Pulsed Photothermal Phase Transformation Control for Titanium Oxide Structures and Reversible Bandgap Shift

UT-B ID 200702021

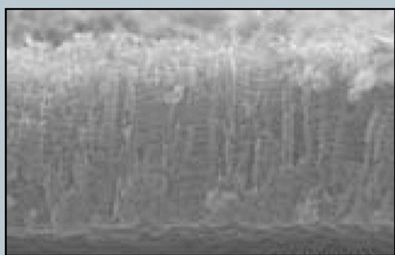

Image of TiO_2 nanotubes

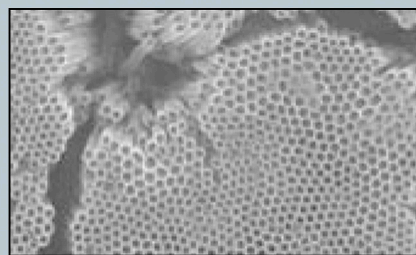

Image of TiO_2 nanotubes in anatase phase

Technology Summary

Titaniam oxide (TiO_2) has the potential to contribute to solar and hydrogen energy systems, if its phase and band energy can be modified. ORNL researchers used pulsed photothermal processing to tailor the band energy gap and to obtain, and then reverse, the desired titania phase (anatase, rutile, etc.). These transformations enable titanium oxides to be used for solar absorption, hydrogen production, or photovoltaic applications.

The researchers put TiO_2 through a high temperature phase change by placing it on a temperature sensitive, flexible substrate. The material was then treated with a pulsed thermal processing flashlamp or laser to change the band gap to fit the solar spectrum. This invention successfully synthesized different titania phases; it also modified the substrate to enable improved nanomechanical investigation of titania phases and synthesized titania.

Three strategies were used to yield strained titania: spontaneously formed titania nanoparticles, thin film approaches, and electrochemical oxidation. This approach makes it possible to identify the processes that might induce intrinsic tensile stress or facilitate the application of external strain to the phases. It also enhances current understanding of the fundamental mechanisms involved in stress-induced band gap engineering for nanostructured semiconductor materials.

Advantages

- Synthesis of select titania phases
- Method for shifting band gap of titanium oxides to fit the solar spectrum
- Enhanced nanomechanical investigation of titania
- Method is appropriate for thermally sensitive, low cost substrates

Potential Applications

- Autonomously powered systems that can operate unattended for extended periods
- Agile photovoltaics (using stressed semiconductors) and hydrogen generation applications
- Solar, hydrogen, and antibacterial applications
- Hydrogen-based transportation and other high energy density applications

Patent

Claus Daniel, Constantino Tsouris, Nickolay V. Lavrik, Panagiotis G. Datskos, Ronald D. Ott, and Viviane Schwartz, *Pulsed Photothermal Phase Transformation Control for Titanium Oxide Structures and Reversible Bandgap Shift for Solar Absorption*, U.S. Patent Application 12/889,478, filed September 24, 2010.

Lead Inventor

Claus Daniel
Materials Science and Technology Division
Oak Ridge National Laboratory

Licensing Contact

Alexander G. DeTrana
Technology Commercialization Manager,
Materials Science
UT-Battelle, LLC
Oak Ridge National Laboratory
Office Phone: 865.576.9682
E-mail: detranaag@ornl.gov

PARTNERSHIPS