Synthesis, Characterization and Utilization of Metal-TCNQ Nanostructured Materials for water splitting

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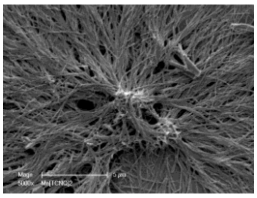
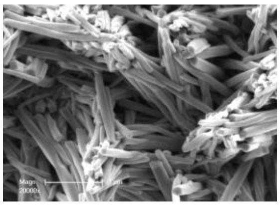
Abstract:

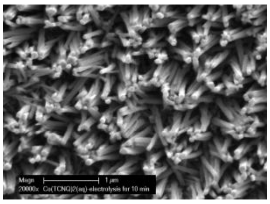
TCNQ-based molecular materials have potential applications in diverse areas such as, data and energy storage devices, organic field-effect transistors, electrochromic and magnetic devices, as well as photoanodes for water splitting and H_2 production. In this presentation, facile electrochemical approaches for the synthesis, characterization, and fabrication of morphology-tunable semiconducting/magnetic M[TCNQ]2-based materials (M = Mn, Fe, Co, Ni, Zn, and Cd) onto conducting (Pt, Au, GC) and semiconducting (ITO) electrode surfaces will be discussed. These approaches involve solid-solid phase transformations of TCNQ microcrystals, attached to an electrode surface, into the corresponding M[TCNQ]2-based materials when immersed in an aqueous solution of $M^{2+}_{(aq)}$ electrolytes and undergoing one-electron reduction to form the TCNQ- radical. The overall TCNQ/$M[TCNQ]_2(H_2O)_2$ conversion processes require the transfer of two-electron charge-transfer at the triple phase, electrode| $TCNQ/TCNQ^-|M^{2+}_{(aq)}$ junction, with a nucleation-growth rate-determining step. Characterization of these M[TCNQ]2-based materials via wide range of spectroscopic (IR, Raman), microscopic (optical, SEM, EDAX), as well as conventional and synchrotron-based XRD techniques will be highlighted. Importantly, different sizes (1-8 µm length) and morphologies (nanowires, nanorods, nanofibers, and flower-like architectures, see below) of the generated $M[TCNQ]_2(H_2O)_2$ materials are obtained depending on the identity of the incorporated $M^{2+}_{(aq)}$ ion (M = Mn, Fe, Co, Ni, Zn, Cd) and the method of TCNQ immobilization onto electrode surface. Significantly, this study provides an easy access for controlling the morphology and crystals size of the electrochemically generated $M[TCNQ]_2(H_2O)_2$ molecular materials, as well as their fabrication onto conducting and semiconducting substrates to suit their potential applications in photo-electrochemical devices for water splitting and Hydrogen production.



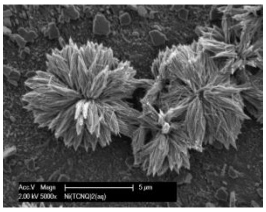
$Mn[TCNQ]_2(H_2O)_2$



$Fe[TCNQ]_2(H_2O)_2$



$Co[TCNQ]_2(H_2O)_2$



$Ni[TCNQ]_2(H_2O)_2$

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