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Enhancement of catalytic activity of immobilized laccase for diclofenac biodegradation by carbon nanotubes

Ran Xu, Rongzhi Tang, Qijun Zhou, Fengting Li, Bingru Zhang*

State Key Laboratory of Pollution Control and Resource Reuse, College of Environmental Science and Engineering, Tongji University, Shanghai 200092, PR China.

Abstract

Laccase was immobilized on a novel conductive polyvinyl alcohol (PVA)/chitosan (CS)/multi-walled carbon nanotubes (MWNTs) composite nanofibrous membrane. Its stabilities and catalytic activity for diclofenac degradation were comprehensively investigated. Laccase was covalently immobilized on the surface of PVA/CS/MWNTs nanofibrous membranes with an average fiber diameter of 100–200 nm. Both enzyme loading and activity retention of the immobilized laccase were found to be significant higher on the nanofibrous membranes with MWNTs (907 mg laccase/g membrane, 76.7% of free laccase) than those without (862 mg laccase/g membrane, 63.5% of free laccase). Immobilized laccase on the PVA/CS/MWNTs nanofibrous membranes exhibited high stabilities, reuse capabilities and removal efficiency for diclofenac. Cyclic voltammetry measurements demonstrated that MWNTs enhanced the electrochemical capacitance of the nanofibrous membrane. It suggests carbon nanotubes may play a significant role on the enhancement of laccase activity immobilized on the nanofibers by improving electron transfer between the enzyme and substrate molecules.

Keywords: laccase; multi-walled carbon nanotubes; diclofenac degradation; enzyme immobilization; nanofibrous membrane

1. Introduction

In most industrial applications, immobilized enzymes, which feature recyclability and improved stability, exhibit greater application potential than their free forms. The catalytic behavior of immobilized enzymes strongly depends on the properties of their carriers, such as material types, structures, and compositions [1,2]. Among the