EFFECT OF THE BUFFER LAYER THICKNESS ON SPR D-SHAPED POF SENSORS IN CHEMICAL APPLICATIONS BASED ON MIPS

Letizia De Maria[1], Maria Pesavento[2], Nunzio Cennamo[3], Paola Zuppella[4], Luigi Zeni[3]*

1 RSE S.p.A, via Rubattino 54, Milan, Italy
2 University of Pavia, via Taramelli 12, Pavia, Italy
3 University of Campania "L. Vanvitelli", Aversa,Italy
4 IFN – CNR via Trasea 7, 35131 - Padova
**letizia.demaria@rse-web.it*

An investigation for optimizing the buffer layer thickness in SPR sensors to operate in the refractive index range used for chemical industrial applications with MIPs.

Keywords: SPR sensors, chemical detection.

Abstract

SPR platforms based on D-shaped plastic optical fibres (POFs) combined with receptors (bio or synthetic) have been proposed as simple and low-cost solutions for chemical sensing of different substances, from big proteins to industrial chemical markers in different fields [1,2]. For example, an SPR-POF platform combined with a molecular imprinted polymer (MIP) has been successfully applied for chemical detection of a degradation marker of the insulating paper in transformers oil (2-furaldheide, 2-FAL), overcoming problems of sample pretreatment [2].

This D-shaped SPR–POF platform is based on a multilayer configuration consisting of a buffer layer, which can be a photoresist of high refractive index, a thin metal film (typically 60 nm thick) and a sensing over-layer, which behaves as chemical receptor. Several investigations have been performed to optimize the multilayer structure for improving the SPR detection in view of a specific application. For example, in [3] a bimetallic layer was proposed to simplify the manufacturing of SPR platforms, in [4] the use of SPR sensors with different metal layers was assessed for multi-analyte detection in a cascaded configuration using only one spectrometer. Alternatively, in [5] a comparative analysis of two SPR-POF sensing platforms, based on two different types of photoresist buffer layers (SU-8 3005 and S1813) has been reported for high refractive index applications.

This paper deals with the performances of SPR platforms as a function of the buffer layer (S1813) thickness.

A family of SPR platforms have been prepared by dropped the same Microposit S1813 photoresist (about 0.1 ml) and by different spinning rates to produce differently thick buffer layers. These platforms have been tested by different water-glycerol solutions. The experimental results obtained for the considered SPR platforms are reported in Figure 1. From Figure 1 it emerges that for low refractive index range the sensitivities are comparable: the effect of the buffer layer thickness is negligible. On the contrary, in the high refractive index range, the sensor's sensitivity increases when the thickness of the photoresist layer decreases; therefore the thickness of the photoresist layer it is of overwhelming importance for optimizing sensor's performances for high values of the refractive indices (higher then 1.39). This result is important because when an MIP receptor is used, the refractive index in contact with the gold layer is higher then 1.39, due to the high refractive index of the polymer.

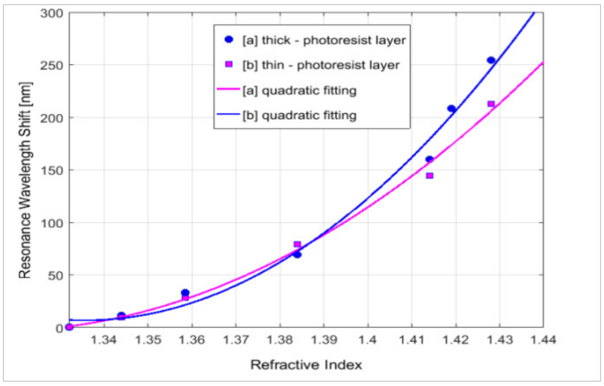

Fig.1 Resonance wavelength variation vs refractive index measured for two SPR-POF by different photoresist buffer layers, sensors, obtained under the gold film: experimental data (diamond and square dots) and quadratic fitting (curves).

These experimental results are in good agreement with the numerical results obtained by an N-layer model, used to simulate SPR spectra as a function of refractive index of the dielectric in contact with the gold layer, for different thickness of the photoresist buffer layer.

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