

Electrochemical synthesis and characterization of thiophene conducting polymer in aqueous micellar medium

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Abstract

In opposite with the usually applied synthesis in organic media, the polymerization of bithiophene in aqueous media has been studied. The use of a non-ionic surfactant (polyoxyethylene octyl phenyl ether (Triton X-100)) is useful not only to solubilize the hydrophobic monomer but it is also important to incorporate various — biologically and catalytically active—additives. In this paper, the optimization of the polymerization conditions as well as the characterization of the electrochemical, spectral and mass exchange behavior of these composite films is summarized. The layers have shown imperceptible electroactivity in monomer-free aqueous LiClO_4 solutions, and electrochemical quartz crystal microbalance (EQCM) studies exhibited scarce ion movements, caused assumingly by the fact that the dopant species — moving together with their hydrate shell in the aqueous media—could not penetrate into the hydrophobic film. In contrast, nice reversible redox transformation could be obtained in organic medium such as acetonitrile, where—according to the EQCM results—the charge carrier formation/depletion is accompanied by the incorporation/removal of ClO_4^- anions. In this solution, the spectral changes have proved the transformation into the conducting state, connected to both mono- and dication forms. The incorporation of the surfactant has been demonstrated by the extraordinary surface morphology of the polybithiophene (pBT) films, characterized by scanning electron microscopy. The elementary composition of the curious shell-shaped objects, monitored by energy dispersive X-ray spectroscopy (EDX), evidenced the presence of Triton X-100 by the increased C/S ratio compared to neat polybithiophene, while the Cl/S data reflected the changes connected to the doping level as a consequence of ClO_4^- anion movements. Moreover, ex situ attenuated total reflectance (ATR) FT-IR measurements clearly showed the existence of C—O bonds, also proving the successful functionalization by the surfactant, built permanently into the redox active films.

Keywords: Polybithiophene, Non-ionic surfactant, Redox process, EQCM, SEM, Energy dispersive X-ray spectroscopy, FT-IR