Composite WO_3/TiO_2 Nanotubes for Solar Photo-conversion and Electrochromic Applications

Karla Reyes and David B. Robinson
Sandia National Laboratories
Livermore, CA

Nanostructured WO_3/TiO_2 composite materials have been developed, characterized and tested for solar photoconversion and electrochromic applications. This has resulted in a low-cost synthetic approach to prepare composite WO_3/TiO_2 nanotubes that can be detached from a Ti foil substrate and transferred to different substrates, including glass. SEM images show that these materials have the same ordered structure as TiO_2 nanotubes, with an external nanostructured WO_3 layer. Diffuse reflectance spectra show an improvement in the visible absorption relative to bare TiO_2 nanotubes and in the UV absorption relative to bare WO_3 films. Photo-electrochemical studies were conducted by employing these materials as photoanodes. Incident photon-to-current efficiency (IPCE) increased from 30% (for bare WO_3) to 50% (for WO_3/TiO_2 composites) and extended up to the visible region (575 nm). With the addition of methanol, a model organic pollutant, the photo-currents exhibited more than a 5-fold increase. Chemical oxygen demand (COD) measurements showed the simultaneous photo-degradation of methanol.

In addition, the materials were tested for electrochromic applications. The composite WO_3/TiO_2 nanostructures showed 10 times higher ion storage capacity and enhanced electrochromic contrast compared to pure WO_3 and TiO_2. The cycling stability of these composite nanostructures was superior compared with WO_3 films. The results of this work indicate that the unique structure and composition of these composites materials enhance the charge carrier transport and optical properties compared with the parent materials. In particular, these materials show a great potential for solar photoconversion including wastewater treatment and water splitting, in addition to electrochromic applications, including smart windows.

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.