NEWSLETTER

International Society of Bionic Engineering

Volume 10, Issue 3, 2021

Contents

Cover Photo: Wuhan University, China (the Venue of ICBE 2022)

Lynn Reaser

Fermanian Business and Economic Institute, USA

Economics and Bionics: New Windows of Opportunity

The Fermanian Business and Economic Institute (FBEI) and its lead researcher, Dr. Lynn Reaser, have been deeply engaged in Bionics for more than a decade. The Institute is part of Point Loma Nazarene University, located in San Diego, California.

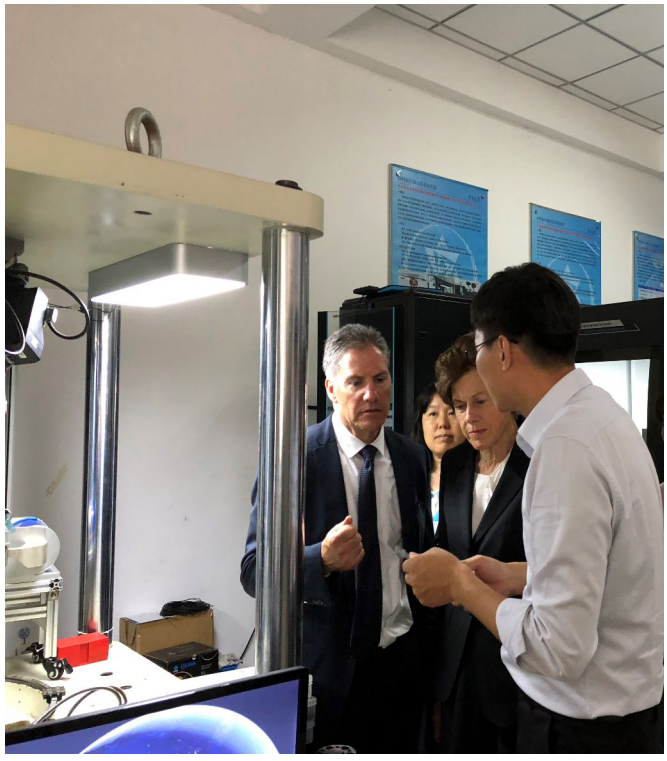
Prior to her current position, Dr. Reaser served as Chief Economist for the Investment Strategies Group at Bank of America. FBEI provides economic and business analysis for companies, government agencies, and non-profit organizations.

Major Studies

Reaser has believed that demonstrating its economic benefit is key to driving Bionics forward. FBEI published its first report in 2010: "Global Biomimicry Efforts: An Economic Game Changer." The study demonstrated that Biomimicry could advance both economic growth and environmental goals through concepts found in nature.

A follow-up 2013 study represented a progress report, analyzing the successes and failures of companies examined in the initial case studies. A third major study in 2014 investigated how 3D printing might propel Biomimicry by allowing more design flexibility. In 2020, FBEI released a report that studied the potential impact of Bionics in the Republic of Korea.

Because of FBEI's analysis of the economic dimensions of Bionics, Dr. Reaser has addressed conferences in Spain, Switzerland, France, China, and various parts of the U.S.



The Da Vinci Index™ and Partnership with Jilin University

In 2011, FBEI developed the Da Vinci Index™ (U.S.) to retain ongoing interest in Biomimicry and to track progress in the field. Jilin University sent a delegation to the United States in 2017 to explore development of a Da Vinci Index for China. After FBEI's visit to Jilin University, the two organizations formed an agreement to develop the Da Vinci China Index™. That Index, formally launched in 2019, has documented China's leading strides in Bionics. In 2020, it reached another all-time high, jumping nearly 20% over the prior year and the Index is now about 125 times its 2000 value.

Conclusion

Bionics in 2021 is still a small field with enormous potential. With the world struggling to achieve economic gains, social equity, and sustainable growth, the domain has much to offer. Nature can provide valuable knowledge on how national economies can grow in a sustainable way and can serve as a major source of innovation. Reaser and the FBEI look forward to further cooperation with Jilin University, China, and the rest of the world to help drive the field of Bionics forward.

Xiangheng Xiao

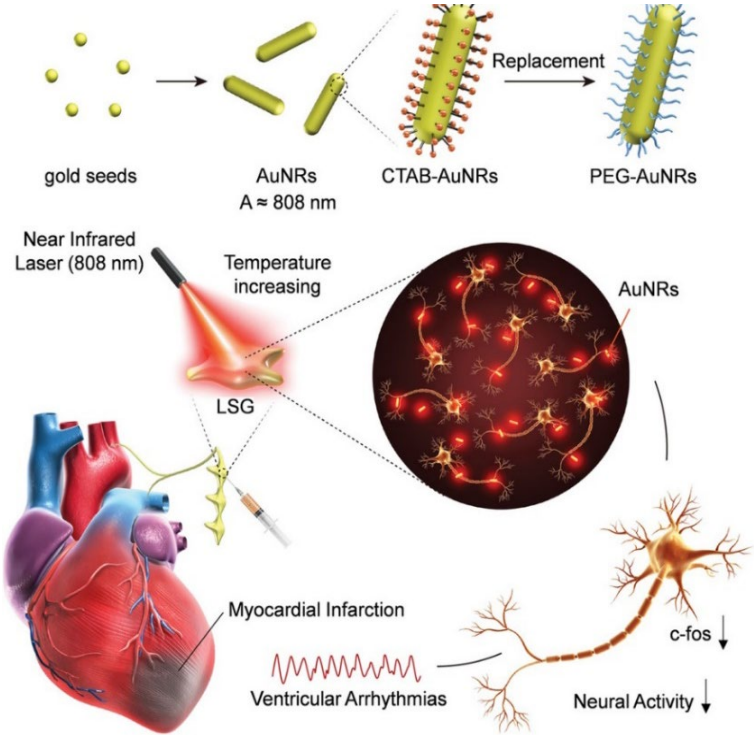
Wuhan University, China

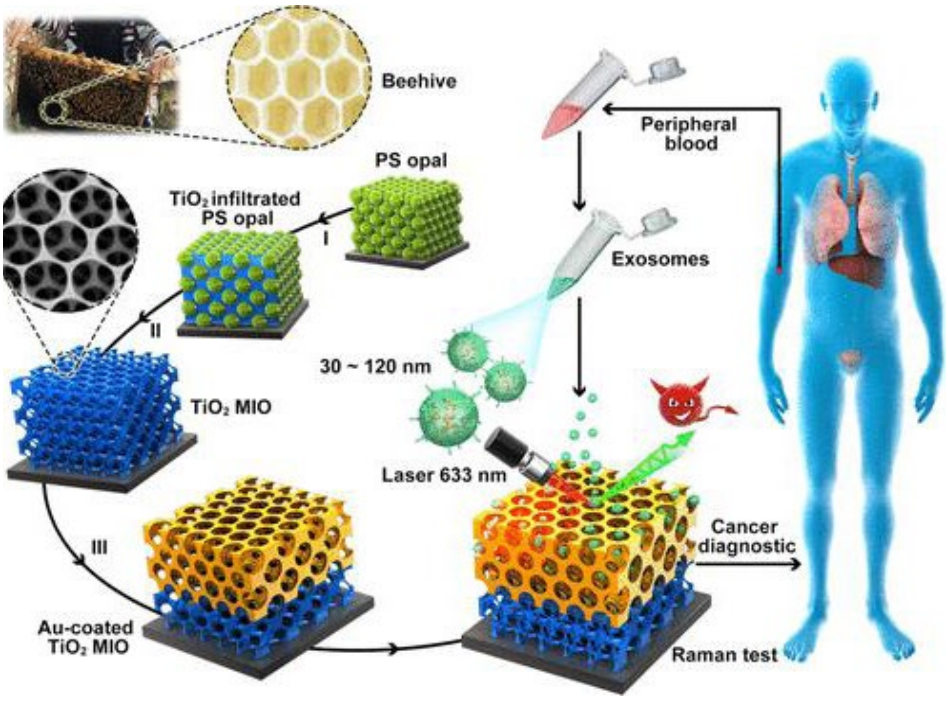
Dr. Xiangheng Xiao is a professor at the School of Physical Science and Technology, Wuhan University. He received his B.S. degree (2001) and Ph.D. degree (2008) from Wuhan University. From 2008 to present, he has been teaching at the School of Physical Science and Technology, Wuhan University. His main research interests are focused on the use of bioinspired nanoarray structures with specific detection sensitivity, energy conversion, ion-beam modification of nanoscale material, and beyond.

Dr. Xiao's research contains mainly two parts, i.e., understanding of the fundamental properties of precious metal nanoparticles in photothermal therapy and designing of bioinspired nanoarrays with high-efficiency spectral analysis of biological objects, which have resulted in publications in leading journals like Nature Communications, Advanced Materials, Advanced Energy Materials, Light: Science & Applications, Angewandte Chemie International Edition, etc.

Representative contributions include:

(1) Designing a new near infrared neuromodulation for protecting against malignant ventricular arrhythmias. Near infrared irradiation of the left stellate ganglion treated with the synthesized PEG-gold nanorods could reversely suppress left stellate ganglion (LSG) function, neural activity, and the

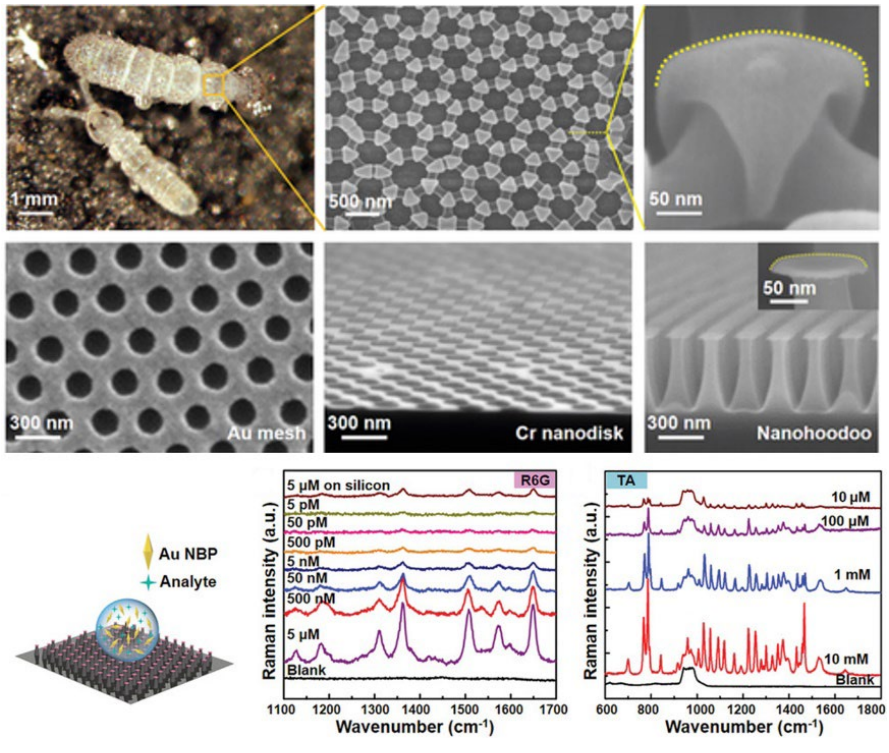




sized nanohoodoo arrays with quasi-doubly reentrant structures over square centimeters through combining the nanosphere lithography and the template-protected selective reactive ion etching technique was demonstrated. The arrays have outstanding performance and wide applications. The simple and massive production of the superamphiphobic nanohoodoo structures will push their practical application processes in diverse fields where wettability and liquid repellency need to be carefully engineered, such as achieving a SERS sensitivity improvement by enriching the analyte molecules on the nano hoodoo arrays.

occurrence of ventricular arrhythmias (VAs). The concept may become a noninvasive method for modulating cardiac autonomic nerves, thereby benefiting more patients with VAs in the future.

(2) Mimicking the beehives, an Au-coated TiO2 macroporous inverse opal structure with an engineered “slow light effect” and thus with outstanding SERS performance was developed by a template-based sol–gel method. This beehive-inspired nanostructure could capture and analyze the exosomes from plasma of cancer patients without any labeling processes, which has obvious advantages (noninvasive and time-saving) over currently clinically used tumor liquid biopsy techniques (such as western blot).



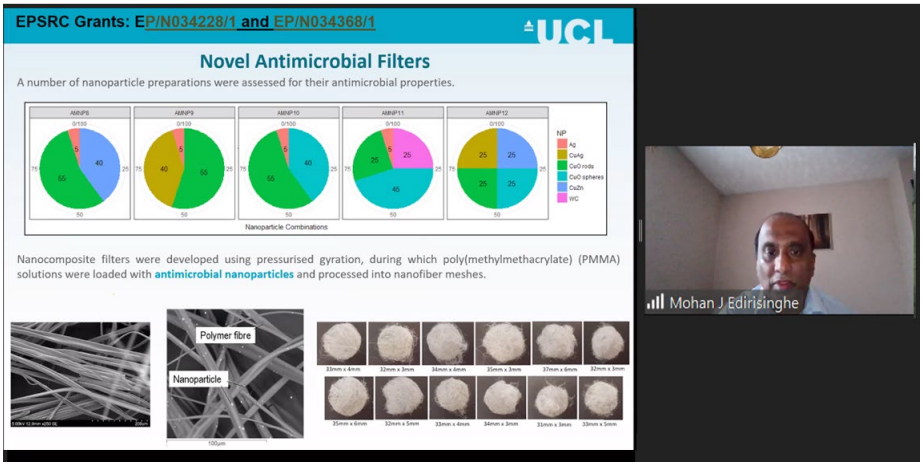
(3) Mimicking the springtails, 100 nm-

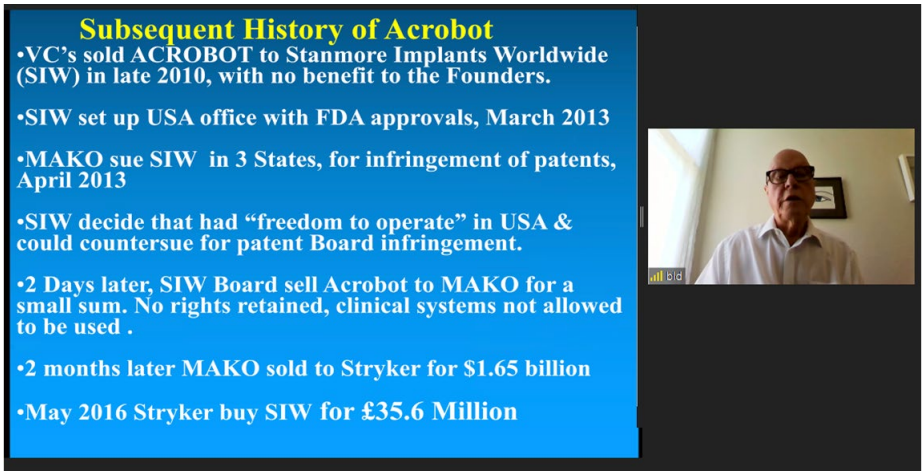
2021 International Workshop on Bionic Engineering (IWBE 2021)

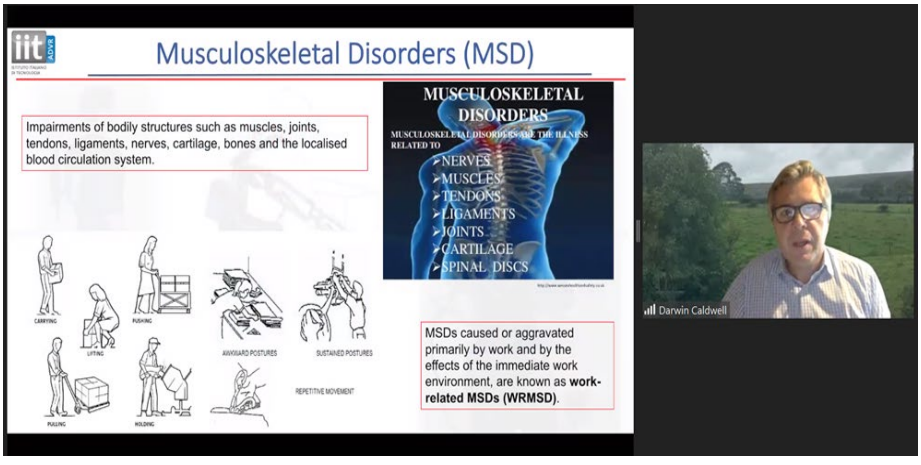
The 2021 International Workshop on Bionic Engineering (IWBE 2021) and the 4th International Workshop on Biorobotics & Bioengineering was successfully held online on September 16-17, 2021. This workshop was hosted by the International Society of Bionic Engineering (ISBE), jointly organized by the University of Manchester and Jilin University. Over 200 delegates from more than 20 countries attended the workshop. Thomas Stegmaier, president of ISBE and Professor of DITF (Germany), Zhihui Zhang, general secretary of ISBE and professor of Jilin University, and Lei Ren, vice general secretary of ISBE and professor of University of Manchester, delivered speeches at the opening ceremony which was chaired by Guowu Wei, vice chairman of ISBE Youth Commission and professor at the University of Salford, UK.

The workshop focused on the topics of machinery and materials, bionic healthcare engineering, biologically inspired robotics, life-like sensing, actuation and computation, biomimetic design methodologies. The aims of the workshop were to provide a sound international exchange and cooperation platform for researchers in bionics, and to promote deep integration in bionic fields, especially in basic research and engineering application in the field of healthcare.

Prof. Mohan Edirisinghe from University College London, Prof. Brian Davies from Imperial







College London and Prof. Darwin Caldwell from Stituto Italiano di Tecnologia (IIT) who are also academicians of the Royal Academy of Engineering delivered plenary speeches on manufacturing for healthcare, cost-effective robotic surgery and exoskeletons for industrial (occupational) application and proposed the future directions of the biomedical engineering research.

The best presentation awards and best paper awards were selected at the end of the workshop. Six scholars respectively from the Max Planck Institute (Germany), University of Manchester (UK), University of Auckland (New Zealand), Vienna University of Technology (Austria), DITF Denkendorf (Germany) won the awards. Prof. Julian F. V. Vincent, Emeritus President of ISBE, delivered speeches to affirm the achievements of the winners and expressed the expectations for the future development of bionics at the award ceremony.

The workshop not only provided an important platform for the experts and scholars around the world to share their ideas and achievements on bionics, but also established more extensive relations for future multidisciplinary exchanges, cooperation and collaborative innovation. It is of great significance to promote the development of bionic discipline, and conducive to a new round of bionics science research upsurge in energy, materials, advanced manufacturing and life health fields.

The International Youth Conference of Bionic Science and Engineering 2021 (IYCBSE2021) was successfully held online on July 17-18, 2021. This conference was hosted by the International Society of Bionic Engineering (ISBE), jointly organized by City University of Hong Kong, Shenzhen Institute of Advanced Technology, Chinese Academy of Sciences, Hubei University and Jilin University. There are over 400 representatives on bionics register for the conference, and more than 10,000 scholars and postgraduates watch the conference live online.

The opening ceremony of the conference was co-chaired by Prof. Zuankai Wang from City University of Hong Kong, China, and Prof. Xuemin Du from Shenzhen Institute of Advanced Technology, CAS. Prof. Luquan Ren, academician of Chinese Academy of Sciences and standing vice-president of the ISBE, delivered a welcome speech.

Prof. Zhigang Suo from Harvard University, USA, Prof. Zhenan Bao from Stanford University, USA, Prof. Ding Han from Huazhong University of Science and Technology, China, Prof. Jiang Lei from Beihang University & Technical Institute of Physics and Chemistry, CAS, China, Prof. Shuhong Yu from University of Science and Technology of China, Prof. Jian Lu from the City University of Hong Kong, China and Prof. David Quéré from École Polytechnique, France made plenary speeches. The topics are mainly focused on Interfacial and transport

phenomena, Nature-inspired structural and functional materials, Nature-inspired robots and flexible electronics, Nature-inspired energy transport, storage, conversion and harvesting, Bionic implants, organs and systems, and Youth Forum of Guangdong-Hong Kong-Macao Greater Bay Area.

Prof. Lei Ren from the University of Manchester, UK, Prof. Liqiu Wang from the University of Hong Kong, China and other 20 senior specialists on bionics, as well as more than 80 outstanding young scholars gave keynote reports. “Youth Forum of Guangdong-Hong Kong-Macao Greater Bay Area " aroused heated discussions among the representatives from United Kingdom, Denmark, and China. three best oral presentation awards and three best poster awards were selected. Six students respectively from Tsinghua University, Sun Yat-sen University, the Chinese University of Hong Kong, and Shenzhen Institute of Advanced Technology, CAS won the awards.

This conference witnessed the rapid development of bionics in recent years, and presented high-level research achievements in this field. It not only provided an unforgettable international academic conference for experts and scholars on bionics, but also laid a solid foundation for future exchanges, cooperation and collaborative innovation. It is believed that the intense collision of ideas at the conference will lead a new upsurge of research on bionics around the world.

The 2021 Belt and Road Bionic Innovation Design Industrialization Forum

From June 25 to 27, 2021, "The 2021 Belt and Road Bionic Innovation Design Industrialization Forum" supported by the International Bionic Engineering Society(ISBE) was held in Lishui District, Nanjing, China. Prof. Zhang Zhihui, General Secretary of the ISBE attended the forum and delivered a speech at the opening ceremony.

There are more than 100 representatives from Japan, Singapore, Germany, Denmark, the United States and other countries attended the forum. The goal of the forum is to pay equal attention to science and industrialization, and to create a new pattern of bionics industry in China. The forum rapidly arouses strong interests and heated discussions among participants.

During the forum, Professor Xiqiao Feng from Tsinghua University made a report about “the Surface Infiltration Kinetics of Biological Materials”, surface infiltration of micro/nano scale effect, surface infiltration mechanics structure - property - function relationship between the quantitative model, surface infiltration in the process of heat, electricity and other effects, as well as in industrial and life study and so on has carried on the detailed report, Professor Zhang Deyuan from Beijing University of Aeronautics and Astronautics made a report on “Interface Energy Field Effect in Micro/Nano Biomimetic Manufacturing”, and analyzed the new method of biomimetic wave cutting and interface energy field effect of biomimetic forming manufacturing. Professor Zhongze Gu from Southeast University made a report on “Biomimetic Microstructure Materials based on 3D Laser Printing” and introduced the biomimetic microstructure controllable materials and microstructure scanning probe. Professor Hesheng Wang from Shanghai Jiao Tong University gave a report on “Robot Visual Servo” and introduced the self-landing of shipboard UAV based on vision and the contact control of flight manipulator. Professor Zhendong Dai of Nanjing University of Aeronautics and Astronautics reviewed the bionics and its technology industry in bionics and its Industrialization Development, and prospected the bionics research and key

technology breakthrough of China Southern Airlines, the development of the industrialization of aviation bionics technology and the application scenarios of gecko-like robot in narrow space.

Outside the forum, A flexible adhesion grasping equipment was shown at Nanjing Li Hang Bionic Industry Research Institute. Under the operation of the staff, the mechanical arm equipped with flexible adhesive material can easily pick up eggs, cherry tomatoes, water filled balloons and other items, and put them in the designated position. According to the staff, the secret of the robot arm's flexibility lies in the flexible adhesive material installed at the end, which has the characteristics of stable adhesion and efficient desorption. In the future, combined with robot vision technology, this technology can be applied to many fields, such as picking blueberries and other berries. It is understood that Nanjing Lihang Industry Institute of Bionic Technology was established by the Institute of Biomimetic Structure and Material Protection, Nanjing University of Aeronautics and Astronautics, Professor Zhendong Dai's talent team cooperation with Lishui district people's government , committed to promoting the bionic technology innovation and industrialization, hatching, introduction of innovative enterprise, has developed seven products and projects: flexible adhesion material is one of them.

After the forum, the delegates also visited Nanjing Lihang Industry Institute of Bionic Technology. As the host, Nanjing Lihang Industry Institute of Bionic Technology fully demonstrated the achievements of bionics, so that the participants better understand the methods of the results of the industrialization, so as to contribute to the industrialization development of bionic discipline.

Welcoming our new ISBE General Secretary

Prof. Zhihui Zhang starts to serve as the General Secretary of the ISBE in September, 2021.

Prof. Zhang received his PhD degree in Materials Processing Engineering from Jilin University in 2007. He is mainly engaged in the researches of bionic design and additive manufacturing, bionic tribology of mechanical surfaces, and bionic deformation and driving technology for smart materials and devices.

Zhihui Zhang is currently the professor of the Key Laboratory of Bionic Engineering of Ministry of Education, Jilin University, and the director of the national cooperation base of international science and technology of bionic engineering. As a young and middle-aged science and technology innovation leading talent of the Ministry of Science and Technology as well as the chief scientist of the national key R&D project of additive manufacturing, Prof. Zhang has published more than 120 SCI cited papers and 32 invention patents, among which 7 patents have been transformed into products, such as bionic mold, bionic gear, bionic grinding roller and so on. In 2020, he was awarded with the National Science Fund for Distinguished Young Scholar.

According to the Statutes, the General Secretary of the ISBE shall come from the country where the Secretariat is located. And with the recommendation of the representatives of China, Prof. Zhihui Zhang was nominated and then elected as our new ISBE General Secretary at the Board of Directors meeting.

Congratulations, Prof. Zhang, for serving as the General Secretary of ISBE! We also acknowledge Prof. Li for his contribution to our society as the General Secretary during his tenure.

Announcing the launch of the research group, Life Design Lab

LifeDesign Lab | exploring the engineering design of living systems

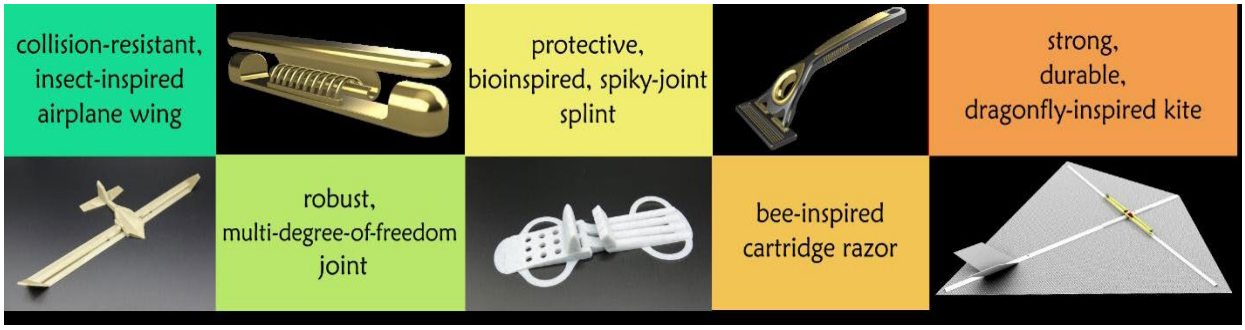
A new Research Group, "Life Design Lab", dedicated to Engineering Biology has freshly opened in the School of Engineering at London South Bank University (LSBU).

The aim of our group is to understand the design and technological complexities of living systems. We work on the mechanics of biological materials/structures and their biomimetic applications for technology. Specifically, we want to develop life-inspired concepts and elaborate them into a technology readiness level that can be transformed into marketable products with potentials to improve human life and benefit economy.

The group brings together researchers who have interest in Engineering Biology and want to study life from an engineering perspective. We work on interdisciplinary research and have expertise joining from different fields (e.g. physics, biology, material science and engineering).

LifeDesign Lab is led by Dr. Hamed Rajabi, a Lecturer at LSBU. Hamed has an interdisciplinary research background. He received his first PhD in Mechanical Engineering followed by the second one in Biology. Collaborations with researchers from various fields have enabled him to employ methods and techniques from different fields into his research and, thereby, answer questions that can be addressed only using multidisciplinary approaches.

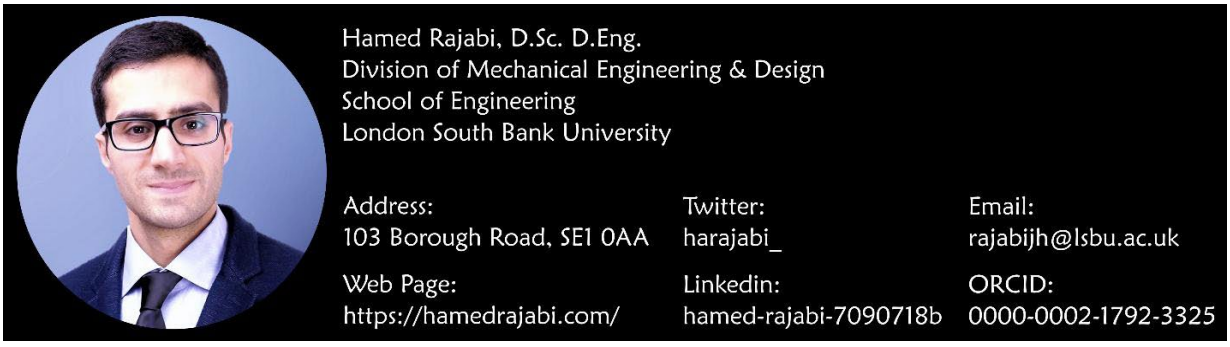
The LSBU School of Engineering is internationally recognized and was the founding discipline of the university in 1892. The School, which has been educating professional engineers for more than



125 years, is currently building on its strengths, particularly its 25th ranking nationally by research intensity. The School offers amazing facilities, academic excellence and cutting edge research to create an exciting, dynamic environment for its members.

The group is looking for creative and passionate postgraduate students and postdocs! Prospective students and Postdocs who are interested in unraveling the complexities of biological systems and learning from them to make engineering systems with enhanced performance are invited to join LifeDesign Lab at LSBU. The group welcomes anyone who wants to contribute to the development of a diverse and vibrant community.

Further information can be found on https://hamedrajabi.com/lifedesign-lab/



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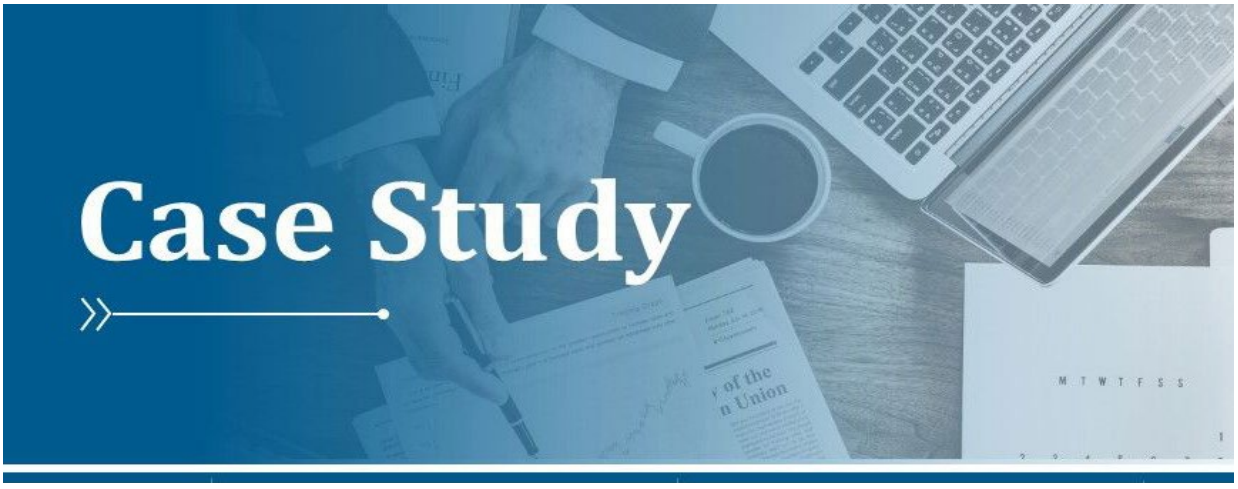

The secretariat of ISBE has recently received some CASE STUDIES kindly provided by our members demonstrating bionic sensor inspired by skin, bio-inspired viscous liquid transport devices, earthworm-inspired anti-fouling coatings, etc. We are grateful for these great supports, and it is also hoped that more scholars engaged in bionic research could share their CASE STUDIES on the platform of the ISBE. Your kindness and consideration will be appreciated.

We look forward to receiving your submissions!

Email: xmtian@isbe-online.org
Tel: +86-431-85166507

Case Study at ISBE Website

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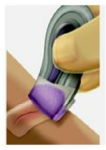

A Barnacle-Inspired One-Component Biomedical Adhesive

The case was provided by the Individual Member of ISBE
Chao Liang & Biru Hu (hubiru08@nudt.edu.cn)
of National University of Defense Technology

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1. Biological Prototype

Barnacles, a marine fouling organism, anchor themselves tenaciously to various substrates in seawater by secreting and curing a multi-protein underwater cement.

Barnacles attaching to ship hulls and water pipelines

Due to its strong adhesive, water-proof and biocompatible ability, barnacle cement is an ideal model for engineering bio-inspired biomedical adhesives.

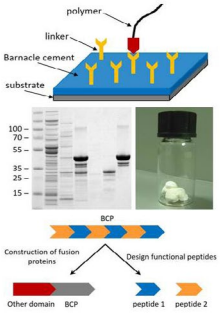
Nature communications, 2011, 2: 244.

2

2. Bionic Study

Bionic studies of barnacle cement have been performed from three different levels:

- Taking advantage of natural barnacle cement directly for surface modification.
- Reconstitution of barnacle cement through producing recombinant barnacle cement proteins (BCPs).
- Design of functional molecules inspired by BCPs.

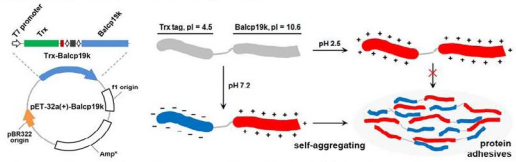


Biomacromolecules, 2013, 14: 2041-2051
Biochemistry, 2015, 54: 826-835.

3

3. Design and Processing

To fabricate a barnacle-inspired one-component adhesive, thioredoxin (Trx) with an acidic isoelectric point (pI) was fused with Balcp19k having a basic pI to construct the hybrid protein Trx-Balcp19k.



Here, the adhesive protein Balcp19k plays the surface binding role while the Trx tag mediates inter-molecular electrostatic attractions at suitable conditions, leading to self-aggregating protein adhesives.

PLoS ONE, 2015, 10: e0136493.

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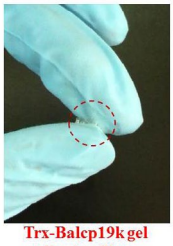
3. Design and Processing

Based on our design, a super sticky gel-like adhesive called Trx-Balcp19k gel was successfully fabricated by producing recombinant Trx-Balcp19k and dialyzing it against pure water to trigger intermolecular electrostatic attraction.

Super sticky Trx-Balcp19k gel

Lyophilized Trx-Balcp19k gel



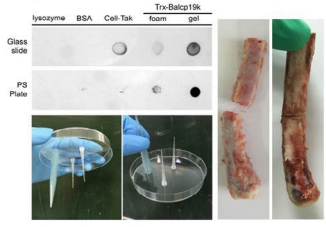
Trx-Balcp19k gel adhesive fibers

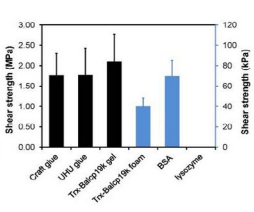
5

3. Design and Processing

Trx-Balcp19k gel can adhere to a variety of substrates and stick different objects together, such as plastics as well as broken ribs together.

Quantitative test shows that it has an adhesive strength of 2.10±0.67 MPa in air, comparable to several commercial glues and recombinant mussel foot proteins.





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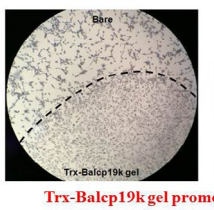
4. Achievements and Application

Trx-Balcp19k gel exhibits good cell compatibility and is capable of promoting cell adhesion.

Animal experiments show that it can markedly accelerate the healing process of rat skin traumas compared to pure water-treated controls.



Left: Trx-Balcp19k gel
Right: pure water-treated

Trx-Balcp19k gel promotes cell adhesion and wound healing

7

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- We have successfully engineered a barnacle-inspired, super adhesive, one-component protein adhesive.
- The adhesive displays good biocompatibility and can promote cell adhesion and would healing, exhibiting great potential for biomedical applications.

8

After 10 years of successful ISO standardization of biomimetics within DIN Germany the committee management will be transferred to SAC China

Heike Beismann (Germany, Westfälische Hochschule), Olaf Rehme (Germany, Siemens AG), Michael Schmitt (Germany, DIN), Roman Rüttinger (Germany, DIN)

At the end of the year 2021 the secretariat of the Technical Committee Biomimetics at ISO (International Standardization Organisation, ISO/TC 266 “Biomimetics”) will be transferred from DIN (Deutsches Institut für Normung, Germany) to SAC (Standardisation Administration of China, China). On this occasion, we look back on the previous 10 years of activities that have led to the publication of three basic standards in the field of biomimetics (ISO 18459, ISO 18457 and ISO 18458).

Starting point

The starting point of the international activities was a set of German VDI Guidelines (VDI 6220 to VDI 6226, VDI: Verein Deutscher Ingenieure, Association of German Engineers) dealing with biomimetics. Three bilingual guidelines were selected to serve as a basis for the preparation of international standards within the framework of the project ISOBIONIK, funded by the German Federal Ministry of Economics and Technology.

Establishment of standardization bodies

The first step towards transferring the VDI Guidelines to the international standardization level was the establishment of the Working Committee NA 062-08-60 AA "Bionik" in the DIN Standards Committee for Materials Testing (NMP). The constituent meeting of this working committee took place on 13.9.2011 in Berlin. With Dr. Olaf Rehme from Siemens AG an industry representative could be won for the office of chairman. The working committee now concentrated on the establishment of the International Technical Committee ISO/TC 266 "Biomimetics", which was concluded on 9/10 October 2012 with the founding meeting in Berlin. Dr. Olaf Rehme also assumed the chairmanship of this committee.

Three working groups could be founded, each dedicated to one of the standardization projects. ISO 18458 deals with biomimetic terminology and methodology, ISO 18457 with structures and materials and ISO 18459 with biomimetic optimization.

Terminology: ISO 18458

ISO 18458 (chaired by Prof. Dr. Heike Beismann, Germany, Westfälische Hochschule) deals with the question of what biomimetics is and when a product or process is "biomimetic". Internationally "biomimetics" is now defined as "interdisciplinary cooperation of biology and technology or other fields of innovation with the goal of solving practical problems through the function analysis of biological systems, their abstraction into models, and the transfer into and application of these models to the solution". There is also a differentiation from terms that are often used synonymously with biomimetics, but convey different contents. For example, the term biomimicry or bionics.

The definition of when a product is biomimetic can be understood as the central point of the standard. The decision whether a product or a technology can be regarded as biomimetic can be made on the basis of three criteria (steps). According to ISO 18458, a product can only be classified as biomimetic if it follows the following three steps of the biomimetic process:

- a functional analysis of an available biological system was performed;

- the biological system has been abstracted into a model;

- the model has been transferred and applied to design the product.

This definition is clarified in the standard by means of several examples.

Optimization: ISO 18459

ISO 18459 (chaired by Dr. Iwiza Tesari, Germany, Karlsruhe Institute of Technology) describes the functions and applications of biomimetic structural optimization methods. For example, the process of building up and decomposing bone substance can be used as a biological model for topology optimization. Thus lightweight components are designed for the development of vehicle frames by removing underloaded material using the soft-kill option method (see Figure 1).

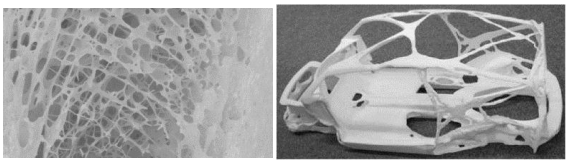


Figure 1 - Topology optimization for designing lightweight components by removing underloaded material (Source: ISO 18459:2015)

The standard describes in detail computer-aided optimization techniques based on the biological model of natural growth and FEM optimization techniques for technical components such as Computer Aided Optimization (CAO), Soft Kill Option (SKO) and Computer Aided Internal Optimization (CAIO). In addition, a simpler and faster "Method of Tensile Triangles" is described that can be used by any designer.

Materials: ISO 18457

ISO 18457 (chaired by Stephan Hoornaert, Belgium) deals with biomimetics in relation to the development of materials, structures, surfaces, components and manufacturing technologies. For example, the Morpho butterfly (see Figure 2) creates the bright blue appearance of its wings through a structural colouring. Its wing scales have a lamellar structure that produces optical interference effects. The lamella structure of the wing scales could serve as a biological model for the colouring of biomimetic tissues. From the abstraction of the mechanism of structural colours, optical interference colours can be created by stacking two polymers with different refractive indices.

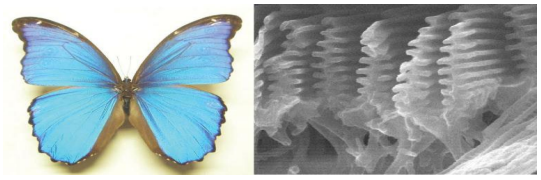


Figure 2 - Morpho butterfly and lamellate structure of the wing scales (source: ISO 18457:2016)

Further Activities

The standards described above form the core of the activities of ISO/TC 266. Another activity is a Japanese initiative, which is being worked on in the Japan-led ISO/TC 266/WG 4 "Knowledge infrastructure of biomimetics" working group. Under the ISO/TR 18887 series of standards, a three-part technical report is in preparation which has set itself the task of providing technical aids with the help of which a person concerned with an engineering problem can come across key words that lead to biological models for problem solving.

Apart from this initiative, ISO/TC 266 is currently in a phase of developing a strategy for future activities. This is therefore an excellent time for newcomers to implement their own ideas. The handover of the committee management and the chairmanship to China opens up the opportunity to give new impetus at exactly the right time and to push ISO/TC 266 into new directions.

The last international meeting of the Technical Committee “Biomimetics” led by Germany took place online on 8 to 10 September 2021. DIN Germany welcomes as new committee manager Xiugong Qin and is pleased to welcome Prof. Dr. Zhihui Zhang (China, Jilin University) as its new Chairman.

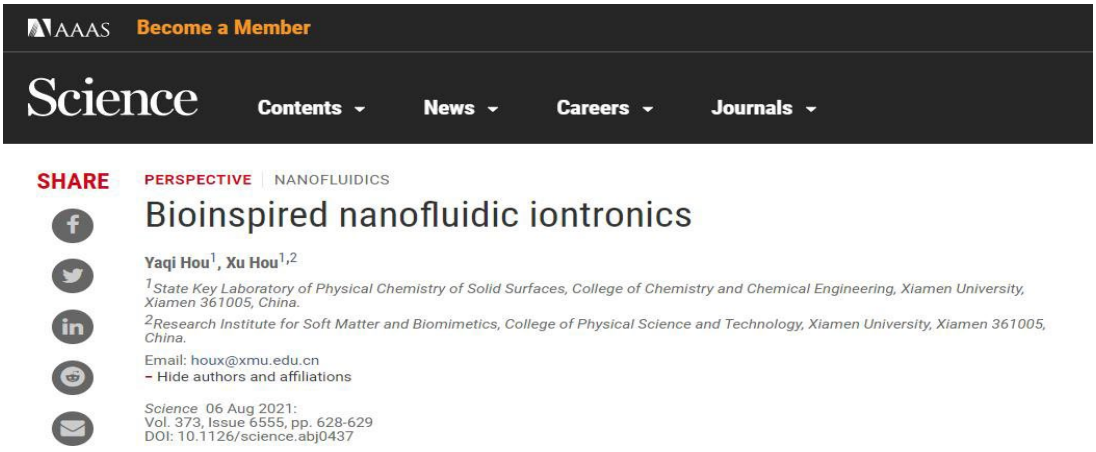
Learning from Nature: Bioinspired Nanofluidic Iontronics

Yaqi Hou, Xiamen University, China

Prof. Xu Hou at Xiamen University from China was invited to contribute a Perspective article in Science (On 6th August) to propose a

new concept "bioinspired nanofluidic iontronics", which is a very promising field for the future studies on brain-computer interface (BCI) and artificial intelligence (AI) technologies.

Conventional electronic computers have the problem of intensive energy consumption,



especially in pattern recognition, intelligent reasoning and other AI tasks. Different from electronic computers, neurons, the functional units equivalent to processor and memory areas, are integrated in the brain and transmit signals through ionic conduction, which is super energy-efficient even when human is conducting high-level mental activities. Inspired by our brain, using ions as the carriers and transmitting signal through ionic conduction are growing as an alternative to traditional von Neumann computing and showing great potential in BCI, which is called as "bioinspired nanofluidic iontronics".

Figure *The interdisciplinary fields involved in the emerging bioinspired nanofluidic iontronics for the future, such as brain-computer interface, artificial intelligence, energy-efficient computer architecture, etc.*

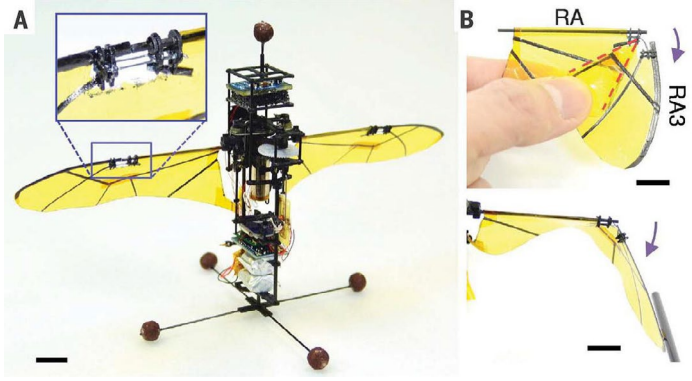
Bioinspired nanofluidic iontronics, as a new interdisciplinary field, is a burgeoning research area. Such nanofluidic iontronic systems could have compatible signal with neurons, high biocompatibility and dynamic deformability in aqueous solution environment, which could have great implications for interfacing devices with neural systems and will have nice prospects in the future. For more information, see https://xuhougroup.xmu.edu.cn/.

Reference: Y. Hou, X. Hou, Bioinspired Nanofluidic Iontronics, Science 2021, 373, 628.

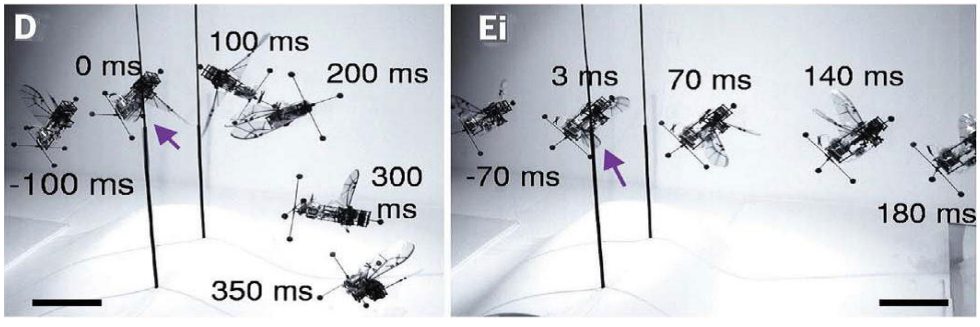
Mechanisms of collision recovery in flying beetles and flapping-wing robots

Hoang Vu Phan and Hoon Cheol Park, Konkuk University, Korea

The Bioinspired System Laboratory at Konkuk University, Seoul, South Korea led by Professor Hoon Cheol Park published a research paper in Science last year December (Mechanisms of collision recovery in flying beetles and flapping-wing robots, Science 370, 1214–1219, 2020). The paper reported new findings on the unfolding hindwing of the rhinoceros beetle: (1) the hindwings are fully unfolded by aid of initial flapping wing motion, which creates aerodynamic and inertial forces. Even when the membranes of the hindwings are clipped, still they can be unfolded, which proves the important role of the inertial force produced by flapping motion in the wing unfolding process. (2) Once the hindwings are fully unfolded, they are not folded back during flapping flight. When the outer part of the hindwing is hit by an obstacle, it is instantly folded and immediately unfolded within the same flapping cycle, which enables the beetle to continue stable flight. This indicates the presence of a shock energy absorbing mechanism within the hindwing. Inspired by such a mechanism, artificial wings equipped with elastic energy storage mechanism were fabricated and installed into a tailless insect-like flapping-wing robot (KU Beetle). The robot successfully demonstrated stable flight even after the wing tip collided with an obstacle, just like the rhinoceros beetle.



The KU Beetle equipped with foldable artificial wings



KU Beetle flight after collision: (left) without folding function, (right) with folding function

Numerical Evaluation of Biomimicry-Based Strategies for Urban Heat Island Mitigation in Panama

Kevin Araque[1], Paola Palacios[1], Dafni Mora[1,2] and Miguel Chen Austin[1,2],*
1Research Group Energy and Comfort in Bioclimatic Buildings, Faculty of Mechanical Engineering, Universidad Tecnológica de Panamá, Panama City 0819, Panama;
2Centro de Estudios Multidisciplinarios en Ciencias, Ingeniería y Tecnología (CEMCIT-AIP), Avenida Domingo Díaz, Panama City 0819, Panama
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Demographic growth is causing cities to expand their urban areas, increasing the risk of overheating, creating insurmountable microclimatic conditions. Due to this, many studies have been carried out on the urban heat island (UHI) effect and its mitigation. Therefore, this research aims to evaluate the heat mitigation potential by applying biomimicry-based strategies for the microclimate within a tropical urban area in Panama City. For this, the outdoor thermal comfort for three case studies (base case, case 1, and case 2) of a historical heritage development were evaluated, in which the Envi-met software was used to emulate and evaluate the thermal performance of these strategies during March (hotter month) and October (rainier month). The strategies used were extracted from the zebra skin contrast, permeable human skin, evaporative cooling of trees, and the selective-reflective Saharan ant skin. The results showed a reduction of 2.8 °C in the air temperature at 11:00, the mean radiant temperature decreased by 2.2 °C, and the Physiological Equivalent Temperature (PET) index managed to reduce the thermal comfort indicator. Although significant changes were obtained, high risks of discomfort persist due to the layout and proximity of the buildings, which is not recommended for tropical climates. For more information see Araque, K., Palacios, P., Mora, D. and Chen Austin, M. (2021). Numerical Evaluation of Biomimicry-Based Strategies for Urban Heat Island Mitigation in Panama. Biomimetics, MDPI. https://doi.org/10.3390/biomimetics6030048

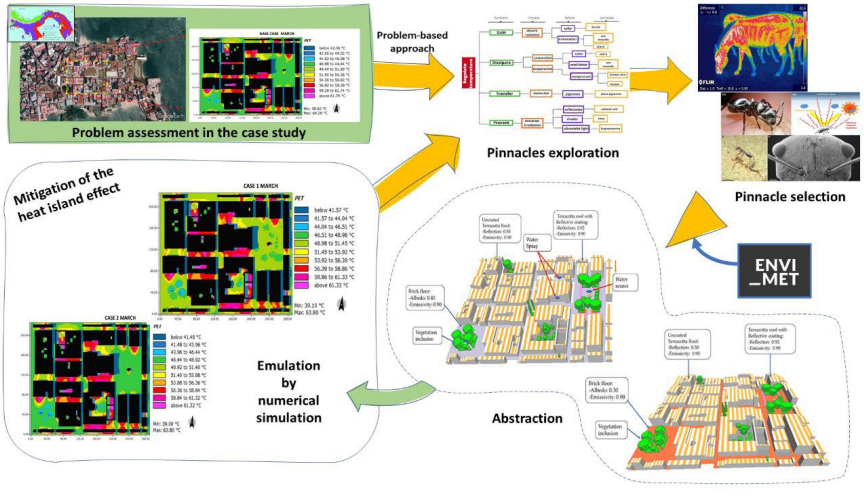


Figure: Overview of the methodology implemented

Bee wings inspire the design of robotic and industrial joints

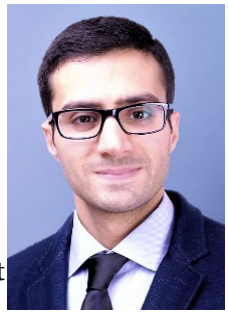
S. H. Eraghi[1,2], A. Toofani[1,2], A. Khaheshi[3,4], M. Khorsandi[1,2], A. Darvizeh[1,2], S. Gorb[3], and H. Rajabi[3,4],*

1 Faculty of Mechanical Engineering, University of Guilan, Rasht, Iran

2 Division of Mechanical Engineering, Ahrar Institute of Technology and Higher Education, Rasht, Iran

3 Functional Morphology and Biomechanics, Institute of Zoology, Kiel University, Kiel, Germany

4 Division of Mechanical Engineering and Design, School of Engineering, London South Bank University, London, United Kingdom



In a study recently published in Advanced Science, a team of researchers have designed and fabricated an unprecedented bee-inspired mechanical joint that integrates multiple functions into a single joint, and thereby, enhances the capabilities of existing classical and conventional joints.

Wing-to-wing coupling mechanisms in bees and wasps are multi-functional joints that couple their fore and hind wings during flight and uncouple them at rest using a set of structural components and a special material composition gradient. They synchronize motions of insect wings that not only minimize their aerodynamic interference but also allow the insects to attain more lift and better gliding performance. Using several modern imaging techniques, such as scanning electron microscopy and confocal laser scanning microscopy together with finite element simulations, the researchers investigated the structure–material–function relationship of wing-to-wing couplings of nine castes and species of bees and wasps and showed that the springiness, compliance, robustness, and asymmetric behavior augment the functionality of the couplings by reducing stress concentrations and minimizing the impacts of excessive flight forces. In addition, they established a quantitative link between the morphological diversity of coupling mechanisms and the forces to which they are subjected during flight.

The researchers incorporated the underlying design principles of wing-to-wing coupling mechanisms of bees and wasps into the design of a mechanical joint capable of rotation, sliding, locking/unlocking as well as resisting tension and compression, each in two orthogonal directions. Unlike conventional joints, the bee-inspired joint can be simply disassembled without a

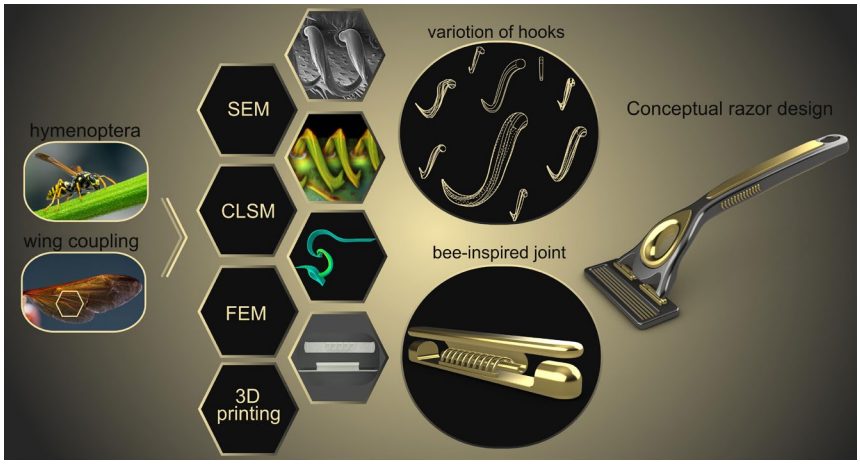


Figure 1. From inspiration to design. Detailed analyses of wing coupling by means of complementary methods resulted in development of a bioinspired joint for everyday life applications.

compromise in its load-bearing capacity and robustness. Using an example of a cartridge razor, the researchers then showed that their bioinspired engineering design can be utilized in real-life applications and thus be transferred into marketable technology. Furthermore, the bee-inspired joint can be particularly used in robotic and industrial applications, where the easy and rapid replacement of components, as well as multiple degrees of freedom, are of great importance.

For more information, see: https://doi.org/10.1002/advs.202004383 or contact Dr. Hamed Rajabi by email: harajabi@hotmail.com; rajabijh@lsbu.ac.uk

Bioinspired Color-Changeable Organogel Tactile Sensor with Excellent Overall Performance

Ya-Feng Liu[1,2], Qun Liu[1], Jun-Fei Long[1], Feng-Lian Yi[1], Yuan-Qing Li[1,4*], Xiao-Hua Lei[3], Pei Huang[1,4], Bing Du[5], Ning Hu[6,7], Shao-Yun Fu[1,4*]

1 Chongqing University, Chongqing 400044, China; 2 Tsinghua University, Beijing 100084, China; 3 Chongqing University, Chongqing 400044, China; 4 Chongqing University, Chongqing 400044, China; 5 Chongqing University of Science and Technology, Chongqing, 401331 China; 6 Hebei University of Technology, Tianjin, 300401, China; 7 Hebei University of Technology, Tianjin 300401, China.

Inspired by chameleons' structural color regulation capability, a simple but effective swelling method is proposed for the first time to prepare ionic polyacrylamide (PAAm) organogel for simultaneous tactile sensing and interactive color changing. The PAAm organogel obtained by swelling the PAAm scaffold in the dimethyl sulfoxide solution of organic electrochromic material (OECM) shows an extremely large stretch-ability with an elongation of 1600%, a super softness with a compressive modulus of 7.2 kPa, an excellent transmittance up to 90% and a very fast response time of 0.5 s combined with the characteristic of interactive color changing. The PAAm organogel also suggests a universal design ability to tailor coloration spectra for tactile sensors by simply changing the type and content of OECM. The tactile sensor based on PAAm organogel can serve as a wearable device for precisely tracing human body motion performance and directly visualizing the stress distribution via interactive color changing capability. It is demonstrated that the swelling method proposed here is a simple and practical strategy to prepare ionic organogels with both piezo-resistive and electrochromic effects.

The detail content is referred to: Liu Y F, Liu Q, Long J F, et al. Bioinspired Color-Changeable Organogel Tactile Sensor with Excellent Overall Performance. ACS Applied Materials & Interfaces, 2020, 10.1021/acsami.0c12811.

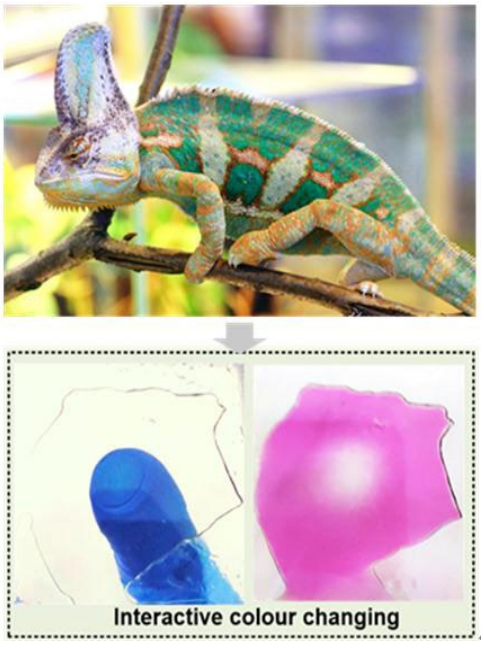


Figure 1.Interactive color changing capability inspired by chameleon.

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The theme of ICBE & IYCBSE 2022 is "human, nature, harmony", including but not limited to the topics of biological systems, biodiversity, bioinspired functional structures and surfaces, biomaterials and bioinspired materials, bionic machinery, biomechanics and rehabilitation engineering, biosensors and signal processing, bioinspired motion and robotics, artificial intelligence, nature inspired energy system, biofabrication and bioinspired manufacturing, industrial applications of bionics, sustainable and environmentally friendly novel technologies.

Paper submission

Original work written in English using the template provided and submitted online in PDF format. Selected peer-reviewed papers will be published in the Journal of Bionic Engineering.
Submission page: under construction

Important date

Deadline for abstract and full paper submission: May 30, 2022
Deadline for early-bird registration: July 30, 2022
Conference date: October 7-10, 2022

Conference hotel

Optics Valley Kingdom Plaza Hotel Wuhan
Address: No 1 Wujiawan, hongshan district, Wuhan

Contact information

Prof. Longjian Xue, Prof. Zhiguang Guo, Dr. Ximei Tian
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Securing our Future Environment – Air, Water, Energy

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IFToMM for Sustainable Development Goals

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- Biomechanical Engineering
- Transportation Machinery
- Rotordynamics
- Multibody Dynamics
- Micromachines
- Engines and Powertrains
- PC History of Mechanism
- PC Education
- IFToMM Italy

Author's Schedule

Full paper or extended abstract submission: 15/05/2021

Notification of acceptance: 15/06/2021

Registration before: 30/09/2021

Final paper submission: 15/07/2021

Registration Fees

In order to promote the first edition of IFToMM for Sustainable Development Goals, the participation at I4SDG 2021 will be *free of charge*

CALL FOR PAPERS

The aims of the Workshop are to

- Present IFToMM as an active world organization that can contribute to United Nation 2030 Development Agenda
- Present and highlight all the research activities realized in IFToMM community that can contribute to reach some target within SDGs, Sustainable Development Goals
- Increase the awareness related to SDGs in IFToMM scientific community
- Generate a network of active researchers, with specific interest on effects of new technologies on sustainable world
- Foster dialogue between technologists and humanists.

Workshop Topics

Papers are welcome on topics related to the aspects of theory, design, practice and application of the Mechanism and Machine Science, which can give some contribution in reaching one or more Sustainable Development Goals, including but not limited to:

- Biomechanical Engineering
- Linkage and mechanical control
- Sustainable Energy Systems
- Robotics and Mechatronics
- Green Tribology
- Transportation Machinery
- Rotordynamics
- Multibody Dynamics
- Micromachines
- Engines and Powertrains
- History of Mechanism and Machine Science
- Education
- Terminology
- Computational Kinematics
- Gearing and Transmissions
- Vibrations
- Reliability
- Humanitarian Engineering and Appropriate Technologies
- Socio-Technical Systems for sustainable and inclusive development

A Round Table on the topics and an interactive session for PhD students will be organized.

Paper submission, proceedings

Authors are kindly invited to submit a full paper for a Scopus indexed book of the Springer Series *Mechanisms and Machine Science*, with the title: IFToMM for Sustainable Development Goals - Proceedings of the first I4SDG Workshop. Each paper/presentation must relate to one or more SDGs, and to one TC/PC/topic.
In alternative is it possible to submit an extended abstract, not included in the book, for authors who are interested to presentation-only participation.
A selection of presented papers will be invited with extended version for a special issue in the International Journal of Mechanics and Control (www.jomac.it).

Best Paper awards

Best Paper awards will be given in categories of Research, Application, and Student Work.

Conference Webpage: http://www.iftommitaly.it/i4sdg2021/

The 2nd International Conference on Automation Control, Algorithms and Intelligent Bionics (ACAIB 2022) will be held in Qingdao, China from March 25 to 27, 2022. This conference focuses on the latest research on "Automatic Control, Algorithm and Intelligent Bionics", aiming to gather experts, scholars, researchers and related practitioners in this field from all over the world, share research results, explore hot issues and exchange new experiences and technologies. We warmly welcome experts and scholars in related fields to submit their new research or technical contributions to ACAIB 2022, and share valuable experiences with scientists and scholars from all over the world!

Submission Methods

1.The submitted papers must not be under consideration elsewhere.
2.Please send the full paper(word+pdf) to SUBMISSION SYSTEM
3.Please submit the full paper, if presentation and publication are both needed.
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IEEE ARM 2022

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IEEE International Conference on Advanced Robotics and Mechatronics

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The IEEE International Conference on Advanced Robotics and Mechatronics (ICARM) is the flagship conference of both IEEE-SMC TC on Bio-mechatronics and Bio-robotics Systems, and IEEE-RAS TC on Neuro-Robotics Systems. The ICARM 2022 will take place in the Guilin from July 9th to 11th, 2022. The conference would be organized by Guilin University of Technology (GUT), China, and Guangxi University, China. The conference will provide an international forum for researchers, educators, engineers in general areas of mechatronics, robotics, automation and sensors to disseminate their latest research results and exchange views on the future research directions of these fields.

Topics of Interest:

- Intelligent mechatronics, automation, control systems
- Bionic robotics, autonomous and evolutionary robotics
- Modelling of human sensory and motor systems
- Bionic robot navigation, task and motion planning
- Locomotion and manipulation in biological and robot systems
- Teleoperation, tele-robotics, haptics, and semi-autonomous systems
- Robotic systems modeling, optimization, simulation and experiments
- Control system modeling and simulation techniques and methodologies
- AI, intelligent control, neuro-control, fuzzy control and their applications
- Industrial automation, process control, manufacturing process
- Rehabilitation robot system, neuro-robotics, wearable robots

Important Dates

20 January 2022: Full papers and organized session proposals

20 January 2022: Proposal for tutorials and workshops

20 April 2022: Notification of paper and session acceptance

20 May 2022: Submission of final papers in IEEE PDF format

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ISBE Newsletter

Volume 10, Issue3, 2021

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