Enhanced Sensitivity of Silicon-On-Insulator Surface Plasmon Interference Biosensors with Additional Silicon Top Layer

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I. Introduction

Recently we have proposed a highly integrated and sensitive surface plasmon interference (SPI) sensor based on silicon-on-insulator (SOI) technology [1]. It was demonstrated that the device could achieve a sensitivity of 463.5 nm/ RIU (refractive index unit). However, the sensitivity of the sensor is relatively low and thus an improvement to be competitive to the-state-of-the-art devices is needed. In this work, we found that an enhanced sensitivity of the SPI sensor can be obtained by adding a silicon layer on top of the Au layer.

II. Enhanced sensitivity by additional Si top layer

The sensitivity is strongly dependent on the group index difference of the top and bottom SP modes of the interferometer. The difference between the group indices (Δn_g) becomes smaller, the sensitivity becomes substantially larger. To improve the sensitivity, one of the best options is making the two modes more alike, which can be accomplished by adding a thin Si layer on top of the Au layer.

The investigated structure has a 70-nm-thick Au layer embedded into a 220-nm-thick silicon membrane with 90-µm-length sensed area. By changing the refractive index of the 45-nm-thick adsorbed layer, we monitor a shift of transmission minima in the transmission spectra to calculate the sensitivity of the sensor. We found that the highest sensitivity is 6150 nm/RIU (refractive index unit) with a corresponding refractive index of the adsorbed layer of 3.476 as seen in Fig. 1. This index is the one of Si, again giving evidence for the theory that making the interferometer more symmetrical is the reason for the improvement.

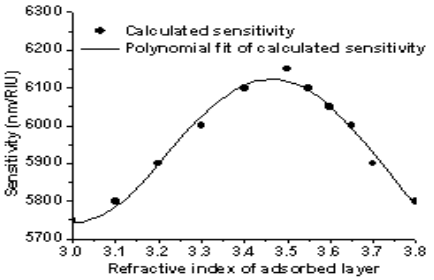

Figure 1. Sensitivity of the sensor with respect to refractive index of adsorbed layer.

III. Conclusion

In this contribution, we have theoretically proposed the utility of the Si top layer to make the interferometer more symmetrical to enhance the sensitivity of the surface plasmon interference biosensor on silicon-on-insulator.

References

[1] P. Debackere, S. Scheerlinck, P. Bienstman, and R. Baets, *Surface plasmon interferometter in silicon-on-insulator: novel concept for an intergrated biosensor*, Opt. Express, vol. 14, pp. 7063-7072, 2006.

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