Surface Plasmon Resonance Sensors: Optimization of Diffraction Grating and Prism Couplers

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Abstract

Surface plasmon resonance (SPR) sensors proved themselves as a promising device for many kinds of applications such as optical biosensing [1], binding constant determination [2] or nanofilm thickness measurements [3]. Here we simulate using COMSOL Multiphysics® the light-polaritons coupling for the two most commonly used SPR setups: Attenuated total reflection (Kretschmann configuration) and diffraction gratings as shown in Figure 1. Furthermore, we illustrate a comprehensive designing rule to determine the parameters for optimizing the generation of surface plasmon polaritons (SPP) for the both setups i.e. grating couplers and Kretschmann configuration. Moreover, a computational analysis are demonstrated for three detection methods: Resonant angle (Figure 2), Resonant wavelength (Figure 3) and Thickness of metal (Figure 4), in SPR sensors for both the SPR setups.

Reference

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Figures used in the abstract

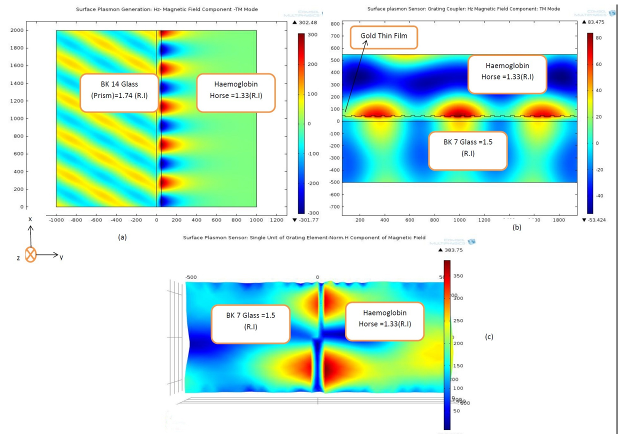

Figure 1: (a) Surface Plasmon Polariton (SPP) generation for a transverse magnetic mode (TM). XY: plane of incidence; Z: polarization direction; X: direction of propagation of the generated SPP. The Hz component is shown. (b) Surface Plasmon Resonance through a grating coupler with 23 grating element with a period of 580nm. The Hz component is shown (c). Surface plasmon Resonance demonstration through single element with Floquet periodic boundary condition with a period of 580nm. The norm of the magnetic field H is shown. R.I. stands for Refractive Index.

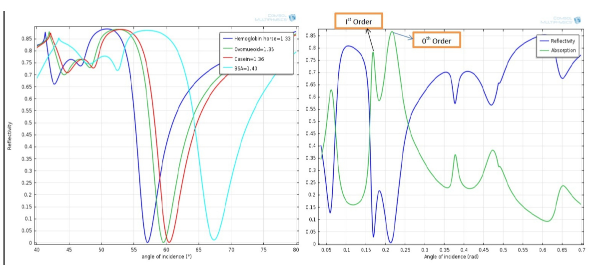

Figure 2: (a) Reflectivity as a function of the angle of incidence calculated at 632nm (Helium Neon Laser). Various proteins (refractive indexes) taken from human and animal blood samples were considered [4] in Kretschmann configuration. (b) Reflectivity and absorption as a function of the angle of incidence when fibronogen (FIB) was considered [5] in grating couplers.

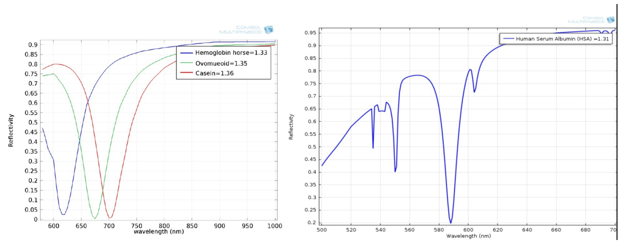

Figure 3: (a) Reflectivity as a function of wavelength calculated for various proteins taken from human and animal blood sample [4] in Kretschmann configuration. (b) Reflectivity as a function of wavelength human serum Albumin taken from human blood sample [5] in grating couplers.

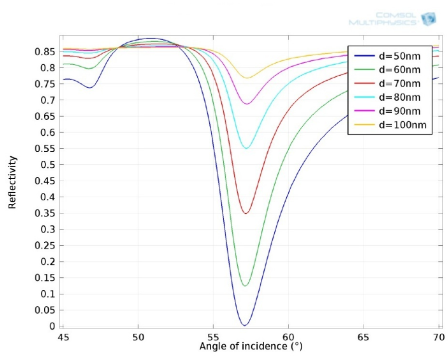

Figure 4: Reflectivity as a function of the thickness of the metal (d) with respect to the incidence angle calculated for the fibronogen protein (FIB) taken from human blood sample [5] in in Kretschmann configuration .