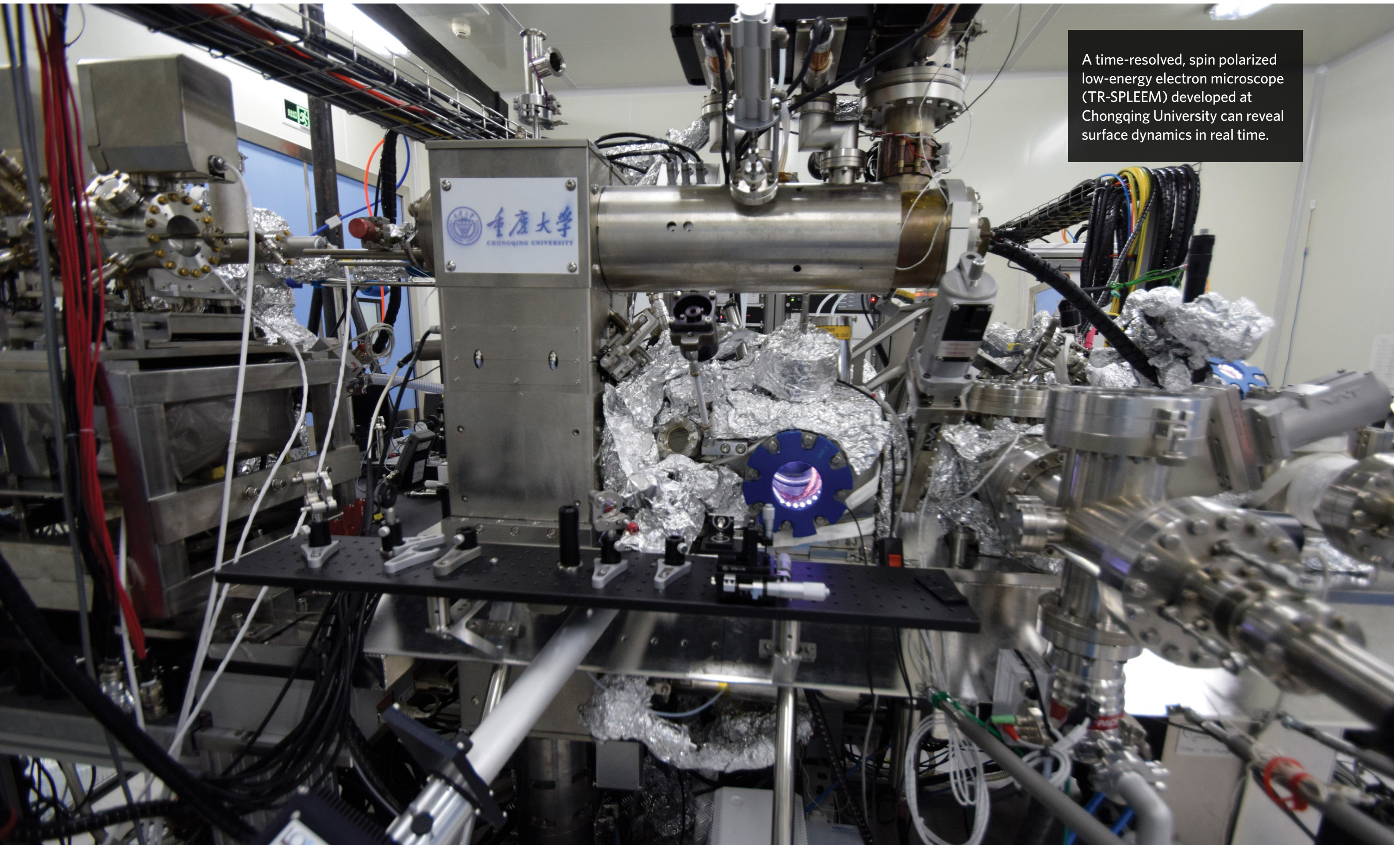

A time-resolved, spin polarized low-energy electron microscope (TR-SPLEEM) developed at Chongqing University can reveal surface dynamics in real time.

MAGNESIUM AND MICROSCOPY DRIVE MATERIAL DEVELOPMENTS

Researchers at Chongqing University are putting NEW LIGHTWEIGHT AND INNOVATIVE MATERIALS through their paces using pioneering in-house technologies.

Some of the world's most cutting-edge lightweight materials are being designed by researchers at Chongqing University's College of Materials Science and Engineering.

For example, Fusheng Pan, director of the college's National Engineering Research Center for Magnesium Alloys, is examining the potential of magnesium-based materials for use in future vehicles and batteries.

Magnesium, he explains, is the world's lightest structural metal; it is about 30% lighter than aluminium and 75% lighter than steel. It could find use in light cars and devices, says Pan.

In addition, magnesium-based materials have large hydrogen-storage capacities, which could be harnessed in future battery technologies. And their high theoretical capacity and discharge voltage make them promising for battery anodes.

Pan adds that magnesium is also highly recyclable and abundant — it is the eighth most common element in the Earth's crust. Moreover, of the roughly 900,000 tonnes produced globally each year, 80% comes from China.

In 2016, Pan was elected chairman of the International Organization for Standardization's Magnesium Alloy Technical Committee, which develops and maintains global standards for magnesium terminology and use.

In addition to developing new magnesium-based materials and other light alloys, the college is advancing other functional materials, as well as refining related processing and fabrication technologies, developing next-generation green building materials and steels, and fine-tuning advanced electron microscopy.

TRANSMISSION ELECTRON MICROSCOPY

To develop commercially viable materials, advances are needed in electron microscopy and other tools that reveal dynamic real-world behaviours in response to external stimuli. To address this, the college has developed new ways to conduct *in situ* experiments by integrating cutting-edge characterization tools.

Chongqing's Electron Microscope Center is home to one of the world's first three-dimensional (3D) transmission electron microscopes (TEMs), co-developed in 2012 by Xiaoxu Huang, who runs the centre.

The microscope enables non-destructive 3D orientation mapping and reconstruction of nanocrystalline materials with spatial resolutions down to 1 nanometre, as well as 3D quantitative characterization of irregularities in crystal structures, known as dislocation structures, that govern key physical and mechanical properties.

Recently, the centre has made several important findings, including an advance in ultrastrong nickel engineering, which was published in *Nature* in 2020. In this study, Huang and his colleagues used radial X-ray diffraction to look at nickel yield stress and deformation texturing at different grain sizes *in situ*.

They revealed a continuous strengthening in samples ranging from average grain sizes of 200 nanometres down to 3 nanometres, at which point their nickel was ten times stronger than a typical commercial nickel material. The cause, unravelled by simulations and TEM work, proved to be the multiple strengthening mechanisms, including both partial and full dislocation hardening and suppression of grain-boundary plasticity.

LOW-ENERGY ELECTRON MICROSCOPY

To investigate material surface dynamics in real time, researchers at the college have improved on low-energy electron microscopy (LEEM) and photoemission electron microscopy (PEEM), both of which harness low-energy electrons (up to 100 electron volts).

Tremendous progress has been made at the college in aberration correction (AC) for LEEM, which now has a spatial resolution of 1.8 nanometres.

The integration of an ultrafast spin-polarized electron source for AC-LEEM, known as AC-SPLEEM, enables the study of dynamic processes in bulk samples with dramatically improved temporal resolution compared to standard instruments. This allows Chongqing's researchers to study surface phase transitions, photochemical reactions, melting-crystallization processes, self-assembly, charge harvesting in thin-film solar cells, and switching in phase-change memory and spin dynamics.

These advances are helping to unravel heat-assisted nanoscale structure phase transitions, such as changes in magnetic phases and dynamics, on surfaces. In photochemistry, the ultrafast mode also allows the study of excitation-induced surface reactions in everything from pumped ultraviolet to infrared light.

Wen-Xin Tang, deputy director of the Electron Microscopy Center, has also pioneered a unique ultrafast time-resolved aberration-corrected spin-polarized LEEM (TR-AC-SPLEEM).

Tang's tool brings with it new opportunities for studying surface dynamic processes using LEEM/SPLEEM. For example, with well-controlled electron spin, the dynamics of magnetic-domain ultrafast spin can be investigated with high spatial and temporal resolutions.

This capability will help further the understanding of the nanoscale magnetic properties and processes that help determine the performance of certain devices, ranging from high-density magnetic data storage to magnetic sensor and spintronic devices. This will help scientists understand the correlation between structure and magnetism in ultrafast processes on surfaces at the nanoscale.

The college's researchers are also using other methods to look into advanced materials, including integrated characterization via dual-beam microscopes; conventional imaging and diffraction; chemical analyses; electron back-scattered diffraction; and analysis of electron dispersive spectra.

The college offers three undergraduate majors: material science and engineering; material forming and control engineering; and metallurgical engineering. It has a faculty of roughly 240, as well as 1,420 undergraduate and 1,040 graduate students. ■

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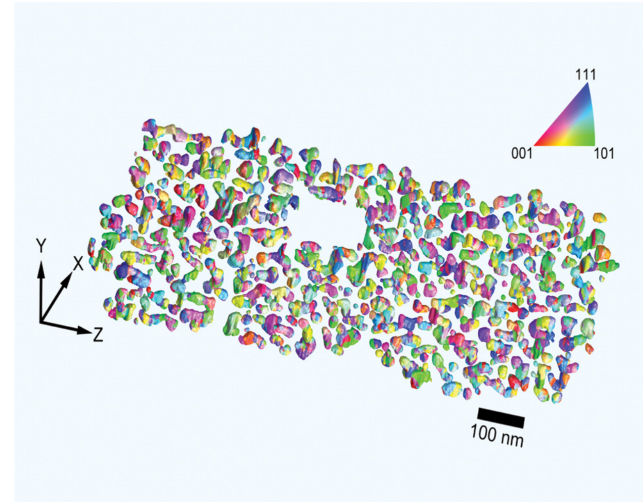
GLOBAL TALENT INVITED

CHONGQING UNIVERSITY'S COLLEGE OF MATERIALS SCIENCE AND ENGINEERING invites international scholars and talented young researchers to join its growing team. Principal investigator positions are available, as are academic and non-academic leadership roles within material science and technology projects.

Competitive compensation, use of advanced research platforms, and comfortable living conditions are provided.

We encourage interested candidates to get in touch with the college.



Chongqing University co-developed the pioneering 3D orientation mapping technology used to model these polycrystalline gold nanoparticles.

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