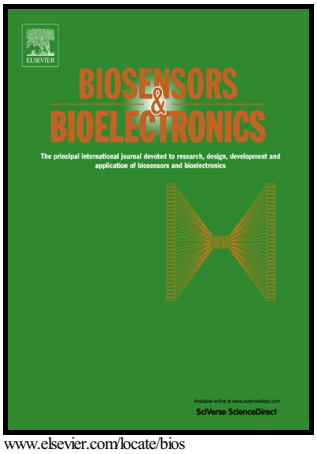

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High-sensitivity four-layer polymer fiber-optic evanescent wave sensor

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Abstract

We present a novel four-layer structure consisting of bottom, second, third, and surface layers in the sensing region, for a D-shaped step-index fiber-optic evanescent wave (FOEW) sensor. To reduce the background noise, the surface of the longitudinal section in the D-shaped region is coated with a light-absorbing film. We check the morphologies of the second and surface layers, examine the refractive indices (RIs) of the third and surface layers, and analyze the composition of the surface layer. We also investigate the effects of the thicknesses and RIs of the third and surface layers and the LA film on the light transmission and sensitivity of the FOEW sensors. The results highlight the very good sensitivity of the proposed FOEW sensor with a four-layer structure, which reached -0.077 $(\mu g/l)^{-1}$ in the detection of the target antibody; the sensitivity of the novel FOEW sensor was 7.60 and 1.52 times better than that of a conventional sensor with a core–cladding structure and an FOEW sensor with a three-layer structure doped with GeO_2. The applications of this high-sensitivity FOEW sensor can be extended to biodefense, disease diagnosis, and biomedical and biochemical analysis.

Keywords: Fiber-optic evanescent wave sensor; Four-layer structure; Canada balsam; GeO_2 nanoparticle; Sensitivity; Mouse IgG

1. Introduction

Fiber-optic evanescent wave (FOEW) sensors are based on the interaction of an analyte with an evanescent field of light through an optical fiber, and their measurements are not affected by the bulk solution because the penetration depth of the evanescent field is ten to several hundred nanometers (Vollmer and Arnold, 2008; Zhong et al., 2014). Furthermore, FOEW sensors are more sensitive than single-point attenuated total reflection (ATR) sensors because multiple reflections occur within a short sensing region (Amezcua-Correa et al., 2007; Wang and Wolfbeis, 2015). Thus, FOEW sensors, which are composed of polymer and silica optical fibers, have been widely applied in chemistry, biochemistry, the life sciences, and environmental research (Eggleton et al., 2011; Li et al., 2014;