Mechanistic Aspects of Photoelectrochemical Polymerization of Polypyrrole on a TiO2 Nanotube Array

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Abstract

Hybrid assemblies based on conducting polymers (CPs) and inorganic semiconductors (SCs) are attractive materials from both scientific and technological perspectives. Intensive efforts have been devoted to assemble such hybrid materials with organized nanoscale architecture. In this study, the concept of light induced electrodeposition of CPs onto inorganic SCs has been extended to the TiO_2 nanotube array (NTA)/polypyrrole (PPy) hybrid. Development of the hybrid structure was monitored by SEM, and evidence for homogeneous distribution of the PPy component was demonstrated. The contribution of photoelectrochemical and electrochemical polymerization was assessed by chronocoulometry, applying different potential values during the potentiostatic polymerization procedure. Mechanistic aspects related to the contribution of light are also discussed, and conclusions are supported with UV-Vis data. Spectroscopic probes such as FT-IR and Raman spectroscopy confirmed the chemical identity of the components of the hybrid material. The hybrid assembly exhibited a quasi- reversible voltammetric behavior; however, the electroactivity showed a strong dependence on the synthetic procedure. The fact that both components are electroactive in the hybrid configuration suggests that these assemblies may be utilized in practical applications; for example, solar energy conversion and storage.

Keywords

Conducting polymers; semiconductor; hybrid; solar cell; supercapacitor