Using Ionic Liquids to Make Titanium Dioxide Nanotubes

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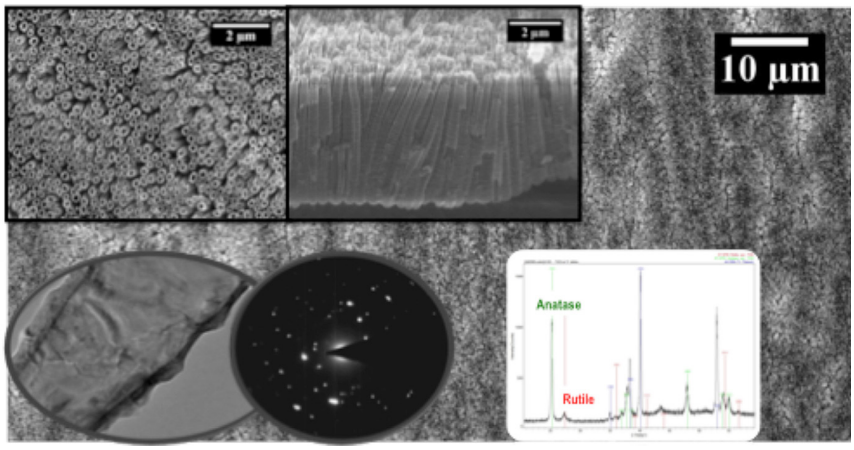

Titanium dioxide nanotubes—view from top (left) and cross-sectional view (right)

Technology Summary

Since self-organized TiO_2 nanotube (NT) arrays were first reported in 1999, there has been increasing research interest due to their comparably larger surface area, chemical stability, biocompatibility and the ability to provide an excellent electron percolation pathway for vectoral charge transfer between interfaces. The most commonly used fabrication method is anodization of titanium metal in aqueous or organic polarized electrolytes baths containing fluoride species such as NH_4F, HF, or NaF. However, anodization-produced TiO_2 NT arrays are usually covered by a nanoporous debris layer and contaminated with the decomposition products of the organic electrolyte, which cause a longer charge transport time, reduce transmittance, and deteriorate the semiconductor characteristics.

ORNL has recently successfully developed debris-free, low-contaminant TiO_2 NT arrays using a new group of electrolytes based on high-electrical-conductivity ionic liquids as chemical dissolution agents. The elimination of the debris layer allows both inner and outer surfaces of NTs accessible. Avoiding compositing with decomposition products of electrolytes and associated cracking improve the electron transport and reduces the photon recombination.

Advantages

- Debris-free and well-separated for easier access of electrolytes in solar or battery cells
- Low-contamination and crack-free for higher efficiency photo-conversion and better electrode performance in energy storage

Potential Applications

- Water photoelectrolysis catalysts (for hydrogen generation), photovoltaic components in dye-sensitized solar cells, and as hydrogen gas sensors
- Energy storage applications such as anodes for lithium-ion batteries and electrodes for supercapacitors.
- Ongoing interest in these nanotubes for electronic components, microfluidic devices, nanofiltration devices, drug delivery devices, photocatalytic devices, and tissue engineering components

Patent

Jun Qu, Huimin Luo, and Sheng Dai. *Method for Synthesis of Titanium Dioxide Nanotubes Using Ionic Liquids*, U.S. Patent Application 12/481,174, filed June 9, 2009.

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