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Tailoring the transmission and absorption spectra in a graphene-dielectric multilayer system for Lorentzian profile in the chemical potential

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ABSTRACT

In this work, we show how to modulate the transmission, reflection, and absorption spectra of a dielectric-graphene multilayer structure, by tailoring the profile on the chemical potential of the graphene sheets, through a discrete Lorentzian profile for the chemical potential (μ_g) as a function of the depth of the proposed structure. Whereas the reflection spectrum is slightly affected with the stack of graphenes, but transmission and absorption spectra are modulated in a frequency region where there is no absorption as compared to a single or multilayer system with constant μ_g. Additionally, we develop and test an analytic expression that predicts the asymptotic behavior for transmission and absorption for different numbers of graphene sheets, dielectric host media, incident angle, and light polarization. Finally, we explain the physical differences between the spectra obtained for TM and TE polarizations of the incident light on the structure.

1. Introduction

Electromagnetic waves propagation in periodic [1,2] and aperiodic [3–5] structures has been an essential subject of research since the last century, due to the ability of such systems to modulate the flow of light. For instance, these structures can be designed to have a wide stop-band (or pass-band) range of frequencies where the electromagnetic waves cannot be propagated (or can be fully propagated), which is suitable for the applications in optical filters [6], waveguides, among others [7,8]. Another type of multilayer structures are the dielectric-metal stacks. In this case, the absorption of the metallic layers plays an important role in the photonic structure, and the optical response is strongly modified in comparison with a nonabsorbent superlattice [9,10]. Similarly, multi-structured systems where the constituent layers follow a profile modulated with different physical parameters that characterize the material have been studied by several groups [11–16]. For example, Tung et al., reported the electronic proprieties of a multilayer semiconductor system for a Gaussian profile in the concentration of carriers [11]. Through this modification, they showed that the desired pass-band or stop-band of the structure can be obtained. Yamada et al., showed a method based on the inverse Fourier transform of the refractive index in order to design an optical filter [12]. Moreover, our research group has shown the possibility to

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