Water Adsorption Properties of Titanium(IV) Oxide Embedded in Multiwalled Carbon Nanotubes (CNT)

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Abstract

Titanium(IV) oxide was embedded into carbon nanotubes through sonication. The water adsorption properties of the carbon nanotubes, titanium(IV) oxide and the titanium(IV) oxide embedded carbon nanotubes have been studied using near infrared spectroscopy and second derivative techniques. Each sample was evacuated, then exposed to 40% and 60% relative humidity to adsorb water molecules and the evolving adsorption near infrared spectra were studied. Adsorption properties were further studied by gravimetric analysis. Near infrared spectroscopy of titanium(IV) oxide showed a high water adsorption characterized by the presence of sharp peaks at 7169 cm^{-1} and 5282 cm^{-1} (first overtone of OH on the surface of titanium(IV) oxide and the combination frequency of the free water molecules respectively) . The CNT s showed no water adsorption. Titanium(IV) oxide embedded carbon nanotubes showed a peak at 5282cm^{-1} suggesting the inclusion of the titanium(IV) oxide in the CNT .Spectroscopic data and Scanning Electron Microscopic studies confirm that the titanium(IV) oxide has been embedded into the carbon nanotube samples. This conjugation can enhance the electronic and optical properties of TiO_2 which is advantageous in the water splitting and the solar cell applications. The water adsorption profiles show that the TiO_2 adsorbs more water at a relative humidity of 60% than at relative humidity of 40%. However, the titanium(IV) oxide embedded in CNTs loses its ability to adsorb water. Embedding of titanium(IV) oxide in CNT has altered the adsorption properties of pure TiO_2

Keywords: Carbon nano-tubes, Titanium(IV) oxide nanoparticles, Near Infrared Spectroscopy, Second derivative, Water adsorption