhang is the recipient of several honors and awards, including, NSFC National Science Fund for Distinguished Young Scholars (2022), ASME Gustus L. Larson Memorial Award (2022), Clarivate Highly Cited Researcher (2022 & 2020), The Xplorer Prize (2021), ASME Thomas J.R. Hughes Young Investigator Award (2019), Society of Engineering Science's Young Investigator Medal (2018), ASME Sia Nemat-Nasser Early Career Award (2018), Eshelby Mechanics Award for Young Faculty (2017), ASME Melville Medal (2017), Journal of Applied Mechanics Award (2017), Qiu Shi Outstanding Young Scholar Award (2016), and MIT Technology Review's 35 Innovators Under 35 (Global) (2016). He is an editor of Mechanics of Materials, an associate editor of Science Advances, Research, and International Journal of Smart and Nano Materials, a past associate editor of ASME Journal of Applied Mechanics, and serves on the editorial board of several other academic journals.*

Mechanomedicine: From Biomechanics and Mechanobiology to Mechanodiagnosis and Mechanotherapy

Feng Xu
Xi'an Jiaotong University, China
Email: fengxu@mail.xjtu.edu.cn

The evolution of modern science and technology is fundamentally based on the integration of various disciplines. In particular, the integration of engineering, physics, and biomedicine has catalyzed significant innovations over recent decades, shaping a new era in biomedical research. One typical example of this emerging innovation is the role of mechanics in medicine, where mechanics has historically been integral, from traditional practices like Chinese acupuncture and massage to modern sports rehabilitation. In living organisms, mechanical cues not only serve as markers for diagnosing diseases but also play a crucial role in intervening in these diseases. Recent advancements in biomechanics and mechanobiology have underscored the vital importance of mechanical cues in both physiology and pathology, leading to the emergence of mechanodiagnosis and mechanotherapy. These advancements collectively form an emerging field, i.e., "Mechanomedicine", which integrates biomechanics and mechanobiology principles to revolutionize medical diagnosis and treatment. This field brings forth groundbreaking theoretical foundations and practical solutions that are crucial for progress in biomedicine. The talk will explore the confluence of mechanics and biomedicine, showcasing recent interdisciplinary strategies in biomedical research, especially in tackling significant challenges in disease diagnosis and treatment.

Biography: *Feng Xu received his Ph.D. from Cambridge University and worked as a research fellow at Harvard Medical School and Harvard-MIT HST. Currently, Dr. Xu is a Professor at Xi'an Jiaotong University, and serving as the Dean of the School of Life Sciences and Technology, Vice Director of the Health Science Center, Director of the Key Laboratory of Biomedical Information Engineering of the Ministry of Education, Head of the Intelligent Diagnostic Technology and Equipment Center of the National Medical Research and Education Integration Platform, and Director of the Bioinspired Engineering and Biomechanics Center (BEBC). He is the recipient of the "Outstanding Youth Fund" from the National Natural Science Foundation of China, and Special Allowances Experts of the State Council.*

Dr. Xu's current research aims at advancing human health through academic excellence in education and research that integrates engineering, science, biology and medicine with focus on mechanomedicine. He has edited multiple books / journal special issues and is an author on more than 350 peer-reviewed journal articles, editorials and review papers, 20 book chapters/books, and 80 issued patents. His work has been published in leading journals, routinely highlighted in international media, and cited >29,000 times by high profile journals with an H-index of 89. His scientific contribution has been reflected by several awards, including the "National Natural Science Award" second prize, "Ministry of Education Science and Technology Award" first prize, and "Chinese Medical Science and Technology Award" first prize. He has also received several personal honors, like the "Chinese Mechanics Young Scientist Award" and the "Commemorative Medal for the 70th Anniversary of the Founding of the People's Republic of China". Dr. Xu has been recognized in the Top 2% Scientists Worldwide (2020/2021/2022) and also Clarivate Highly Cited Researchers (2021/2022/2023).

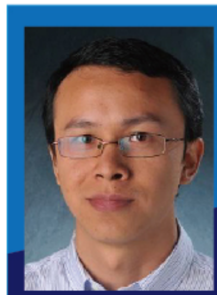
Scaling Laws and Network Structures of Hydrogels

Wei Hong
Southern University of Science and Technology, China
Email: hongw@sustech.edu.cn

Composed mostly of water and a loosely crosslinked polymer network, a hydrogel appears and feels like liquid. Questions naturally arise: Are the mechanical properties fully determined by its chemical composition, just like a liquid solution, or would the synthesis condition or process affect its network structure and further macroscopic properties? Through carefully planned experiments, we systematically studied the mechanical properties of a set of polymeric gels with identical chemical compositions but prepared through different processes. Strong dependences of the mechanical properties on the synthesis conditions were identified, and the results were found to follow a set of scaling laws. From basic theories and fundamental yet intuitive hypotheses characterizing the network topology and structural evolution, we derive the scaling laws which perfectly capture the experimental observations. We further studied the fracture of these chemically identical gels and found some intriguing relations between fracture toughness and synthesis processes. These findings provide insights to the mechanisms in the formation of network structures and topologies at synthesis, and their profound effects on macroscopic properties. The theory established may influence the future design and synthesis of polymeric materials with extraordinary performances.

Biography: *Wei Hong is currently Professor and Associate Chair of the Department of Mechanics and Aerospace Engineering and the Director of Faculty Development at Southern University of Science and Technology (SUSTech). Wei received both B.S. and M.S. degrees from Tsinghua University, and Ph.D. in Engineering Sciences from Harvard University. Wei worked as Assistant Professor and later Associate Professor in the Department of Aerospace Engineering at Iowa State University. He also held a joint appointment from Hokkaido University and was appointed as Associate Professor and later as Professor. He joined SUSTech in 2018. Wei's research covers a broad spectrum in mechanics, including solid mechanics, fracture mechanics, microstructure evolution, multiphysics modeling, and his current research is focused on polymer physics, soft matter mechanics, adhesion, dielectric breakdown, and surface instabilities.*

Multifunctional Wearable Electronics with Stretching, Self-healing, Recycling and Reconfiguring Capabilities



Jianliang Xiao
University of Colorado Boulder, USA
Email: Jianliang.Xiao@colorado.edu

Wearable electronics can be integrated with human body for monitoring physical activities and health conditions, for human-computer interfaces, and for virtual/augmented reality. We here report a multifunctional wearable electronic system that combines advances in materials, chemistry and mechanics to enable superior stretchability, self-healability, recyclability and reconfigurability. This electronic system heterogeneously integrates rigid, soft and liquid materials through a low-cost and scalable fabrication method. Multifunctional wearable electronic devices that can sense electrocardiograph (ECG), temperature, motion, strain and acoustic signals are demonstrated. A high-performance wearable thermoelectric generator (TEG) that can convert otherwise wasted body heat into electric power will also be discussed. The properties reported in these wearable electronic systems provide an approach to address sustainability and environment issues associated with mass production and use of electronics. Such electronic systems can find applications in many areas, including health care, robotics, and prosthetics, and can benefit the wellbeing, economy, and sustainability of our society.

Biography: *Jianliang Xiao is an Associate Professor in the Department of Mechanical Engineering at University of Colorado Boulder. Before joining CU-Boulder, he was a Postdoctoral Research Associate at the Department of Materials Science and Engineering, University of Illinois at Urbana-Champaign. He obtained his Ph.D. degree in Mechanical Engineering in 2009 from Northwestern University, M.S. and B.S. degrees in Engineering Mechanics in 2006 and 2003 from Tsinghua University, respectively. His research interests include stretchable/flexible electronics, and mechanics of soft materials, thin films and nanomaterials. He was a recipient of the Best Paper Awards from ACM MobiCom '19, and Theoretical & Applied Mechanics Letters, the College Outstanding Dissertation Award (as advisor), Best Poster award (Colorado Photonics Industry Association Annual Meeting), ACS PRF Doctoral New Investigator award, and ASME Haythornthwaite Research Initiation Award. He is a secretary of the Executive Committee and Newsletter Editor of ASME Applied Mechanics Division, Associate Editor of Frontiers in Sensors, and Editorial Board member of NPJ Flexible Electronics, Science China Technological Sciences, Micromachines, Frontiers in Electronics, and Frontiers in Bioengineering and Biotechnology.*

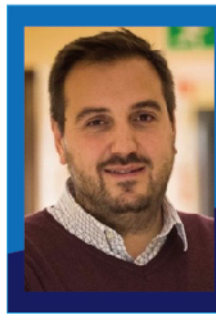
Morphomechanics of Soft Films: Growth, Shrinkage and Curvature

Fan Xu
Fudan University, China
Email: fanxu@fudan.edu.cn

Many biological structures exhibit intriguing morphological patterns adapted to environmental cues, which contribute to their important biological functions and also inspire material designs. In this talk, we present a variety of morphogenesis of diverse soft films across different length scales. We report some unprecedented wrinkling phenomena in elastically deformed film-substrate systems upon growth/shrinkage or mechanical forces, from planar to curved geometry. All the cases involve highly nonlinear deformations and multiple bifurcations. We develop mathematical models and derive universal scaling laws to understand the underlying morphoelastic mechanism, and more importantly to quantitatively predict multiple symmetry breakings beyond the critical instability threshold. Moreover, we demonstrate bio-inspired applications by harnessing surface instability such as a target adaptive grasper. Our results not only reveal novel instability topographies, providing fundamental insights into surface morphogenesis of deformed soft films that are ubiquitous in the real world, but also provide a platform to design morphology-related functional surfaces.

Biography: *Dr. Fan Xu is a professor of solid mechanics at Fudan University (China). He received his bachelor's degree in engineering mechanics from Wuhan University (China) in 2009, and his master's degree in solid mechanics from Arts et Métiers ParisTech (France) in 2011. He completed his PhD in solid mechanics at University of Lorraine (France) in 2014, studying mechanical instability of film/substrate systems. He continued to work in LEM3-CNRS as a postdoctoral researcher, and expanded his research interests to mechanics of soft materials and slender structures. His current research interests include morphomechanics and physics of thin films, soft matter and 2D materials. He has published more than 70 papers in international journals such as Phys. Rev. Lett., Nature Comput. Sci., Nature Biomed. Eng., J. Mech. Phys. Solids, Comput. Method. Appl. Mech. Eng., Nano Lett., Adv. Funct. Mater., Angew. Chem., etc. His research was highlighted by Nature, Nature Phys., Nature Comput. Sci., Nature Biomed. Eng., and selected as cover image by Nature Comput. Sci., Phys. Rev. Lett., Nano Lett., and Proc. Roy. Soc. A. He received the Excellent Young Scientists Fund of NSFC, ASME Prize (French section), and was selected as "Shanghai Shuguang Scholar" and "2018 Ten Emerging Star Scientists in China".*

Recent Advances in the Modeling of Magnetorheological Elastomers and Their Instabilities



Kostas Danas
Ecole Polytechnique, France
Email: konstantinos.danas@polytechnique.edu

In this talk, our work on magnetorheological elastomers (MREs) including experiments, theory and numerical implementation will be presented. MREs are composite materials comprising metallic soft (e.g. iron) or hard (e.g. NdFeB) magnetic micron-sized particles. The first are known as s-MREs and the latter as h-MREs. Out of these materials one can devise a number of interesting meso- and macrostructures slender or not that can lead to a number of functionalities such as surface patterning, negative or positive swelling and others. Recent developments in the thermodynamically consistent modeling of the coupled response for such materials using a combination of homogenization methods, phenomenological modeling and numerical computations will be briefly presented. These models will then be used to study experimentally and numerically a MRE film/substrate structure and its wrinkling response, which evolves into a novel pattern called crinkling.

Biography: *Kostas Danas holds a tenured position as a CNRS Research Director (Directeur de Recherche) and Associate Professor at the Solid Mechanics Laboratory (LMS), Department of Mechanics at Ecole Polytechnique. He was born and raised in Kozani, Greece and studied at the Department of Mechanical Engineering at the University of Thessaly, Volos, Greece where he received his Dipl. Ing. in Mechanical Engineering (2003) with highest honors (rank 1st). He received his M.Sc (2004) from the University of Pennsylvania and his Ph.D. (2008) from the Ecole Polytechique, France and the University of Pennsylvania, PA, USA. After the end of his graduate studies, he moved to the University of Cambridge, U.K. as a postdoctoral Research Associate. In 2009, he applied for a research faculty position at the Centre National de la Recherche Scientifique (C.N.R.S.) where he was ranked 1st in the section of solid mechanics. He has obtained his HDR (Habilitation à diriger des recherches, 2016) from University of Pierre and Marie Curie, Paris. His main research interests are in the field of solid mechanics and composite materials. He is currently working on the experimental, numerical and theoretical analysis of microstructured active elastomers and their instabilities as well as on the modelling and fracture of metallic and 3D printed polymeric porous materials. He has recently been awarded an ERC starting grant (2014) to carry out research on the low energy control of instabilities in magnetorheological elastomers (MREs). Kostas is the recipient of the Bronze Medal from the Centre National de la Recherche Scientifique (CNRS) in 2017 and the Jean Mandel prize (2019) awarded bi-annually for excellence in research in mechanics to young scientists (below 40) working in France .*

Distinguished Representatives

Alphabetic order based on surname

Yuli Chen
Beihang University

Dr. Yuli Chen is currently a professor at Beihang University in China. Her research interest is focused on the damage and failure of heterogeneous materials and structures, multi-scale analysis and design of advanced materials, and impact resistance of composite structures. She has been selected into the Program for New Century Excellent Talents (2013), National Natural Science Foundation for Excellent Young Scientist Fund Program (2016), the Young Changjiang Scholars Program (2017) and National Natural Science Foundation for Distinguished Young Scholars (2022), and she has received CSTAM Youth Science and Technology Award (2021), the first prize of Natural Science Award from CSTAM (2021) and the second prize for National Teaching Achievements (2023). She is now the vice secretary general of CSTAM, the associate editor of Forces in Mechanics and the Chinese associate editor of Composites Part A: Applied Science and Manufacturing.

Email: yulichen@buaa.edu.cn

Hui Chen
Ningbo University

Dr. Hui Chen received his Ph.D. degree in Mechanical and Aerospace Engineering from the University of Missouri and his master's and bachelor's degrees in Engineering Mechanics from Ningbo University. Before joining Ningbo University in 2022, he was a Postdoctoral Fellow at the University of Missouri. His research interests include wave propagation and mechanics in elastic/acoustic metamaterials and structural materials, topological mechanics, vibration and sound wave mitigation. He has authored one book chapter and 40 Journal papers (include Nature Communications, Science Advances, Physical Review Letters, Journal of the Mechanics and Physics of Solids, et al.).

Email: chenhui2@nbu.edu.cn

Zhaohe Dai
Peking Unviersity

Zhaohe Dai is an Assistant Professor in the Department of Mechanics and Engineering Science, College of Engineering, Peking University (PKU). He received his B.Sc. degree in Theoretical and Applied Mechanics from the University of Science and Technology of China in 2013, M.S. degree in Solid Mechanics from the Institute of Mechanics in 2016, and Ph.D. in Solid Mechanics from the University of Texas at Austin in 2020. Before joining PKU in March 2022, he undertook postdoctoral research in the Mathematical Institute, University of Oxford, as a Marie Curie Fellow. His research interests are focused on the mechanics of thin films and their surfaces and interfaces. He has published more than 60 peer-reviewed articles so far (with more than 3,900 citations according to Google Scholar). Many of these have been in high-impact journals such as Physical Review Letters (PRL), Nature Communications, PNAS, Advanced Materials, Nano Letters, JMPS, and so on. His research has been highlighted by 6 journal covers such as PRL and news media such as APS physics, MRS news, and so on. He has been honored with the Distinguished Young Scholars (Overseas) award.

Email: daizh@pku.edu.cn

Yangkun Du
University of Glasgow

Dr. Yangkun Du serves as a Research Associate at the University of Glasgow (UK), having been honored with the prestigious EU Marie Curie Postdoctoral Fellowship. He is also a winner of the Excellent Doctoral Dissertation Award by the Chinese Society of Mechanics, as well as nominations for the Excellent Doctoral Dissertation Award in both Zhejiang Province and Zhejiang University. He is a member of the Chinese Society of Theoretical and Applied Mechanics and the European Mechanics Society, and a registered expert in the EU database. His research interests span a wide spectrum, including soft matter mechanics, growth theory, residual stress theory, surface instability, nonlinear contact mechanics, and nonlinear viscoelasticity. He has published 18 papers in esteemed journals, including 5 papers in the Journal of the Mechanics and Physics of Solids (JMPS), and papers in Soft Matter, Physical Review E, Science China Physics, Mechanics & Astronomy, and International Journal of Mechanical Sciences (IJMS).

Email: Yangkun.Du@glasgow.ac.uk

Yang Gao
Zhejiang University

Yang Gao, hundred-talent assistant professor at the Department of Engineering Mechanics, Zhejiang University. He received his B.S. degree from Peking University in 2012 and Ph.D. degree from Georgia Institute of Technology in 2017. Before joining ZJU in 2020, Dr. Gao worked as postdoc scholar at University of California, Berkeley. Dr. Gao has authored multiple peer-reviewed papers on high-profile journals, including Nature Materials, Nature Nanotechnology, etc. He is also a recipient of the National Young Talent Programme of China. His research is focused on the novel mechanical and other physical properties of nano-materials like 2D materials and van der Waals heterostructures, using the methods of scanning probe microscopy and diamond anvil cell.

Email: ygao96@zju.edu.cn

Yufeng Guo
Nanjing University of Aeronautics and Astronautics

Dr. Yufeng Guo is a professor of College of Aerospace Engineering, State Key Laboratory of Mechanics and Control for Aerospace Structures, Nanjing University of Aeronautics and Astronautics. His research interests include the interlayer interaction and mechanical behavior, mechanical-electric-chemical coupling and device principle, structural design and performance tuning of low-dimensional materials and systems. Prof. Yufeng Guo published over 64 SCI papers on international journals including Phys. Rev. Lett., Adv. Funct. Mater., Matter, Nano Energy, Nanoscale Horiz., J. Phys. Chem. Lett. etc., which have already been cited over 2250 times in international journals such as Science, Nature Materials and Nature Nanotechnology. Some theoretical predictions have been confirmed by other experiments. Prof. Yufeng Guo won the second Prize of National Natural Science (the fourth place), and obtained Excellent Youth Foundation of National Natural Science Foundation of China, Distinguished Youth Foundation of National Natural Science Foundation of Jiangsu Province, and Changjiang Scholars Program of Young Scholars and New Century Excellent Talents in University of MOE.

Email: yfguo@nuaa.edu.cn

Zheng Jia
Zhejiang University

Dr. Zheng Jia received his Ph.D. degree in Mechanics of Materials from the University of Maryland – College Park in December 2014. Afterward, he was a postdoctoral researcher at Northwestern University and Johns Hopkins University for two years and one year, respectively. Dr. Jia joined the Department of Engineering Mechanics at Zhejiang University as Assistant Professor in December 2017. He became Associate Professor with tenure in January 2021. Starting from January 2022, he is serving as the associate director of the institute of applied mechanics at Zhejiang University. Dr. Jia is now leading a multidisciplinary research group to advance the mechanics of soft materials. His lab is currently working on three major research thrusts: 1) mechanics of hydrogels; 2) design and synthesis of functional hydrogels and elastomers; 3) manufacture of ionotronic devices and flexible structures. Representative work of his group includes the constitutive model of anisotropic hydrogels, fracture of bilayer soft materials, delayed tensile instability of hydrogels, liquid-free ionic conductive elastomers, as well as mechanics of novel electrodes for lithium-ion batteries. Dr. Jia has published about 57 peer-reviewed journal articles so far (with more than 4700 citations according to Google Scholar), many of which have appeared in high-impact journals such as Nature, Nature Communications, Advanced Materials, PNAS, Nano Letters, ACS Nano, and the Journal of Mechanics and Physics of Solids. His current h-index is 28. He has been honored with the Extreme Mechanics Letters Young Investigator Awards. He is currently the special EML editor, and the youth editorial board member of Extreme Mechanics Letters and Soft Science. He has been the editor of the iMechanica Journal Club from 2020 to 2021.

Email: zheng.jia@zju.edu.cn

Bo Li
Tsinghua University

Dr. Bo Li is an Associate Professor at Tsinghua University. His research interest is biomechanics and soft matter mechanics. Currently, he serves as a member of the Biomechanics Committee and a member of the Soft Matter Mechanics Working Group of the Chinese Society of Mechanics. Dr. Li received his PhD degree in mechanics from Tsinghua University in 2011 and had been a post-doctoral researcher at Johns Hopkins University during 2011-2014. In 2015, Dr. Li joined the faculty of the Department of Engineering Mechanics at Tsinghua University. He is the recipient of the National Excellent Doctoral Dissertation Award from the Ministry of Education (2013), the First Prize in Natural Science from the Ministry of Education (2017), the Second Prize in National Natural Science (2019), and the Youth Science and Technology Award from the Chinese Society of Mechanics (2021). He was selected for the Overseas Youth Program (2015), and supported by the Excellent Youth Fund (2019) and the Outstanding Youth Fund (2023) of the National Natural Science Foundation of China. He has published more than one hundred twenty papers in peer-reviewed scientific journals.

Email: libome@tsinghua.edu.cn

Dechang Li
Zhejiang University

Dechang Li, associate professor in the Department of Engineering Mechanics at Zhejiang University. His research interests include cellular and molecular mechanics, as well as the structure and mechanical behavior of biomaterials. He primarily utilizes simulations and theoretical modeling, combined with experiments to quantitatively reveal the kinetic process and structure-function relationship of biomolecules. The objective is to predict and regulate biomolecular function, and to provide theoretical guidance for the targeted treatment of critical diseases and the optimal design of biomaterials. Currently, he focuses on the mechanisms of lipid membranes interacting with soft materials and proteins, which are associated with the application of flexible electronics and the function of mitochondria, respectively. He has published over 50 peer-reviewed papers in various journals, including PRL, Cell Reports, Nature Communications, Advanced Materials, Nano Letters, ACS Nano, Biophysical Journal, Journal of Molecular Biology, Soft Matter, Progress in Lipid Research, and others.

Email: dcli@zju.edu.cn

Long Li
Lanzhou University

Long Li an Associate Professor of Engineering Mechanics at Lanzhou University. Long Li received his BS degree from Hunan University in 2010, and his Ph.D. degree from Lanzhou University in 2015. He worked as a postdoctoral fellow at University of Erlangen-Nuremberg in 2018-2020. His research interests lie in the area of soft matter mechanics, biomechanics, biophysics as well as active biomaterials. His research is at the multi-scale interfaces between mechanics and biological materials, such as cell adhesion, cellular uptake of NP, packaging DNA into capsid, cell mechanics and membrane adhesion and includes both computational and theoretical components.

Email: longl@lzu.edu.cn

Chaofeng Lü
Ningbo Unviersity

Chaofeng Lü is currently the Vice President and Pao Yue-Kong Distinguished Professor of Ningbo University, the Director of Center for Mechanics Plus under Extreme Environments. His research interests include mechanics of smart materials and structures, flexible and stretchable intelligent devices, self-assembly of materials, and mechanics of materials under hypergravity conditions. He has co-authored over 120 refereed international journal articles and 50 international conference papers, which have received more than 6200 self-excluded independent SCI citations with an H-index 34. His recent awards include the Elsevier Highly Cited Chinese Researchers (2020, 2021), NSFC Distinguished Young Scientist (2019), Changjiang Scholar Young Scientist (2017), National Natural Science Award (2015), NSFC Outstanding Young Scientist (2013), and MOE Natural Science Award (2012). He is now the Director of the Electronic and Electromagnetic Devices Mechanics Division of CSTAM, the Editorial Board member of Mechanics of Advanced Materials and Structures, Forces in Mechanics, Sensors, Materials, and Journal of Zhejiang University A – Science.

Email: lucf@nbu.edu.cn

Zhilong Peng
Beijing Institute of Technology

Zhilong Peng received his Ph.D degree of Solid Mechanics in Institute of Mechanics, Chinese Academy of Sciences in 2012, and now he is a professor of solid mechanics in Beijing Institute of Technology. His research interests includ biomimetic material mechanics, surface/interface mechanics, biomimetic design of functional surfaces. He has published over 60 SCI indexed papers, and received the awards of the National Natural Science Fund for Excellent Young Scientists Fund Program in 2020, distinguished doctoral theses of Chinese Academy of Sciences in 2013, and joined the Youth Innovation Promotion Association of Chinese Academy of Sciences in 2015. Zhilong Peng is the members of Soft Materials Mechanics working group and Rational Mechanics and the Mathematical Method in Mechanics working committee of CSTAM.

Email: pengzhilong@bit.edu.cn

Jin Qian
Zhejiang University

Jin Qian received his B.E. degree from Peking University in 2000, and his M.S. degree from Institute of Mechanics, Chinese Academy of Sciences in 2003. He entered Brown University in March 2006, obtained his Sc.M. degree in Applied Mathematics in May 2009, and defended his Ph.D. dissertation (Solid Mechanics) in August 2009. He spent two years at Georgia Institute of Technology as a Postdoc Fellow. He is now a Professor of Zhejiang University, and serves as the Deputy Dean of the School of Aeronautics and Astronautics. His research interests include the mechanics and 3D printing of soft materials, mechanics of bio-inspired materials and structures, cell mechanics, etc.

Email: jqian@zju.edu.cn

Li-Hua Shao
Beihang University

Prof. Dr.-Ing Li-Hua Shao is currently Professor and Associate Dean of School of Aeronautic Science and Engineering of Beihang University. She received her B.Eng degree in mechanics 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, strength and failure of porous media and composite materials. Shao's research work has been published in journals including Sci. Adv., PNAS, J. Mech. Phys. Solids, Adv. Mater., etc. She won the 1st Chou Pei-yuan Young Investigator Award in Mechanics of Chinese Society of Theoretical and Applied Mechanics (CSTAM), 2023. She serves as a Junior Editorial Advisory Board member of Engineering Fracture Mechanics, and Secretary General of Working Committee of Female Scientists of CSTAM.

Email: shaolihua@buaa.edu.cn

Xinghua Shi
National Center for Nanoscience and Technology

Xinghua Shi received his Bachelor degree from Peking University, Master degree from Institute of Mechanics, Chinese Academy of Sciences and PhD from Brown University. From 2011-2016 back in Institute of Mechanics, CAS as an Associate Professor, he studied nanoparticle-cell interaction with multiscale modeling. In the beginning of 2016 he moved to National Center for Nanoscience and Technology as full Professor and Principle Investigator. There he focused on the simulation of catalysis, self-assembly and drug delivery.

Email: shixh@nanoctr.cn

Jizhou Song
Zhejiang University

Jizhou Song is a QiuShi Professor of Department of Engineering Mechanics at Zhejiang University. He is a Fellow of American Society of Mechanical Engineers (ASME). He received his Ph.D. degree from University of Illinois at Urbana-Champaign in 2007. His current research interests include tunable adhesive for advanced transfer printing and mechanics of stretchable electronics with applications in human-machine interface. He has published more than 150 peer-reviewed journal papers and received several awards including the Outstanding Young Scholar Award from Qiu Shi Science & Technologies Foundation (2014), the 16th Young Science & Technology Award from the Chinese Society of Theoretical and Applied Mechanics (2019), and the National Science Fund for Distinguished Young Scholars (2022). He served as an associate editor for the Journal of Applied Mechanics and an editorial board member for various journals including npj Flexible Electronics, International Journal of Applied Mechanics, etc.

Email: jzsong@zju.edu.cn

Yewang Su
Institute of Mechanics, Chinese Academy of Sciences

Yewang Su is a Professor of the Institute of Mechanics, Chinese Academy of Sciences. He has been dedicated to the study of the mechanics of flexible structures and devices. He was selected for National Young Talent program and the Chinese Academy of Sciences' BR program. Additionally, he serves as the leader of an innovative cross-disciplinary team at the Chinese Academy of Sciences (with only 20 teams selected nationwide each year). With more than 100 high-level academic papers published, his work has been cited over 10,000 times in SCI. His publications, in which he is either the first or corresponding author, include papers in JMPS (3), IJSS (5), PNAS, Nature Communications (3), Advanced Materials (2), Advanced Functional Materials (5), ACS Nano (3), Nano Energy (3), Small, and among others. He has authored one English monograph and two book chapters. He has applied for more than 30 invention patents, submitted two international PCT patent applications, and developed flexible sensors applied to national major needs such as Mars Exploration. He serves as an editorial board member of the internationally renowned journal Composite Structures. He leads various research projects, including National Natural Science Foundation project, Chinese Academy of Sciences' Original Innovation project, Beijing Municipal Science and Technology Commission's Major Special project in Huairou Science City, and application project of research achievements in Aerospace and Medical Enterprises.

Email: yewangsu@imech.ac.cn

Yipin Su
Huanjiang Laboratory

Dr. Yipin Su joined the Huanjiang Laboratory through the "Platform Hundred Talents" program of Zhejiang University in May 2023. He earned his Ph.D. in Solid Mechanics from Zhejiang University in 2016. Subsequently, he conducted research visits in Ireland, Israel, the United States, Italy, and other countries. In 2017, he was awarded the Government of Ireland Postdoctoral Fellowship Programme. In 2019, he received the prestigious "Seal of Excellence" award from the Marie Skłodowska-Curie Individual Fellowships under Horizon 2020, European Union. In 2023, he was selected for the "Hometown of Eminent Scholars" Young Talent Program in Shaoxing, the "Reservoir" Program for Young Talent by the Chinese Society of Theoretical and Applied Mechanics, and the National High-Level Young Talent Program.

Dr. Su's research focuses on materials and structural stability analysis, nonlinear mechanics of smart soft materials, and wave analysis, as well as self-enhancing/self-healing materials and structural control. He has published 30 SCI papers in journals such as Advanced Materials, Journal of the Mechanics and Physics of Solids, Proceedings of the Royal Society A, International Journal of Engineering Science, and International Journal of Solids and Structures. His research has been cited over 600 times in SCI papers and has been featured in various international journals and magazines, including "Nature" and "NSF News".

Email: su_yp@zju.edu.cn

Guannan Wang
Zhejiang University

Dr. Guannan Wang is the assistant professor of Civil Engineering at Zhejiang University. He obtained his Ph.D. degree at the University of Virginia, after which he conducted postdoc research at Texas Tech University. His research interests are focused on the micromechanics of heterogeneous materials as well as multiscale and multiphysics modeling. He has authored over 70 peer-reviewed articles, which are positively cited or evaluated by peer researchers. His research results are also applied to several national projects such as the Hongkong-Zhuhai-Macao Bridge, Xiang'an Bridge of Xiamen City, etc. His was award the NSFC Excellent Young Scholars Fund in 2023, he was also enrolled into the "Youth Talent Lift Program" of China Association for Science and Technology in 2021.

Email: guannanwang@zju.edu.cn

Bin Wu
Zhejiang University

Dr. Bin Wu received his BSc (Hons.) and PhD (Hons.) degrees in Engineering Mechanics at Chongqing University in 2012 and in Solid Mechanics at Zhejiang University in 2018, respectively. He was a Marie Curie Individual Fellow (MSCA-IF) at the University of Galway from 2020 to 2022. He joined the Department of Engineering Mechanics, Zhejiang University as a Principal Investigator in 2023. Before that, he was a Postdoctoral Fellow at Politecnico di Torino in 2018 and an IRC (Irish Research Council) Postdoctoral Fellow at the University of Galway in 2019. His research interests include mechanics of smart materials and structures, wave mechanics, soft matter mechanics, tunable phononic crystals and metamaterials, fluid-structure interactions, and customized CUF FEM. He has presided over or participated in 7 research projects and has authored 1 book chapter and 38 journal papers (including Appl. Mech. Rev., J. Mech. Phys. Solids, J. Fluid Mech., J. Sound Vib., et al.), with Google Scholar citations over 1300 and an h-index of 20. He serves as Contributing Editor of Mech. Adv. Mater. Struct., and Young Scientist Commitee Member of J. Zhejiang Univ. Sci. A. He has won the Nomination Award for Excellent Doctorate Dissertation of the Chinese Society of Theoretical and Applied Mechanics (CSTAM) in 2019, and the Lloyd H. Donnell Applied Mechanics Reviews Paper Award in 2022.

Email: bin.wu@zju.edu.cn

Rui Xiao
Zhejiang University

Rui Xiao is a tenured associate professor in the Department of Engineering Mechanics at Zhejiang University. He received his bachelor's degree from University of Science and Technology of China in 2009, and MS and PhD degrees from Johns Hopkins University in 2011 and 2015. He also conducted research in University of Erlangen-Nuremberg under the support of a Humboldt Research Fellowship from 2021 to 2022. Dr. Xiao's research area is the constitutive relationship of polymers and the mechanics of soft materials. He was awarded the NSFC Excellent Young Scholars Fund in 2020. As the first or corresponding author, he has published more than 70 papers in peer-reviewed journals.

Email: rxiao@zju.edu.cn

Guang-Kui Xu
Xi'an Jiaotong University

Dr. Guang-Kui Xu obtained his bachelor's degree from the Department of Engineering Mechanics at Xi'an Jiaotong University in 2006, his doctoral degree from the Department of Engineering Mechanics at Tsinghua University in 2011, and a postdoctoral position at the Max Planck Institute of Colloid and Interface in Germany from 2011 to 2013. Since January 2014, he has been working in the Department of Engineering Mechanics at Xi'an Jiaotong University, serving as an associate professor and professor, and as the director of the Department of Engineering Mechanics since 2021. He focuses on the interdisciplinary studies of mechanics of soft materials, multi-scale mechanics, and cell mechanics. He has published over 70 SCI papers, including Nature Communications, Science Advances, Nano Letters, ACS Nano, JMPS, Biophysical Journal, Advanced Science, etc. He was selected as Outstanding Young Scientists of NSFC in 2021.

Email: guangkuixu@mail.xjtu.edu.cn

Binglun Yin
Zhejiang University

Binglun Yin is a research fellow of the Hundred Talents Program at Zhejiang University. He obtained his Ph.D. in Solid Mechanics from Zhejiang University in 2015 under the supervision of Prof. Shaoxing Qu. From 2015 to 2020, he conducted postdoctoral research at EPFL in Switzerland under the guidance of Prof. William Curtin. He returned to Zhejiang University in September 2020. Yin's research is within micro- and nano-mechanics, an interdisciplinary field across solid mechanics and materials science. His research focuses on structural metals and complex alloys with practical importance. Based on multiscale modeling and computational simulations, he explores the behaviors of microscopic dislocations that determine the macroscopic mechanical properties of the metals, providing guidance for practical applications. Yin has published over 20 SCI academic papers in journals such as Science, Nature Communications, npj Computational Materials, Acta Materialia, JMPS, etc.

Email: binglun.yin@zju.edu.cn

Quanzi Yuan
Institute of Mechanics, Chinese Academy of Sciences

Dr. Quanzi Yuan is a full professor at the State Key Laboratory of Nonlinear Mechanics, Institute of Mechanics, Chinese Academy of Sciences. His research interest is in the dynamics of the solid-fluid interface. He has published more than 40 papers in NSE, PRL, JFM, JACS, etc., which have been cited more than 2000 times. He has received a number of awards, including the 2nd class prize of National Natural Science Award in China (2014), the Young Elite Scientist Sponsorship Program from CAST (2015), the National Science Fund for Excellent Young Scholars from NSFC (2017), and the Excellent Member of Youth Innovation Promotion Association from CAS (2018).

Email: yuanquanzi@lnm.imech.ac.cn

Zhai Wei
National University of Singapore

Dr. Zhai Wei is an Assistant Professor in the Department of Mechanical Engineering at the National University of Singapore (NUS). She received her B.Eng. degree from the University of Science and Technology Beijing in 2011 and her Ph.D. degree from the University of Cambridge in 2015. She worked as a Research Scientist at the Singapore Institute of Manufacturing Technology, A*STAR, from 2015 to 2019. Her research group at NUS currently focuses on developing multiscale manufacturing technologies, such as additive manufacturing and freeze casting, for multifunctional materials, including lattice structures, hydrogels, and composites. Since joining NUS in 2019, her team has published articles in top scientific journals, including Science Advances, Advanced Materials, Advanced Functional Materials, Acta Materialia, ACS Nano, Nano Letters, Small, Materials Horizons, etc.

Email: mpezwei@nus.edu.sg

Haifei Zhan
Zhejiang University

Haifei Zhan is currently a Research Fellow in the College of Civil Engineering and Architecture at Zhejiang University, China. He obtained his Ph.D degree from Queensland University of Technology (QUT), Australia, after which he worked as Postdoctoral Research Fellow at QUT. Later, he worked as Lecturer at Western Sydney University, and Lecturer and Senior Lecturer at QUT. His research focuses on nanomechanics and nanoscale thermal transport properties of advanced materials. To date, he has published 2 invited book chapters and over 120 peer-reviewed articles, and attracted more than 60 international media reports, such as MIT Technology Review, and Physicsworld. He received Australian Endeavour Research Fellowship, Young Investigator Award (International Chinese Association for Computational Mechanics), and APACM Young Investigator Award (Asian Pacific Association for Computational Mechanics). He was also the recipient of the NSFC Excellent Young Scientists Fund Program (Overseas) in 2021.

Email: zhan_haifei@zju.edu.cn

Yichao Zhu
Dalian University of Technology

Dr. Yichao Zhu is now a full professor based in the School of Mechanics and Aerospace Engineering at Dalian University of Technology (DUT). Dr. Zhu got his Bachelor degree on applied mathematics from Fudan University, and his PhD on applied mathematics from University of Oxford. Dr. Zhu's major research interest lies in the modelling and simulations of multiple-scale problems that arise in physics, engineering and materials science, and he is now devoting efforts to re-vitalising traditional asymptotic homogenisation/localisation techniques with the use of machine learning. Dr. Zhu also bears strong interests in projects, where mathematical tools can be used by all means to solve industrial problems. Dr. Zhu has published more than 40 peer-reviewed articles. He sits in the junior editorial board of Acta Mechanica Solidia Sinica, and serves in the administrative panel on mechanics of soft materials underneath the Chinese Society of Theoretical and Applied Mechanics.

Email: yichaozhu@dlut.edu.cn

Linli Zhu
Zhejiang University

Dr. Linli Zhu is the Professor of Solid Mechanics in Department of Engineering Mechanics, Zhejiang University. He was awarded BE and PhD on Theoretical and Applied Mechanics/Solid Mechanics from Lanzhou Universitv in 2003 and 2008 respectively, Prof. Zhu is currently the Member of Chinese Society of Theoretical and Applied Mechanic, and the Committee member of Zhejiang Society of Theoretical and Applied Mechanic. Prof. Zhu has been selected to National High-level Talents Special Support Program in P.R.China.

Prof. Zhu has published over 90 papers in the peer-reviewed journals, including two papers published in Nature one of which is as the cover article in nature. His research interest is to deep understand on the microstructure-properties correlation and its response to environments for designing the material properties and structural reliability. Taking aim at this fundamental problem, Prof. Zhu has developed plastic model for nanotwinned polycrystalline metals and achieved the scale law for the deformation transitions in nanotwinned metal, addressed the micromechanical models for novel composite metallic materials to reveal the strengthening and toughening mechanism in gradient nanostructured metals and suprananostructured metals, proposed statistic plastic model and the pressured-related grain boundary deformation model to shed light into the improvement of mechanical properties and the pressure-induced strengthening in nanostructured polycrystalline metals; and established the generalized surface elasticity for charged nanostructures and suggested the stress/strain engineering and surface/interface engineering to control the thermal properties of semiconductor nanostructures. Prof. Zhu has been invited to serve as the project review expert for academic organizations and the reviewer for international journals.

Email: llzhu@zju.edu.cn

Shuze Zhu
Zhejiang University

Prof. Zhu Shuze received his Ph.D. in mechanical engineering from the University of Maryland, and then did postdoctoral research in the Department of Chemical Engineering at the Massachusetts Institute of Technology (MIT) and the Department of Mechanical Engineering and Science at the University of Illinois at Urbana-Champaign (UIUC). His research group uses mechanical theoretical modeling and experiments, cross-scale calculations, material synthesis and characterization to study the mechanical behavior of advanced macromolecular nanomaterials and structures, including soft matter polymer materials (such as cellulose, thermoplastic polyurethane, hydrogel), low-dimensional materials (such as two-dimensional materials, graphene), polymer composite materials, micro-nano structures, etc., as well as develop enabling calculation methods, and experimentally develop advanced functional materials with excellent mechanical properties. He has published in journals such as Science, Nature, PNAS, and Physical Review Letters.

Email: shuzezhu@zju.edu.cn

Poster Presentations

Alphabetic order based on surname

No.	Title/Name/Affiliation
P01	**4D Printed Stiffness-tunable Actuator for Loadbearing Soft Machines** Xinpeng Chen, Meng Yang, Kun Jia, Chao Yuan* *Department of Engineering Mechanics, Xi'an Jiaotong University, Xi'an 710049, China*
P02	**Ultra-tough Organo-hydrogel with Multi-mechanisms via Synergy of Freeze-casting Assisted Solution Substitution (FASS)** Xinyu Dong, Xiao Guo, Huajian Gao*, Wei Zhai* *National University of Singapore, Singapore*
P03	**Decoupling Cellular Viscoelasticity from Substrate: a Novel ModelIncorporating Substrate Viscoelastic Relaxation** Yangkun Du, Narina Bileckaja, Shuai Bu, Huabing Yin, Matthew Walker, Jakub Kory, Xiaoyu Luo, Nicholas Hill, Raimondo Penta *University of Glasgow, UK*
P04	**Tough and Functional Hydrogel Adhesion** Yang Gao[1], Tongqing Lu[1], Zhigang Suo[2] *[1]State Key Laboratory of Strength and Vibration of Mechanical Structures, School of Aerospace Engineering, Xi'an Jiaotong University, China;* *[2]School of Engineering and Applied Sciences, Kavli Institute for Bionano Science and Technology, Harvard University, USA*
P05	**Mechanical Modeling and Simulations of Bio-polymer Networks** Bo Gong[1,2], Ji Lin[1], Xi Wei[3], Yuan Lin[3,*], Jin Qian[1,*] *[1]Zhejiang University, China;* *[2]Kunming University of Science and Technology, China;* *[3]The University of Hong Kong, China*
P06	**A Modelling Study of Pulmonary Regurgitation in a Personalized Human Heart** Debao Guan[1], Xiaoyu Luo[2], Mark Danton[3], Hao Gao[2] *[1]School of Control and Science Engineering, Shandong University, China;* *[2]School of Mathematics and Statistics, University of Glasgow, Glasgow, UK;* *[3]Golden Jubilee National Hospital Glasgow, Glasgow, UK*
P07	**Small Dop of Comonomer, Giant Shift on Hydrogen-Bond Dynamics: Rheological Property and Adhesion Function of Co-Hydrogel** Xin Guan, Chuanzhuang Zhao* *School of Materials Science and Chemical Engineering, Ningbo University, Ningbo, 315211, China*
P08	**Mechanical Behaviors of Soft Elastomers Filled with Low Melting Alloys** Zilu He, · Hong Zhang, · Rui Xiao, · Shaoxing Qu *Department of Engineering Mechanics, Zhejiang University , China*
P09	**Tribo-mechanical Responsive Soft Scaffolds Promote Osteoblast Growth** Licheng Hua[1,2], Weili Jiang[1], Conghu Hu[1], Jianke Du[1] *[1]School of Mechanical Engineering & Mechanics, Ningbo University, Ningbo 315211, Zhejiang, China;* *[2]Key Laboratory for Intelligent Nano Materials and Devices of Ministry of Education, Nanjing University of Aeronautics and Astronautics, Nanjing 210016, Jiangsu, China.*
P10	**Flexible Multilayered Electronic Metastructure for Electromagnetic Wave Manipulation with Mechanical Resistance** Yixing Huang[1] *Institute of Advanced Structure Technology, Beijing Institute of Technology, Beijing 100081, P. R. China*

No.	Title/Name/Affiliation
P11	**Parameter Identification of Hyperelastic Materials with the Reformulated Virtual Fields Method Based on the Variation of Elastic Energy** Mingliang Jiang[1], Zhujiang Wang[2] *[1]Hefei University of Technology, China;* *[2]Guangdong Technion – Israel Institute of Technology, China*
P12	**Time-Salt Type Superposition and Salt-Processing of Poly(methacrylamide) Hydrogel based on Hofmeister Series** Yijie Jin, Chuanzhuang Zhao* *School of Materials Science & Chemical Engineering, Ningbo University, Ningbo 315211, China*
P13	**Determining Optimal Position of Flexible Piezoelectric Energy Harvester on Heart** Qi Lai[1,2], Yangyang Zhang[1*], Bingwei Lu[3], Weisheng Zhang[2], Chaofeng Lü[1,4] *[1]Ningbo University, China;* *[2]Dalian University of Technology, China;* *[3]Tsinghua University, China;* *[4]Zhejiang University, China*
P14	**A Hydrogel Composite Stamp Enables a Laserdriven Non-contact Transfer Printing** Chenglong Li[1], Hongyu Luo[1], Jizhou Song[1*] *[1]Department of Engineering Mechanics, Zhejiang University, Hangzhou, China*
P15	**Tunable Tail Swing of Nanomillipedes** Ruiyang Li[1], Yu Cong[2], Fan Xu[1*] *[1]Fudan University, China;* *[2]Université Paris-Saclay, France*
P16	**Moisture-mechanical Behavior in GO Films with Period Structures** Qicong Li[1], Qianjin Lei[1], Mingti Wang[2], Yuhuan Lv[2], Kai Pan[2,*], Linli Zhu[1,*] *[1]Zhejiang University, China;* *[2]Beijing University of Chemical Technology, China*
P17	**Hybrid Printed Rigidity-programmable Substrate/Liquid Metal** 3D circuits towards stretchable electronics Yan Liu, Yuan Jin, Aibing Zhang, Minghua Zhang,Licheng Hua, Jianke Du* and Guangyong Li* *School of Mechanical Engineering and Mechanics, Ningbo University, Ningbo, Zhejiang, China*
P18	**Large Deformation Model and Numerical Framework for Anisotropic Flexible Piezoelectric Materials** Shihao Lv[1], Yan Shi[1*], Cunfa Gao[1] *State Key Laboratory of Mechanics and Control for Aerospace Structures, Nanjing University of Aeronautics & Astronautics,* *Nanjing, 210016, China*
P19	**Designing Ultratough Single-network Hydrogels with Centimeter-scale Flaw-insensitive Lengths Via Inelastic Crack Blunting** Jie Ma, Xizhe Zhang, Daochen Yin, Shaoxing Qu, Shuze Zhu*, Zheng Jia* *Center for X-Mechanics, Department of Engineering Mechanics, Zhejiang University, China*

No.	Title/Name/Affiliation
P20	**Silicon Nanowire Flexible Sensors in Wound Healing Monitor** Jiahao Qin[1,2], Yihao. Shi[3], Bingchang Zhang[4], Yuan. Cheng[1,2], Xiaohong. Zhang[3] *[1]Monash Suzhou Research Institute. Monash University, SIP, Suzhou 215000. P. R. China;* *[2]Department of Materials Science and Engineering. Monash University, Clayton VIC3800. Australia;* *[3]Institute of Functional Nano and Soft Materials (FUNSOM), Jiangsu Key Laboratory for Carbon-Based Functional Materials and Devices, Soochow University, Suzhou 215123. P. R. China;* *[4]School of Optoelectronic Science and Engineering, Key Laboratory of Advanced Optical Manufacturing Technologies of Jiangsu Province, Key Laboratory of Modern Optical Technologies of Education Ministry of China, Soochow University, Suzhou 215006, Jiangsu, P. R. China*
P21	**On the Theory of Mechanically Induced Chemiluminescence Inmultiple Network Elastomers** Peng Sun[1], Shaoxing Qu[1], Rui Xiao[1] *State Key Laboratory of Fluid Power and Mechatronic Svstems, Key Laboratory of Soft Machines and Smart Devices of Zhejiang Province, Department of Engineering Mechanics, Zhejiang University, Hangzhou 310027, China*
P22	**Fast end-to-end Surface Interpretation of SARS-CoV-2 Variants by Differentiable Molecular Surface Interaction Fingerprinting Method** Yao Sun[1*], Ziyang Zheng[1], Yanqi Jiao[1] *School of Science, Harbin Institute of Technology (Shenzhen), Shenzhen, Guangdong, 518055, China*
P23	**Magnetic Hydrogel Micromachines with Active Release of Antibacterial Agent for Biofilm Eradication** Bonan Sun[1,2], Mengmeng Sun[1], Zifeng Zhang[1], Yihang Jiang[1], Bo Hao[1], Xin Wang[1] Yanfei Cao[1], Tony K. F. Chan[1], Joseph J. Y. Sung[1], and Li Zhang[1] *[1]The Chinese University of Hong Kong, Hong Kong SAR;* *[2]Nanyang Technological University, Singapore*
P24	**On the Deformation Characteristics of a Vacuum-powered Soft Pneumatic Actuator** Bin Tang, Xianyang Cai, Guicong Zhou *Dalian University of Technology, China*
P25	**Fatigue Resistant Materials and Heart Valves** Jingda Tang[1], Zhigang Suo[2] *[1]Xi'an Jiaotong University, Xi'an, 710049, China ;* *[2]Harvard University, Cambridge, MA, 02138, USA*
P26	**Prestress-induced 3D Assembly of Soft Material with Programmable Shape** Jiayu Tian, Chenzhe Li and Ying Zhao *School of Aerospace Engineering and Applied Mechanics, Tongji University, Shanghai, China*
P27	**A Constitutive Model for Hydrogels with Tunable Mechanical Properties by Salting-out** Junwei Xu, Jian Li, Xiaocheng Hu, Danming Zhong, Weiqiu Chen, Shaoxing Qu *Department of Engineering Mechanics, Zhejiang University , China*
P28	**The Flexoelectric Effect of Porous Materials and Their Applications** Dongze Yan[1], Jianxiang Wang[2], Pradeep Sharma[3], Li-Hua Shao[1,*] *[1] School of Aeronautic Science and Engineering, Beihang University, Beijing, 100191, P.R. China* *[2] College of Engineering, Peking University, Beijing, 100871, P.R. China* *[3] Department of Mechanical Engineering, University of Houston, Houston, TX 77204,USA*

No.	Title/Name/Affiliation
P29	**Molecular Simulation-guided and Physics-informed Constitutive Modeling of Highly Stretchable Hydrogels with Dynamic Ionic Bonds** Hua Yang, Danming Zhong, Ping Rao, Shaoxing Qu *Department of Engineering Mechanics, Zhejiang University, Zhejiang, China*
P30	**A Solid-shell Model for Large Deformations of Hard-magnetic Soft Materials** Yifan Yang, Fan Xu [1]Fudan University, China
P31	**Multiscale Modeling and Simulation of Skin Platform and Its Applications** Changji Yin, Yuan Cheng[*] *Monash Suzhou Research Institute, Monash University, SIP, Suzhou, China*
P32	**A Structural Stiffness Matrix-based Highly Efficient Computational Method of Soft Tissue Mechanics** Xu Yin[1], Li-Yuan Zhang[2], Guang-Kui Xu[1*] *[1]Xi'an Jiaotong University, China;* *[2]University of Science and Technology, China*
P33	**The Deformation and Rayleigh-Taylor Instability of Hanging Cylinder Hydrogel under Hypergravity** Haoran Zhang[1], Kecheng Li[1], Chaofeng Lv[1,2] *[1]Faculty of Mechanical Engineering & Mechanics, Ningbo University, Ningbo, PR China.* *[2]College of Civil Engineering and Architecture. Zheiang University. Hanazhou, PR China*
P34	**Unusual Mechanical Properties of Bio-inspiredSoft 3D Network Metamaterials** Jingxuan Zhou[1], Zheng-Yang Li[1], Dongjia Yan[1,*], Chuanzeng Zhang[2] *[1]University of Science and Technology Beiing, China* *[2]University of Siegen, Germany*
P35	**Machine-Learning-Based Asymptotic Homogenisation/Localisation** Yichao Zhu *Dalian University of Technology, China*

2023 IUTAM Symposium on
Soft Matter Mechanics

Conference Venue

IUTAM Symposium on Soft Matter Mechanics

Venue: Shangri-La Ningbo

Address: 88 Yuyuan Street, Ningbo, Zhejiang 315040 China

Nestling above the confluence of the city's three rivers, Shangri-La Ningbo presents a vivid picture of this dynamic city through panoramic views. The warm interiors are welcoming and exude a sense of timeless style, blending artistic influences from East and West.

• 562 Asian-style rooms with spacious suites and 57 comfortable apartments

• 9 minutes walk to Tianyi Square

Transportation

IUTAM Symposium on Soft Matter Mechanics

From **Ningbo Railway Station** to the hotel

1. **Taxi:** 4.7 km, about 16 ￥CNY (one way)
2. **Subway:** 2 ￥CNY (one way):
   a) Line 2 from Ningbo Railway Station to Gulou Station;
   b) Line 1 from Gulou Station to Jiangxia Bridge East Station (Exit B);
   c) 780 m to the hotel
3. **Bus:** 2 ￥CNY (one way):
   a) Line 354 from Ningbo Railway Station South Square Stop to Lingqiao East Stop (灵桥东站);
   b) 370 m to the hotel

From **Ningbo Lishe International Airport** to the hotel

1. **Taxi:** 15.3 km, about 46 ￥CNY (one way)
2. **Subway:** 5 ￥CNY (one way):
   a) Line 2 from the airport to Gulou Station;
   b) Line 1 from Gulou Station to Jiangxia Bridge East Station (Exit B);
   c) 780 m to the hotel

Local Tourist Information

IUTAM Symposium on Soft Matter Mechanics

1. Tianyi Pavilion - an symbolic of Ningbo

Tianyi Pavilion is a Chinese National Heritage Site that involves in its totality not only a pavilion, but a library, museum, garden, and several decorative halls that celebrate China's culture. It is the oldest library in Asia, and one of the three largest family libraries in the world.

2. Xikou-Xuedoushan Scenic Area

It's a fantastic scenic area known for its historical connotation and beautiful scenery of lakes and mountains. As the hometown of Chiang Kai-shek, Xikou Scenic Area is famous for its antique cultural atmosphere. Xuedoushan Mountain Scenic Area is famous for its cascading waterfalls, grotesque gorges, dark forest and erect peaks.

3. Youzanzi / 油赞子

Youzanzi is a traditional cuisine in Ningbo. Old Ningbo Youzanzi originated from the Guangxu period of the Qing Dynasty and has a history of more than 100 years. It is a purely handmade traditional leisure food with unique and high-quality ingredients, especially the salty Youzanzi with seaweed strips, which is unique in Ningbo.

Ningbo University

IUTAM Symposium on Soft Matter Mechanics

Ningbo University (NBU) is a key university of Zhejiang, China and one of the universities in the country's “Shuang Yi Liu” (“Double First-Class”) Initiative, enjoying the joint support from the provincial government of Zhejiang, the Ministry of Education (MOE) and Ningbo Municipality, as well as from the State Oceanic Administration and Ningbo Municipality. NBU was set up in 1986 with the donations from Sir Yue-Kong Pao, the shipping magnet in Hong Kong. Mr. Deng Xiaoping inscribed the name of Ningbo University in Chinese characters “Ning Bo Da Xue” to express his best wishes for the new-born university.

The campus is home to 16,469 undergraduate students, 6,923 graduate students, 2,368 international students (including 1,820 studying for academic degrees), and 12,431 students for continuing education. NBU has got 2,826 faculty members,1,843 of whom are teachers.

The university has established cooperation and exchanges with more than 180 higher institutions in more than 70 countries. It has established close ties with universities in Hong Kong, Macao and Taiwan, such as the University of Hong Kong, the Chinese University of Hong Kong, and the Hong Kong University of Science and Technology. It has also signed cooperation protocols with about 30 universities in Taiwan.

In September 2017, the Mechanics discipline at Ningbo University was selected for the "Double First Class" construction initiative. Since 2021, the university has defined a development strategy based on "rooted in Ningbo, exploring the ocean," continuously enhancing the sustainable development capabilities of the Mechanics discipline, gradually forming distinctive features in the field.

Zhejiang University

IUTAM Symposium on Soft Matter Mechanics

Zhejiang University (ZJU) is one of China's top higher education institutions, as well as one of its oldest; its roots can be traced back to 1897 and the founding of the Qiushi Academy.

Located in Hangzhou – one of China's most picturesque cities – the University is organized across seven faculties and 39 schools. It is home to 4,383 full-time faculty members, including 30 members of the Chinese Academy of Sciences and 31 members of the Chinese Academy of Engineering. ZJU has 63,136 full-time students, over 53% of whom are postgraduate students.

Laying claim to several areas of research strength, ZJU currently ranks among the top three on Chinese mainland and within the top 100 in the Times Higher Education World Reputation Rankings and QS World University Rankings. Eighteen disciplines of ZJU have been selected for China's "Double First-class" Initiative (3rd in China) and 39 disciplines graded A in the recent national assessment (1st in China).

ZJU has partnerships in place with more than 200 institutions from more than 30 countries worldwide. Included among them are such leading institutions as Imperial College London, the University of Sydney and the University of Illinois Urbana-Champaign.

With a cohort of 5,609 international students, and around 8,000 faculty and students who participate annually in various overseas mobility programs, ZJU fully harnesses its extensive network to nurture talent with a global outlook. In collaboration with the Universities of Edinburgh and Illinois it has also established the ZJU-UoE and ZJU-UIUC Institutes on Haining International Campus.

Note

Note