DISPERSION RELATION ANALYSIS OF BLOCH SURFACE WAVES AND SURFACE PLASMON POLARITONS USING TOTAL INTERNAL REFLECTION ELLIPSOMETRY

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Electromagnetic surface waves (SW) have been extensively used for various optical sensing. One of the most commonly known and used SWs is the surface plasmon polariton (SPPs) propagating at metal dielectric interface. Surface plasmon polaritons are widely used in optical sensors such as biosensor application [1, 2] due to high sensitivity of such type SW. Some proteins are not biocompatible with metal surfaces, therefore alternative methods are developed. Here comes handy another type of surface waves - Bloch surface wave (BSW) generated at the interface of periodic dielectric structure (photonic crystal) and surrounding media (dielectric) [3]. Bloch surface waves can be tuned in wide spectral range by adjusting the materials and period of the photonic crystal (PC). Due to low losses in the dielectrics the BSW can propagate for long distances. Another advantage of BSW is that it can be excited in both TE and TM polarization, thus allowing us to investigate changes of polarization states. Since there are not many techniques allowing us to investigate polarization and phase changes, we use spectroscopic ellipsometry measuring technique. In order to excite SPP or BSW a glass prism or grating as a coupler to achieve conditions of total internal reflection (TIR) is used. TIR configuration is commonly used in biosensing application as it allows to measure protein interaction without light propagation through liquids, removing additional noise from the system. By combining advantages of TIR and spectroscopic ellipsometry with ability to simultaneously measure the amplitude and phase changes, we get total internal reflection ellipsometry (TIRE) technique.

The aim of this study was to investigate the optical dispersion relations of SPPs and BSWs resonances and analyze their sensitivity to the refractive index changes of ambient medium. The total internal reflection ellipsometry (TIRE) method was employed for excitation and study of SPP and BSW dispersion curves [4]. For excitation of SPP a model consisted of BK-7 glass substrate, 1 nm Cr and 45 nm Au layers was used. Meanwhile, for the BSWs generation a BK-7 glass substrate with PC consisting of 6 bilayers of TiO_2 (60nm) and SiO_2 (110 nm) with single 30 nm TiO_2 layer on top model was used. In this study we present numerical calculations of SPPs and BSWs dispersion relations, the differences of dispersion curves due to changes of refractive index of the medium and sensitivity of ellipsometric parameters Ψ and Δ of such optical sensors. The evaluation showed that SPP was more sensitive in resonance wavelength displacement $\delta\lambda$/RIU (refractive index unit) than BSW. As BSW had a higher sensitivity $\delta\Psi$/RIU and $\delta\Delta$/RIU for ellipsometric parameters Ψ and Δ rather than SPP.

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