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Black Conductive Titanium Oxide High-Capacity Materials for Battery Electrodes

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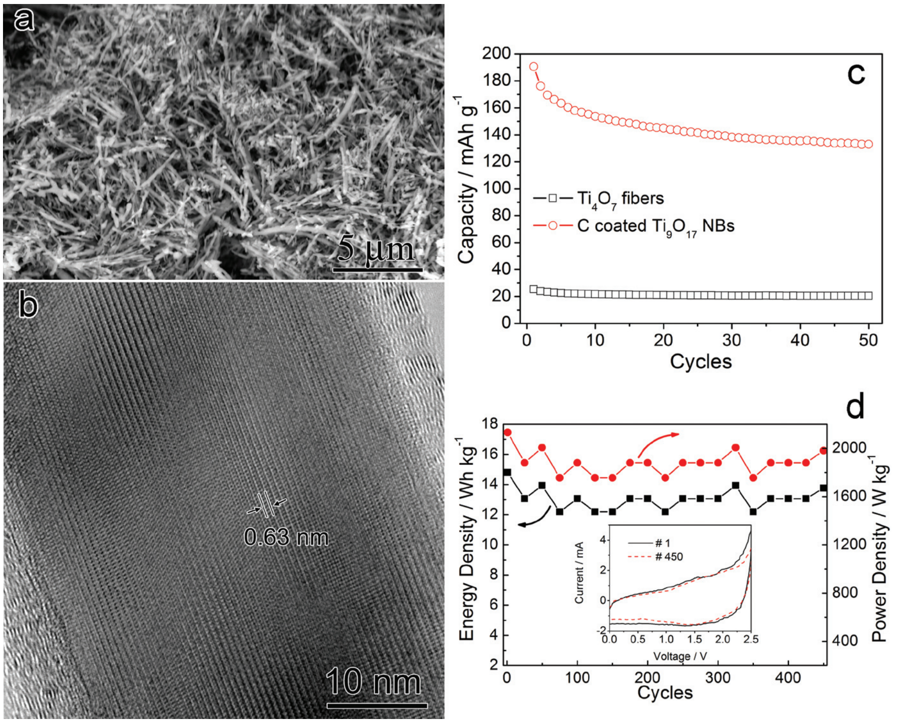
Technology Description

Stoichiometric titanium dioxide (TiO_2) is one of the most widely studied transition-metal oxides because of its many potential applications in photoelectrochemical systems, such as dye-sensitized TiO_2 electrodes for photovoltaic solar cells, and water-splitting catalysts for hydrogen generation, and in environmental purification for creating or degrading specific compounds. However, TiO_2 has a wide bandgap and high electrical resistivity, which limits its use as an electrode.

A set of non-stoichiometric titanium oxides called the Magnéli phases, having a general formula of Ti_nO_{2n-1} with n between 4 and 10, exhibits lower bandgaps and resistivities, with the highest electrical conductivities reported for Ti_4O_7. These phases have been formulated under different conditions, but in all reported cases the resulting oxides have minimum grain sizes on the order of micrometers, regardless of the size of the starting titanium compounds.

In this method, nanoparticles of TiO_2 or hydrogen titanates are first coated with carbon using either wet or dry chemistry methods. During this process the size and shape of the nanoparticles are “locked in.” Subsequently the carbon-coated nanoparticles are heated. This results in the transformation of the original TiO_2 or hydrogen titanates to Magnéli phases without coarsening, so that the original size and shape of the nanoparticles are maintained to a precise degree.



Markets and Applications

People who work on batteries, fuel cells, ultracapacitors, electrosynthesis cells, electro-chemical devices, and soil remediation have applications that could benefit from using nanoscale Magnéli phases of titanium oxide.

Application of these electrode materials may not be limited to substitution for TiO_2 electrodes. Combining the robustness and photosensitivity of TiO_2 with higher electrical conductivity may result in a general electrode material.

Commercial Readiness

At a funding level of about $200,000 per year, this technology could achieve scale-up within two years.

Intellectual Property

A U.S. Provisonal Patent Application is pending. It claims the structures and methods of making them. During scale-up to commercial production it is likely that patentable methods will be developed relating to materials processing. An industrial partner may also choose to protect certain know-how gained during scale-up as trade secrets.

For More Information

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