High speed charging device - success in high capacity graphene-based supercapacitors

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Professor Jie Tang, Group Leader of the 1D Nanomaterials Research Group of the Materials Processing Unit, National Institute for Materials Science, and Mr. Qian Cheng, a doctoral student and NIMS Junior Researcher in the same Group, have succeeded in dramatically increasing the energy density of supercapacitors, which are used to store electrical energy.

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Various new batteries, such as nickel metal hydride batteries, are currently being developed with the aims of achieving higher efficiency and higher energy storage for electric power supplies. In comparison with batteries, capacitors have a larger output power density to enable rapid charging, excellent durability to allow operations in both higher and lower extreme temperatures, better cyclicity for recharging repeatedly over a long period, and are also safer. However, it has been as a great technical challenge to realize high energy density due to the relatively low specific capacity of the conventional capacitor devices.

In order to achieve a revolutionary increase in density of energy storage, Professor Tang and her team, in collaboration with Professor Lu-Chang Qin of the University of North Carolina at Chapel Hill in the United States, have designed and developed a graphene-based composite structure, in which graphene is used as the base material of the capacitor electrodes and carbon nanotubes (CNT) are inserted between the graphene sheets. In this structure graphene offers a far larger specific surface area (2630 m^2/g) than the conventional materials and the CNTs function as spacers as well as conducting paths to enable adsorption of a larger quantity of electrolyte ions on the graphene surface. With this graphene-CNT composite as the capacitor electrodes, Professor Tang has obtained a high energy density of 62.8 Wh/kg and output power density of 58.5 kW/kg using organic electrolyte. By using an ionic liquid as the electrolyte, they have achieved an energy density of 155.6 Wh/kg, which is comparable to that of nickel metal hydride batteries.

Among the many industrial applications of capacitors, the new capacitors developed in this research offer promises as power sources for electric and hybrid vehicles, which require high energy density. As the current production processes are also inexpensive and can be scaled up, large expectations are placed on practical applications.

More information: This research is published in the latest issue of *Physical Chemistry Chemical Physics*, a scientific journal published in London by the Royal Society of Chemistry.

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