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Study of the optical properties of dielectric-graphene-dielectric multilayer quasi-periodic structures: Thue-Morse case

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ABSTRACT:

Potential applications in optoelectronics had generated a great interest on the study of graphene optical properties. Along with this, graphene has exceptional properties such as high mobility and optical transparency, flexibility, mechanical robustness, etc. Due to these properties, graphene could be used in different devices such as transparent conductors, organic light-emitting diodes, photodetectors, touch screens, saturable absorbers and ultrafast lasers. A transfer-matrix method is used in order to calculate graphene optical properties, such as transmission, and absorption in the infrared region. The quasi-periodic structure consists in intercalated graphene sheets between two consecutives dielectrics. The dielectric materials follow the Thue-Morse sequence (ThMo). The graphene sheets are described by the optical conductivity considering interband and intraband transitions. The structure of the spectra depends strongly on the number of sequence generation, width of the different dielectrics and dielectric permittivity. In our case, the infrared region corresponds to a chemical potential greater than kT. In the calculated spectra, the geometrical properties of the Thue-Morse sequence can be observed. We obtain absorption bands well defined.

1. Introduction

Since graphene was discovered, it has aroused great interest because of its superlatives properties such as charge carriers exhibit giant intrinsic mobility, high transparency, linear dispersion, band gap zero, mechanical robustness and environmental stability, absorption of electromagnetic radiation independent of frequency, as well as support of various physical phenomena such as the Klein effect, minimum conductivity, fractional quantum Hall effect, among others [1-5]. The optical properties of graphene have been extensively studied by different research groups, as can be seen in the revision work developed by Bonaccorso [6] and Berardi [7]. Graphene applications in photonics range from optoelectronics, photovoltaic devices, transparent conductors, light-emitting devices, photodetectors, touch screens, flexible smart windows, ultrafast lasers, optical limiters, optical frequency converters, to terahertz devices. For all these devices graphene is a very good and attractive choice, since it has high conductivity, transparency, flexibility and economic advantages. These features can naturally replace the ITO (Indium Tin Oxide), which is widely used