TOYOHASHI UNIVERSITY OF TECHNOLOGY
Master Technology, Create Technology

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Tech-Overtures

Innovative method for controlling the electrical conductivity of composite materials

Toyohashi Tech researchers develop a low cost and time saving method for producing electrically conducting composites based on electrostatic adsorption of CNTs onto resin and ceramic particles.

Hiroyuki Muto and colleagues at the Toyohashi University of Technology (Toyohashi Tech) have developed an innovative method for producing CNT (carbon nano-tube) resin composite material [1] that only requires 1/100 [2] of the conventional amount of CNT additive to produce electrical conductivity in the composite material.

In this method, CNTs were mixed in an electrolyte solution and added to the composite, where the CNTs were adsorbed onto the surfaces of the resin particles due to electrostatic adsorption [3]. Thus, high electrical conductivity was obtained by the addition of a small quantity CNTs. Importantly, the electrical conductivity of the composite materials was readily controlled by changing the amount of electrolyte added to the composite; namely, the degree of CNT adsorption onto the resin particles.

In addition, this approach enables significant reductions in both the production costs and the production time compared with conventional methods for manufacturing conductive resins.

Notably, the use of particles with charged surfaces will enable the production of various combinations of composite materials such as metals, ceramics, and polymers. The researchers expect this method to find applications in the production of enzymes and cosmetics.

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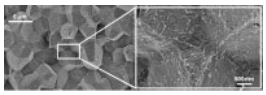
Further information

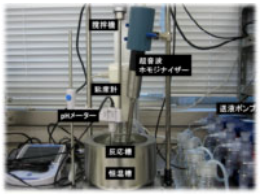
[1] This is a composite material comprising of resin particle with the addition CNTs. By utilizing the high conductivity of CNTs, practical products such as robust, anti-static components for clean rooms in the electronics industry, could be manufactured. The ability to control the electrical conductivity of the composite materials by this production method is expected to lead to a wide range of applications in the electronics industry, including use as alternatives for indium-tin-oxide transparent conductive film for displays, as plates for rechargeable batteries, and in semiconductor devices. Furthermore, the composite resin particles can be used in the production of for plastic materials, such as injection molding or extrusion.

[2] When imparting electrical conductivity to insulating ceramics or polymer materials, the introduction of conducting additive materials that can be linked within the resin structure is required. In conventional methods, the amount of additive is greater than 1% by weight. However, this new method only requires the addition of 0.01% CNT to impart conductivity.

[3] This method adsorbs CNTs onto the matrix resin particles by an electrostatic attractive force, which is a result of charging them positive or negative in appropriate electrolyte solutions. By controlling the concentration of the electrolyte solution added to the composite, the charge-volume of the surfaces of the particles can be changed, thus controlling the degree of adsorption of the CNTs.



Enlarge Image
Cross-section of PMMA resin composite material showing the networks of CNTs on the surfaces of the resin particles. The CNTs are added to induce electrical conductivity.



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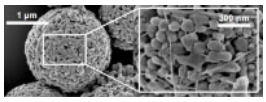
Prototype system for producing PMMA-CNT composite materials



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Ceramic particles with electrostatically attached CNTs fibers.