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High sensitive and selective C-reactive protein detection by means of lossy mode resonance based optical fiber devices

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Abstract

This work presents the development of high sensitive, selective, fast and reusable C-reactive protein (CRP) aptasensors. This novel approach takes advantage of the utilization of high sensitive refractometers based on Lossy Mode Resonances generated by thin indium tin oxide (ITO) films fabricated onto the planar region of D-shaped optical fibers. CRP selectivity is obtained by means of the adhesion of a CRP specific aptamer chain onto the ITO film using the Layer-by-Layer (LbL) nano-assembly fabrication process. The sensing mechanism relies on resonance wavelength shifts originated by refractive index variations of the aptamer chain in presence of the target molecule. Fabricated devices show high selectivity to CRP when compared with other target molecules, such as urea or creatinine, while maintaining a low detection limit (0.0625 mg/L) and fast response time (61 sec.). Additionally, these sensors show a repetitive response for several days and are reusable after a cleaning process in ultrapure water.

Keywords: Biosensors; C-reactive protein; Optical fiber; Lossy Mode Resonance; D-shaped;

1. Introduction

C-reactive protein (CRP) is an acute-phase protein of hepatic origin found in blood plasma. CRP concentration level rise up to three orders in response to inflammation (Cem and Irving, 1999; Thompson et al., 1999). CRP measuring is not specific for any condition but it is a fairly sensitive biomarker of inflammation and has been proven very useful in determining disease progress as well as the effectiveness of treatments in inflammations, infections, tissue necrosis, surgery, burns, cancer, cardiovascular diseases or coronary heart disease risk (Danesh et al., 2004; Lau et al., 2005; Llombart et al., 2013; Pepys and Hirschfield, 2003). Thus, CRP has emerged as an effective disease biomarker in human body with an even more sensitive and accurate reflection of the acute phase response than the ESR (Erythrocyte Sedimentation Rate) in some cases (Liu et al., 2013).

The median concentration of CRP is 0.8 mg/L and always less than 12 mg/L in apparently healthy individuals with higher values in elder people. In particular, the risk of developing cardiovascular disease has been quantified as low below 1.0 mg/L, as average between 1.0 and

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