Materials Science Sparks Sustainable Development

Dialogue

By Staff Reporters

In October 2025, Italian Professor Federico Rosei, an internationally renowned materials scientist who has dedicated many years to researching microscopic quantum materials technology at the atomic and molecular levels, was elected a fellow of The World Academy of Sciences, in recognition of his efforts to promote scientific development in developing nations.

Rosei has a strong and long-standing connection with China. In 2015, he was appointed a "Changjiang Scholar" Chair Professor by China's Ministry of Education, and has played a pivotal role in establishing talent-training programs between Canadian research institutions and Chinese universities, including Soochow University and the University of Electronic Science and Technology of China.

Prof. Federico Rosei (left). (COURTESY PHOTO)

Research on sustainable development

"I have always been interested in fundamental research, but over time, I gradually shifted my focus to sustainable materials such as multiferroic materials, quantum dots, nanostructured materials and excitonic solar cells," said Rosei.

During his time in Canada, he investigated a wide array of material systems. Drawing on fundamental principles, he engaged in materials design, clarifying the intricate relationships between material structure and properties. In the process, he developed various devices applicable to renewable energy technologies.

When discussing the latest advancements in materials science, Rosei places particular emphasis on the appeal of nanomaterials: "When materials are scaled down to the nanoscale, their properties undergo dramatic transformations and begin to exhibit 'quantum' effects that are typically unobservable at the macroscopic scale," he said.

From 2013 to 2023, he served as the UNESCO Chair in Materials and Technologies for Energy Conversion, Saving and Storage. In this role, he led the creation of a collaborative network spanning 22 countries and 30 institutions, including numerous universities in China. "Through exchanges and mutual visits between faculty and students, joint research projects, and the sharing of knowledge in emerging fields, we have nurtured a large number of outstanding young scholars," he said.

Lab to industrial application

In the field of industrial collaboration, his partnership with Jiangsu Meike Solar Co., Ltd. has set a stellar example.

Responding to the challenge of harvesting solar energy, they developed a solar photovoltaic window and door system utilizing quantum dot concentrators, effectively endowing traditional glass windows and doors with solar cell capabilities.

"This concept is innovative because the solar panels harvest solar energy and serve as structural building materials, making full use of the exterior walls' vast surface area," he said. This technology overcomes the challenges associated with traditional silicon-based photovoltaic panels, such as their large footprint and redundant investment, while supporting innovation in new energy technologies and driving industrial upgrading.

In 2020, he played a pivotal role in establishing the Institute of Quantum and Sustainable Technology (IQST) at Jiangsu University (JSU). Focusing on critical scientific questions in the field of photovoltaic new energy technology, IQST prioritizes research into the atomic and molecular-level structural design of materials, as well as the application of quantum theory.

Working alongside the JSU team, he forged long-term, stable collaborative partnerships with institutions such as Soochow University, Nanjing Tech University and Nanjing University. Together, they have published over 50 high-level academic papers and undertaken five provincial- or ministerial-level research projects.

China: a hub of high-quality talent

"Working with Chinese scholars is always a pleasure. They have an admirable professional ethic and are so devoted to their research that I often find it hard to keep up with them," Rosei said. He takes great pride in the Chinese students and postdoctoral researchers he has mentored, noting that many of them have gone on to enjoy successful careers after returning home.

In his view, Chinese universities produce high-quality research. "These institutions are equipped with state-of-the-art facilities, backed by ample funding, and, most importantly, they have attracted a multitude of young talent eager to make their mark."

Rosei spoke highly of China's advancements in the field of materials science: "Currently, the epicentre of materials science research has shifted to Asia — a shift driven primarily by China's progress. China has set ambitious goals centered on its dual carbon goals and has made remarkable strides; indeed, it is now leading global development in the renewable energy sector. Every visit to China is an adventure and a learning experience for me."

This article is in cooperation with International Talent Magazine.

Tech+Culture

Tech Empowers Archaeology: Seeing the Unseen

By Staff Reporters

While traditional field archaeology relied on shovels and brushes to uncover artifacts, guided only by human eyes and hands, the efforts were limited to what could be seen and touched.

Today, with science and technology integrated into archaeology with unprecedented depth, not only have precision and efficiency greatly improved but it has also opened up dimensions of information that traditional methods could never reach.

Remote sensing: 'sharp eyes'

The state of Chu was an important regional state existing between 770 and 223 BCE. The Chu royal mausoleum in Wuwangdun in Anhui province, east China, is the largest, highest-ranking, and most structurally complex royal Chu tomb scientifically excavated in the country to date.

Today, the excavation site is a hub of activities. A temporary protective shed has been erected over the site and laboratories from various disciplines are busy cataloging and preserving the artifacts unearthed from the tomb.

However, just six years ago, this site was merely a mound rising about 16 meters above the ground.

How was the underground site precisely located? Archaeologists used their "sharp eyes."

Professor Zhang Wenjie, vice dean of the School of History and Cultural Heritage at Xiamen University, who led the entire excavation process, described how it was done: During the exploration phase, high-level domestic research teams used large-scale remote sensing technologies, such as satellite remote sensing and drone aerial photography, to conduct preliminary surveys and assess the tomb's macro structure, burial mound, possible distribution of accompanying graves, and the scope of the cemetery.

Remote sensing offers a high vantage point and a broad field of view. By analyzing images of large areas captured by satellites and drones, archaeologists can identify large sites based on differences in surface vegetation and soil color. This technology records the spatial layout of sites and their relationship with the surrounding environment, providing a basis for subsequent excavation and protection plans.

Since the Wuwangdun tomb had been disturbed by multiple robberies, it was possible that the burial environment had changed. Rash excavation could damage the original positional information and state of the artifacts. Therefore, it was necessary to use "sharp eyes" to see clearly what lay beneath.

The archaeological team employed geophysical detection techniques such as high-density resistivity for non-destructive detection of the tomb pit structure and the layout of the coffin chamber. This allowed them to predict the condition of the underground remains and customize a more refined excavation plan.

Precision excavation

The widespread application of remote sensing, digital, and intelligent technologies has made fieldwork more precise and efficient. During the excavation phase, new technologies and methods ensure smooth progress in the work and the safety of the relics.

"Dry lasts a millennium, wet lasts 10, but halfway between, it rots in half a year." This is how the archaeological community sums up their experience acquired through extensive field practice.

The temperature and humidity of the storage environment affect the relics and fluctuating conditions can even lead to tomb collapses. To address this, the archaeological team injected inert gas to reduce the exposure of the revealed relics to oxygen. They also used methods like automatic mist spraying to control the temperature and humidity of the excavation site.

When extracting the artifacts, the team combined traditional methods with new techniques. They used menthol for temporary consolidation, plaster and polymer bandage procedures, liquid nitrogen freezing, and box-lifting technology to extract large artifacts. This maximized the retention of archaeological information, ensured the safety of artifacts during transport, and facilitated subsequent conservation and restoration.

As the excavation progressed, traces of ink, suspected to be remnants of characters, were found on the overlapping surfaces of the coffin lid planks. However, due to mud contamination, only minimal ink traces were visible to the naked eye, and most inscriptions were unidentifiable.

The archaeological team used infrared cameras to record over a thousand ink-written characters on the coffin lid planks. These characters indicated the orientation, compartment names and other details of the coffin chambers. This information helped identify the functional division of the different coffin chambers and provided a basis for in-depth research into the construction of the tomb.

An exhibit at the exhibition "Echoes of King Kaolie — Archaeological Discoveries from the Wuwangdun Tomb No. 1" in the National Museum of China in Beijing, China. (PHOTO: XINHUA)

Hybrid Vigor: Breeding Better-quality Plants, Animals

Traditional Eastern Wisdom

By BI Weizi

China is one of the earliest countries in the world to systematically make use of hybrid vigor (heterosis). From the pre-Qin period to the Ming and Qing dynasties, a comprehensive practical framework was developed for animals, silkworm farming, crops and horticulture using hybrid vigor, where better quality animals and plants result from crossbreeding.

During the Western Zhou and Spring and Autumn period, the *Yi Zhou Shu* and *Chu Ci* document the hybridization of horses and donkeys to produce mules. Northern nomadic peoples pioneered interspecific hybridization techniques, and mules were considered "extraordinary animals." During the Han dynasty, mules spread to the Central Plains through contact with various ethnic groups and became important draft animals. However, hybridization techniques were still in the exploratory stage. By the Wei, Jin and Northern and Southern dynasties, this technology had gradually matured.

During the Ming dynasty, breakthroughs were achieved in silkworm hybridization. In Song Yingxing's *Tiangong Kaiwu* (*The Exploitation of the Works of Nature*), hybridization between silkworm varieties is recorded, with the achievement of "superior hybrids" clearly identified: A yellow-cocooned female and a white-cocooned male produced offspring with brown cocoons that possessed traits of both parents. This is the world's earliest written record of utilizing hybrid vigor in silkworms, predating the West by several centuries.

During the Qing dynasty, refined breeding techniques were developed. In goldfish hybridization, the *Jinyu Tupu* (*Illustrated Treatise on Goldfish*) recommended selecting superior breeds and matching traits for hybridization, resulting in varieties such as variegated and dragon-eye — a prime example of hybrid vigor in ornamental animals.

In rice breeding, naturally mutated rice plants were discovered, and after years of selection, varieties of imperial rice were developed that exhibited early maturity and high yield. Successful trials were conducted in the northern regions such as Chengde and Beijing, overcoming planting boundaries.

The characteristics of ancient Chinese utilization of hybrid vigor can be summarized in four points: First, animal-led hybridization, represented by mules and dzo (cow and yak hybrid). This was the earliest and most successful example of distant hybridization in the world. Second, a milestone in silkworm breeding. Inter-variety hybridization was achieved in the Ming dynasty, clearly demonstrating the concept of "generating superior varieties," making China a pioneer in insect hybrid vigor.

Third, the practice-driven approach, primarily based on production experience rather than modern genetic theory, yet the techniques were precise and the results significant. Fourth, its applications were wide-reaching, covering draft power, food, textiles and ornamental uses, and supporting the development of ancient agriculture and handicrafts.

The use of hybrid vigor in ancient China predates that in the West by around 1,000 years, representing a significant innovation in the history of world agricultural science and technology, and providing the practical basis for modern hybrid breeding, including hybrid rice, corn and livestock.

Sword of Goujian: Still Razor-sharp after Millennia

Science Outreach

By BI Weizi

The Sword of Goujian is a bronze sword famous for its exceptional sharpness, detailed pattern of black diamond engravings, and its remarkable resistance to corrosion, something very unusual among existing artifacts from a similar time period. Unearthed in 1965 from a historic grave in Hubei province, the sword is recognized by the markings on its blade as crafted and owned by Goujian, one of the final rulers of Yue during the Spring and Autumn period (770-481 BCE).

It is believed that the sword has retained its remarkable razor-like edge and corrosion free surface due to its chemical makeup and an almost airtight sheath.

The blade was crafted from a bimetallic mixture of copper and tin. Before Chu swordsmiths created steel blades, high-quality Bronze Age swords were deemed those that effectively balanced the use of tin in the bronze mixture. A high concentration of tin provided hardness but also increased the risk of brittleness, whereas a low concentration resulted in a robust yet soft-edged blade.

A major metallurgical advancement by blacksmiths in the regions of Wu and Yue led to the production of a double-cast blade, initially using a low tin bronze alloy for the central ridge to ensure toughness and flexibility, followed by a high tin bronze alloy on the blade edge for enhanced hardness and strength. A bronze sword with both hardness and strength was thus made possible.

The Sword of Goujian visually represents this metallurgical method, where the yellow-red and yellow-white hues of the blade's ridge and edges respectively symbolize the aesthetic characteristics of this technique. Compositional analysis confirmed that the blade's body ridge is primarily composed of copper, which enhances its pliability and reduces the risk of shattering; conversely, the edges contain a higher tin content, which increases hardness and helps maintain a sharper edge; sulfur also diminishes the likelihood of tarnishing in the designs.

The Sword of Goujian is recognized as one of the earliest existing examples of ancient Chinese sword-making that employed intricate metallurgical composition. The "chemical wisdom" has provided significant motivation for contemporary metal corrosion protection methods, particularly in the realm of cultural artifact conservation.

Building Xiong'an New Area into Innovation Hub

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Xi stressed systematic planning and the integrated advancement of high-quality development and efficient governance, urging efforts to improve the public service system, safeguard and enhance people's well-being, and actively explore future-oriented smart city management models.

Xiong'an must develop a modern industrial system suited to its realities, Xi said, noting that it should advance the high-standard development of a science park to accelerate the application of scientific and technological achievements.

The new area should cultivate clusters of emerging industries and industries of the future, pioneer the implementation of innovative policies in science and technology, finance and other fields, and create a market-oriented and law-based business environment that is up to international standards, he added.

Source: Xinhua