COLORIMETRIC RESONANT IMMUNODETECTION IN PHOTONIC CRYSTALS

D.A. Kopylov[1], I. Kolmycheck[1], T.V. Murzina[1], A. Giannetti[2], S. Tombelli[2], S. Berneschi, S. Soria[2], F. Baldini[2]
[1]Department of Physics, Moscow State University, 119991 Moscow, Russia
[2]IFAC-CNR, "NelloCarrara" Institute of Applied Physics, via Madonna del Piano 10, 50019 Sesto Fiorentino, Florence, Italy

Porous silicon photonic crystalline structures were studied as optical sensors for different proteins. Periodic porous silicon (P-Si) structures were fabricated by electrochemical etching of p-type Si <100>. The layers were formed parallel to the surface of the silicon plate with macropores (70-90 nm) and mesopores (30-50nm) in layers of low and high porosity, respectively. We studied P-Si based microcavities (MC), with MC layers of high and low porosity, between Bragg mirrors composed of several layers (15 to 20) with alternating porosity. After the fabrication, we tested different thermal oxidation procedures in order to minimize the baseline drift in the sensor response.
We have measured the temporal baseline drift of samples soaked in phosphate buffered saline buffer for different thermal oxidation (TO) procedures: 1 step annealing at low temperature (20 min at 400°C); 3 step annealing (20 min at 400°C, 30 min in a ramp of 400°C to 900°C, an 3 min at 900°C); 2 step annealing (20 min at 400°C and 10 min at 900°C). We have studied two time ranges: (i) a 3h period, equivalent to the incubation time of the immunoassay and (ii) overnight. The samples oxidized at low temperature showed the highest spectral drift for both periods of time and in some of the samples we even observed a loss of signal due to the structural collapse of a PC due to the PSi thin layer. Negligible shifts were observed in the other two TO procedures, which prove that the fabricated silicon oxide layers that covers the inside pores' surfaces is thick and stable enough to prevent the porous PSi photonic crystal structure from the destructive influence of the saline buffer. Thus we chose the latter two TO procedures for our samples.
Finally, we have optically verified PSA-antiPSA interactions as a shift in the reflectivity spectrum of P-Si MC [1].

[1] I.A. Kolmychek, D. A. Kopylov,T.V. Murzina, F. Baldini, S.Berneschi, D. Farnesi, A. Giannetti, S. Tombelli, G. Nunzi Conti, and S. Soria, Impact of termal oxidation, surface chemistry and porous silicon morphology for sensing applications. Proc. of SPIE (2013). 8627 , art. no. 86271E.