CARBON NANOTUBES SET TO INNOVATE INDUSTRY

Researchers at SHINSHU UNIVERSITY'S INSTITUTE OF CARBON SCIENCE AND TECHNOLOGY aim to advance Japanese industry with the latest innovations in nanocarbon science.

The Institute of Carbon Science and Technology (ICST) at Shinshu University holds an impressive track record in researching nanocarbon. A material that is expected to transform industrial innovation in the 21st century, nanocarbon can be integrated into polymer composites as carbon nanotube fillers. These composite materials have enhanced characteristics and advanced functions owing to their unique structure and have potential applications in a broad range of areas, including biomedicine, environment, energy, and resources.

Ever since Shinshu alumnus Morinobu Endo (pictured, far right) and colleagues developed a method to synthesize a carbon nanotube using the catalytic vapour-phase process and reported on the structure of a synthesized carbon nanotube in 1976, researchers have been looking for ways to use carbon nanotube composites in practical applications. Their strong and flexible mechanical properties combined with excellent thermoelectric characteristics make carbon nanotubes a greatly promising material, one that is anticipated to lead to new composites. However, few highly successful applications using carbon nanotubes have emerged, other than carbon nanotube composites for lithium-ion battery electrodes. In most cases, carbon nanotubes were found to have degraded the physical properties of composites because carbon nanotubes, a very thin one-dimensional substance, tend to cluster together. Although attempts have been made to homogeneously disperse carbon nanotubes using various high-energy mixers, only a few have met with success. Carbon nanotube agglomerates break into pieces when mixed with a base material using strong force. However, they are not disbanded.

THE ICST HOLDS AN IMPRESSIVE TRACK RECORD IN RESEARCHING NANOCARBON

The ICST's first successful application in this area used carbon nanotubes in an aluminum and rubber composite. Researchers at the institute sought a method to disband carbon nanotube agglomerates and found the answer: a method of mixing that incorporated the elasticity of natural rubber. The researchers found that the high elasticity of natural rubber fiberized the mixture through repeated deformation and restoration, resulting in a carbon nanotube/natural rubber composite. Toru Noguchi (pictured, first right) and colleagues discovered that pouring melted aluminum onto the carbon nanotube/natural rubber composite produced a carbon nanotube/aluminum composite. The resulting composite exhibited a high level of stiffness and heat resistance, as well as highly durable electron emissivity. In the course of investigating the structure and physical properties of the carbon nanotube/natural rubber composite, the researchers found that the fiberized carbon nanotubes formed a structure like a microscopic jungle gym in the natural rubber, which enhanced the physical properties of the composite. The institute named this phenomenon 'cellulation' and has subsequently applied cellulation technology to different kinds of rubber. Fluorocarbon rubber developed with this technology displayed remarkable durability and heat resistance. This new rubber offers practical applications for various types of sealing materials used in harsh environments. Cellulation technology also has extensive applications in automotive and other industries (prototypes are shown in the bottom image).

Since ICST researchers developed a method to increase pseudoelasticity, which can be applied to plastics with low elasticity, the industry has generated many high-performance plastics composites. These composites are expected to lead to higher functionality for recycling plastic waste, which is essential to resolving environmental problems. The institute has also applied cellulation technology to natural cellulose nanofibers—a thin material similar to carbon nanotubes—and new composites are currently under development. Carbon nanotubes and cellulose nanofibers are nano-nano composite materials that compete with and cooperate with each other, and could lead to innovative polymeric materials. The ICST looks forward to developing new innovations with these materials that will ensure Japanese industry continues to go from strength to strength. ■

SHINSHU UNIVERSITY | Institute of Carbon Science and Technology

Institute of Carbon Science and Technology, Interdisciplinary Cluster for Cutting Edge Research, Shinshu University
4-17-1 Wakasato, Nagano 380-8553,Japan
Tel: +81-(0)26-269-5714
Email: noguchi@endomoribu.shinshu-u.ac.jp
URL: www.shinshu-u.ac.jp/institution/icst/english


Shinshu University
Endo Lab.