

Fixation of laccase enzyme into polypyrrole, assisted by chemical interaction with modified magnetite nanoparticles: A facile route to synthesize stable electroactive bionanocomposite catalysts

B. Endrődi, A. Kormányos, O. Berkesi, C. Janáky, C. Visy

ELECTROCHIMICA ACTA

Abstract

Effective bio-electrocatalysts require stable immobilization of sufficient amounts of the bioactive component. In this study, a novel and efficient method for specific binding of laccase enzyme onto magnetite nanoparticles (NPs) is presented. The interaction between the chemically modified magnetite NPs and the enzyme was evidenced by both infrared (FT-IR) and X-ray photoelectron spectroscopy (XPS). Subsequently, the enzyme-coated magnetite NPs were successfully incorporated into polypyrrole matrix during galvanostatic electropolymerization. The encapsulation of laccase covered NPs was proved by EQCN, TEM, and FT-IR spectroscopy; whereas the electrochemical behaviour of the formed bionanocomposite was characterized by cyclic voltammetry. In oxygen saturated solution a cathodic charge surplus was observed, related to the electrochemical reduction of oxygen. This surplus was two times higher in the case of the laccase containing layer compared to its only magnetite containing counterpart. Kinetic aspects of the oxygen reduction reaction (ORR) on the laccase containing films were investigated by hydrodynamic voltammetry, and the four-electron route was found to be exclusive, which is promising from the fuel cell perspective. Such synergistic combination of inorganic NPs and enzymes may open new avenues in the application of these bio-nanocomposite materials.

Keywords: magnetite, laccase, polypyrrole, nanocomposite, oxygen reduction reaction