GLOBALLY RECOGNIZED RESEARCH UNIVERSITY

TOKYO UNIVERSITY OF AGRICULTURE AND TECHNOLOGY is committed to addressing global issues through promoting collaborative research in agriculture and engineering

Tokyo University of Agriculture and Technology (TUAT) has a long history of improving society through advances in agricultural science and engineering. Ever since its beginnings in the 1870s as two government departments that merged in 1949 to form a university, TUAT has placed a strong emphasis on improving the lives of people in Japan and beyond. Input from a broad range of perspectives is required to address major global challenges such as environmental degradation, energy and food supply issues, and obstacles to realizing a sustainable society. The university's vision is to realize globally competitive research capabilities and to become a science and technology hub for developing a sustainable society.

Institute of Global Innovation Research

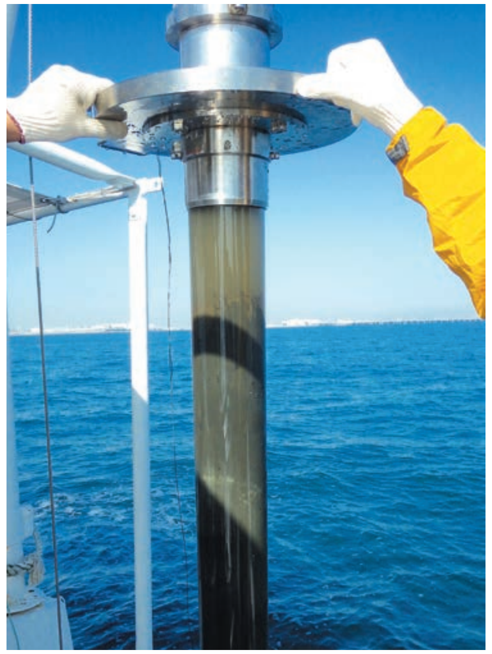
In 2014, TUAT was selected by the Japanese government as one of 12 national universities rapidly promoting global research. To enhance the university's research capabilities in agriculture and engineering, it established the Institute of Global Innovation Research (GIR). This institute prioritizes research in three key areas: food, energy and life sciences. It is developing strategic research teams with the aim of promoting international collaborations. Overseas researchers held in high regard by the scientific community can participate in GIR by visiting TUAT for one to three months and focusing solely on research. In 2016 alone, 34 overseas researchers were either employed or invited by GIR. Since 2014, researchers from 39 institutes in 14 countries (including the US, Germany, the UK, France, Italy, Finland, Australia, Canada and China) have been employed or invited by GIR. Researchers from GIR published more than 150 original papers based on international collaborative research. The institute also aims to help young scientists to develop scientific and management skills by providing various opportunities for them to interact with other scientists from around the world.

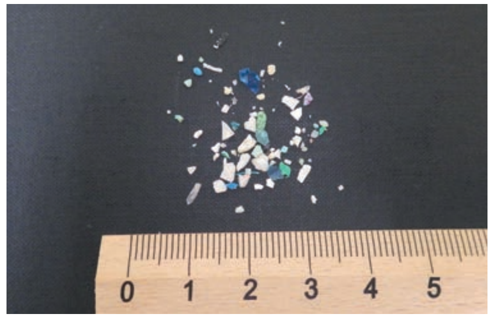
Addressing global food and energy problems

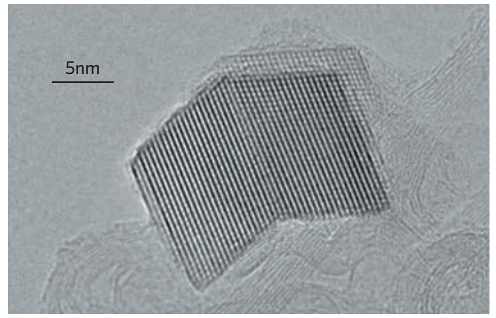
Food production is a critical issue facing the international community. In addition, rising energy consumption globally is predicted to continue, making energy production and storage increasingly important. In GIR, Priority Field 1 Food focuses on the food supply, environmental conservation and biomass energy. Priority Field 2 Energy addresses energy problems through technologies such as electrochemical capacitors, light-emitting diodes, ionic liquids, marine molecules and smart green mobility. Finally, Priority Field 3 Life Science focuses mainly on drug-delivery systems, biodevices, photonics and medical science. Life science is important since it can enable scientists to find fundamental technologies for solving food and energy issues. Moreover, it can have significant implications for health and well-being.

Tackling global challenges through research

With a focus on agriculture and engineering research, TUAT is pursuing its mission of helping realize a sustainable society. By performing cutting-edge research, it aims to become a globally recognized research university.







In GIR Priority Field 1 Food, Hideshige Takada is leading a group that, in collaboration with a distinguished professor from the UK, is focusing on the environmental issue of microplastic pollution. In GIR Priority Field 2 Energy, Katsuhiko Naoi heads a group, which includes three distinguished professors from France, that is concentrating on developing rapidly charging, high-energy-density batteries.

A big problem caused by small particles

Takada is investigating the impact of microplastics on marine environments. Polymers, the main component of plastics, are not toxic in themselves, but Takada has found that they absorb and concentrate toxic chemicals such as polychlorinated biphenyls and DDT. These persistent organic pollutants (POPs) could make their way into humans via the food chain, Takada warns. "Plastics may increase the burden of POPs on human health and adversely affect our endocrine and immune systems," he says.

A pollution map developed by International Pellet Watch (www.pelletwatch.org), a project that Takada founded in 2005, indicates that plastics toxified with POPs are now found in all marine environments. Takada and his colleagues worldwide are calling for policy makers to classify most plastic waste as hazardous and impose stricter control on it. "We should not wait, because plastic pollution is getting serious and we cannot remediate it due to its tiny and persistent nature."

His next step is to conduct a full risk assessment of microplastics in marine ecosystems. "We are not only concerned about the direct impacts of plastic-mediated chemical pollution to ecosystems but also about indirect impacts such as resurrection or remobilization of legacy pollutants," Takada says.

Rapid charging for a smart future

From watches to bullet trains, clean and smart technologies are powered by energy-storage devices. There is a strong demand for batteries and electrochemical capacitors that can be charged more rapidly. One promising technology for meeting this need is hybrid supercapacitors, which have one battery electrode and one activated-carbon capacitor electrode. To realize this, the charging and discharging rates of battery electrodes have to be increased by a factor of between 10 and 100, to make them comparable to those of capacitors. But this is difficult without compromising the battery's lifespan and energy density.

Now, Naoi has resolved this issue by using a method that employs ultracentrifugation. He used this method to create a battery electrode made from $Li_4Ti_5O_{12}$ (LTO) nanocrystals and carbon nanofibres and achieved the world's fastest charging and discharging rates. Combining this electrode with an active carbon electrode, he fabricated a nanohybrid supercapacitor whose energy density is triple that of a conventional one. Naoi has also used the method to develop a super-redox capacitor that has an even higher energy density than the nanohybrid supercapacitor.

Lighter and smaller than conventional devices, Naoi's supercapacitors are attracting industry. Nippon Chemi-Con Corporation has already commercialized the nanohybrid supercapacitor. "There are plans to utilize it in light-rail trains and electric vehicles," Naoi comments. ■

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