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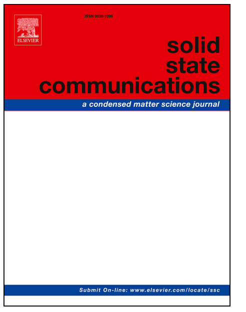

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Analyzing the Effect of Graphene's Chemical Potential on the Performance of a Plasmonic Sensor in Infrared

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Abstract

SPR sensor based on 'glass substrate-Ag film-insulating layer-graphene' plasmonic structure is proposed in the NIR region. The influence of graphene chemical potential (μ) on the sensor's performance, measured in terms of figure-of-merit (FOM), has been analyzed in detail. The analysis suggests that the variation of chemical potential does not affect much the detection sensitivity and detection limit but it affects the FWHM of SPR curve. The variation of FOM with μ follows a certain pattern. In summary, the maximum and almost constant sensing performance may be achieved for $0.9 < \mu < 1$ eV for graphene monolayer. Also, CaF_2 substrate provides much better FOM compared with 2S2G and Si substrates at any value of μ.

Keywords

Plasmon; Graphene; Sensor; Chemical Potential; Figure of Merit.

1. Introduction

Surface plasmon resonance (SPR) occurs when electron density excitations are set-up due to coupling of p-polarized electromagnetic (EM) radiation with the surface plasmons (SPs) propagating along a metal-dielectric interface [1, 2]. These excitations, also known as the surface plasmon polaritons (SPPs), can be achieved by the Kretschmann-Raether attenuated total reflection (ATR) configuration [1, 2].

Among several applications of SPR, the biosensing requires that the detection of biosamples is carried out in a non-destructive manner. The biosamples are nearly transparent when exposed to infrared (IR) wavelength causing much smaller photodamage compared with the visible wavelength [3]. Moreover, bio-detection in IR is able to provide many other key advantages such as improved sensitivity [3], lower power requirements [4], and deeper penetration depth *etc.* [3-5].

The selection of suitable materials for utilization in SPR sensor is an important step. In this context, materials like silica, fluoride, and tellurite glasses *etc.* have been studied in visible and IR spectral regions [6]. However, chalcogenide (ChG) glasses, which are based on the group IV materials containing chalcogens (S, Se, and Te) as one of elements and formed with the addition of other elements such as Ge, As, and Ga *etc*. possess favorable optical properties in NIR. Apart from several device applications [7, 8], favorable properties such as transparency in infrared (IR) region, high refractive index (RI), higher chemical and thermal stability, and low phonon energy have led ChG glasses to be used as substrate material for SPR-based sensors [9, 10].