

Engineering a brilliant body of work

The development of biomaterials for human healing is improving lives across the world. A centre at **SICHUAN UNIVERSITY** is leading the way in their development.

Devices, implants, and materials for bone and tissue regeneration are transforming medical options for people after disease or injury. The National Engineering Research Center for Biomaterials (NERCB) at Sichuan University is a world leader in this interdisciplinary field.

Biomaterial engineering is a burgeoning interdisciplinary science, combining material sciences, biology, medicine, and engineering. Established in 1999, NERCB was the first institute dedicated to the field, and has quickly grown into a cross-disciplinary team of more than 100 faculty and staff, including globally renowned experts. It specializes in tissue and function regeneration and reconstruction, and medical implants. Its results are published in high-quality international journals, widely patented, and recognized by national science and technology awards.

Pioneering bone materials

Calcium phosphate ceramics are promising biomaterials for bone regeneration, and a specialism of Sichuan University's Xingdong Zhang, a member of the Chinese Academy of Engineering (CAE).

As the academic leader and honorary director of NERCB, Zhang's research focuses on biomaterials and tissue engineering for the musculoskeletal system. A pioneer of using lifeless biomaterials to repair tissues and organs, he initiated research on bioactive ceramics in 1983, and was the first in the world to systematically prove that lifeless porous calcium phosphate ceramics can induce bone formation without the use of living cells or bone growth factors. He proposed the underlying mechanism and in 1991 revealed how to make materials osteoinductive.

This work led to Zhang and his team developing the world's first synthetic bone repair product, with the claim of osteoinduction which gained regulatory approval for commercialization. He has founded three companies, whose products, approved by the CFDA, have been used to treat hundreds of thousands of patients in more than 1,000 Chinese hospitals.

Zhang also launched China's first research on plasma coatings for orthopaedic and dental use. In 2009, he found that collagen-based hydrogel



could induce cartilage formation.

Zhang's enormous contributions earned him membership of the US National Academy of Engineering in 2014. Zhang's election as the president of the International Union of Societies for Biomaterials Science and

Engineering (IUSBSE) in 2016 is another demonstration of his impact, and NERCB's growing international reputation. The term "tissue-inducing biomaterials", coined by Zhang, was adopted by the IUSBSE Conference on Definitions in Biomaterials in 2018.



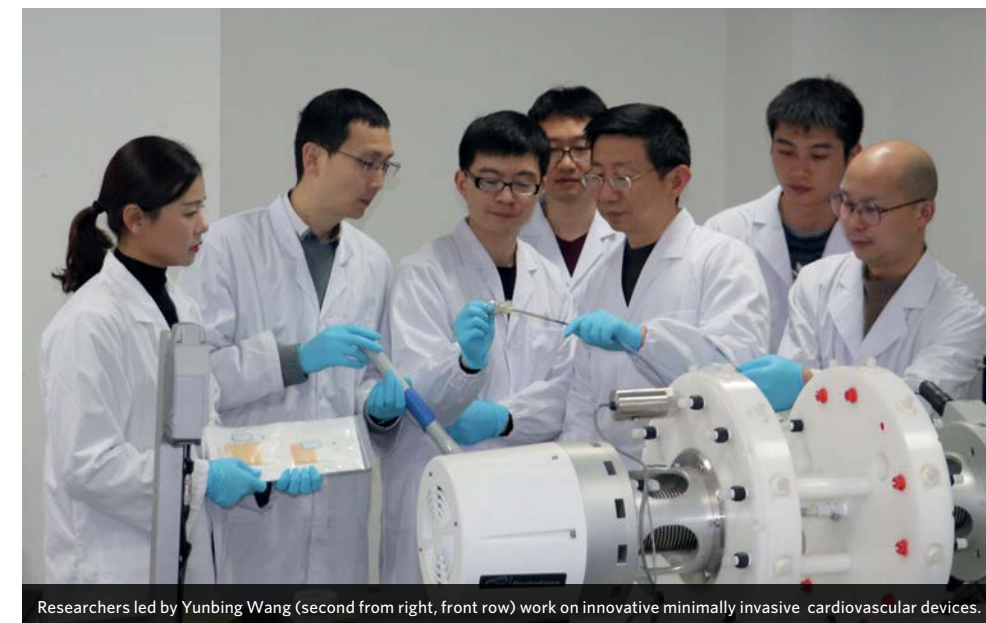
A transcatheter aortic valve implant

Biomaterials supporting cardiovascular treatment

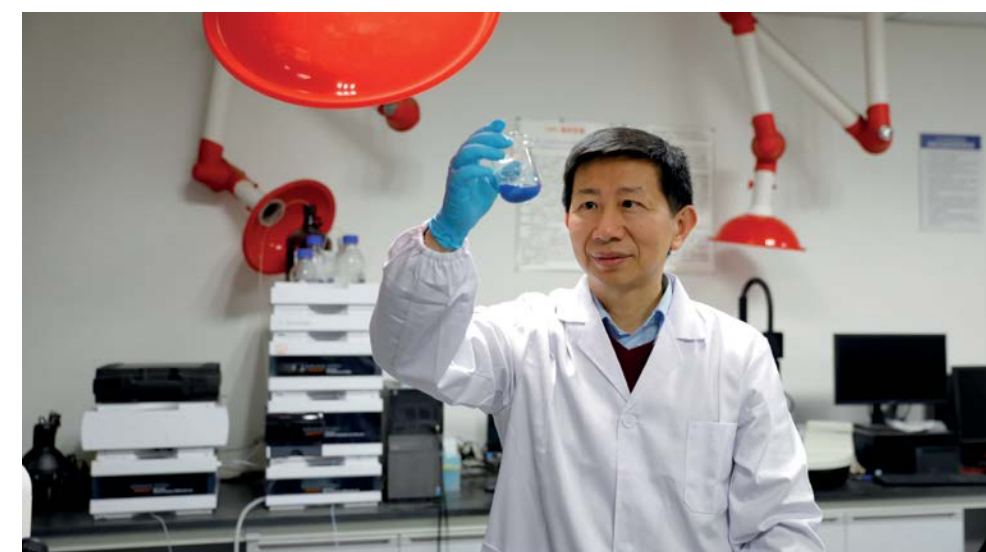
NERCB's director, Yunbing Wang, also the vice president of Chinese Society for Biomaterials, is globally renowned for his research on minimally invasive medical devices for cardiovascular diseases, and diabetes. With more than 150 patents granted in the United States and Europe, he has developed several world-first medical devices.

He and his team have collaborated with a Chinese company to develop a transcatheter aortic valve implant for heart disease treatment. Since its approval by the CFDA in 2017, the product has been used in more than 100 hospitals in China.

By developing novel crosslinking methods, such as radical-polymerization and enzyme-oxidative-polymerization, NERCB researchers were able to regulate physical, chemical, and biological properties of heart valves. In-situ polymerization on the biological valve enables a hydrogel to form for pre-mounted artificial heart valves. The pre-mounted dry-tissue transcatheter valve developed by Wang's group overcomes the storage limitation of traditional biological valve materials. This research, funded by the National Key Research and Development Programme, is expected to lead a technological breakthrough for



Researchers led by Yunbing Wang (second from right, front row) work on innovative minimally invasive cardiovascular devices.



A bio-resorbable cardiovascular stent

treating heart valve diseases.

Wang's team also leads in bio-resorbable stent technologies for vascular restoration therapy. By optimizing material preparation, stent design, coating composition, and surface conditions, they

improved healing of blood vessels after surgery. They developed a 3.0mm stent that can be expanded to more than 4.0mm, eliminating the risk of malapposition, discontinuity, and other adverse effects. Their stent showed great potential in large-scale pre-clinical studies.



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The 9th World Biomaterials Congress was held in Chengdu, China.

GROWING REPUTATION

A founding member of IUSBSE, NERCB has organized many international conferences to promote communication and collaboration in biomaterials, including the 9th World Biomaterials Congress, which drew nearly 4,000 participants from 47 countries and regions to Chengdu, China. It also established the Chinese Society of Biomaterials (CSBM) and launched its official journal, *Regenerative Biomaterials* (RB), in 2014, which is included in the Science Citation Index (SCI) database. NERCB's extensive collaboration with universities and research institutes worldwide enhances its global reputation.

NERCB has built an innovative and integrative R&D chain, linking basic research, product development, testing and evaluations, manufacturing and clinical use.

The Sichuan Testing Center for Biomaterials and Medical Devices, for instance, was

established by NERCB in 2003 for medical instrument testing and evaluation. With national accreditation, it is an independent legal entity with approval for testing, and for providing evaluation reports in Chinese and English.

NERCB has also set up a company called Sichuan

University Engineering Research Center in Biomaterials. It has six pilot production lines for bone-induced calcium phosphate bioceramics, biomedical collagen, hydroxyapatite bioceramics, dental implants, artificial hip joints, and hydroxyapatite powder. ■



NERCB DEVELOPMENTS

2018 conference on Definitions in Biomaterials

A 2018 Chengdu conference to find consensus on biomaterial definitions was chaired by Xingdong Zhang, and drew more than 50 top-level biomaterials scientists from 17 countries.

The milestone event built on advances and agreements from a conference held 32 years ago in Chester in the United Kingdom. Resolutions from the Chengdu conference will be published by Elsevier in *Definitions of Biomaterials for the 21st Century*, in 2019.

Research Centre for Materials Genome Engineering

Launched in January 2019, the centre focuses on design principles, preparation and rapid screening technologies for novel biomaterials. Using big data, high-throughput preparation and characterization, computation technologies, and experimental verification, it aims to develop high-quality, high-tech biomaterials, polymers and metals for application at reduced cost and high efficiency. The centre will play a leading role in the global development of biomaterials.

Research Institute of Regulatory Science for Medical Devices

Established jointly with CFDA in 2018, the institute aims to provide a theoretical basis to regulate and improve the evaluation of medical devices for greater safety, effectiveness, and quality. It will also train regulatory professionals about basic science, regulatory pathways, and social sciences. It will promote the development of medical devices in China.



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