Bringing Conjugated Polymers and Oxide Nanoarchitectures into Intimate Contact: Light-Induced Electrodeposition of Polypyrrole and Polyaniline on Nanoporous WO_3 or TiO_2 Nanotube Array

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Journal of Physical Chemistry C Volume 116 Pages 19145-19155

Abstract

This proof-of-concept study focuses on the photocatalytic electrodeposition of two conducting polymers, namely, polyaniline (PANI) and polypyrrole (PPy), in two different nanostructured inorganic semiconductor host matrices, namely, nanoporous tungsten trioxide and nanotubular titanium dioxide. Oxide semiconductor (WO3 and TiO2) films were initially electrosynthesized on tungsten and titanium foils, respectively, by anodization at different voltages in fluoride-containing aqueous media. The conjugated polymer was electrografted onto the entire surface of the photoexcited oxide semiconductor matrix using potentiostatic and potentiodynamic deposition methods. The crucial role of initial photoelectrochemical deposition, preceding the electrochemical polymerization step, was demonstrated. The photoelectrodeposited and electrodeposited hybrid samples were compared from both morphological and electrochemical perspectives. Importantly, through application of the methodology presented in this article, deposition of electroactive polymers can be achieved homogenously, on both macroscale and nanoscale dimensions. The morphology and structural properties of these assemblies were evaluated by FE-SEM, ATR FT-IR, and Raman spectroscopy, whereas their electroactivity was characterized by cyclic voltammetry.