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Transmittance and Absorption Properties of Graphene Multilayer Quasi-periodic Structure: Period-Doubling case

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ABSTRACT

Graphene is a two dimensional material of special interest due to its unusual electronic, mechanical, chemical, optical among other properties, which suggest a wide range of applications in optoelectronics, computer, ecology, etc. The study of the optical properties of graphene is important due to its potential applications such as ultrafast photonics, optical filters, composite materials, photovoltaics and energy storage device. In this work we study the transmission and absorption properties of a quasi-regular multilayer dielectric-graphene-dielectric system. The multilayer structure is built on the quasi-regular Period-Doubling (PD) sequence. The optical response of graphene takes into account intra-band and inter-band transitions. We use the transfer-matrix method to calculate the transmission and absorption spectra. It is obtained a strong dependence on the number of layers in the system, the width of dielectric media and the optical contrast. Furthermore, we calculate the spectra for both transverse magnetic (TM) and transverse electric (TE) polarization in the infrared region.

1. INTRODUCTION

Graphene is a two dimensional material with special characteristics such as high strength, flexibility, mobility of charge carriers and transparency. Graphene also has a low-energy linear dispersion relation with zero forbidden gap between the valence and conduction bands, frequency-independent absorption of electromagnetic radiation, as well as a variety of physical phenomena, such as Klein effect, minimum conductivity, fractional quantum Hall effect, among others [1] . Due to its unusual electronic, mechanical, chemical, optical properties [2], graphene is an ideal material for a wide range of applications, particularly in electronics [3] and optoelectronics [4, 5]. Nair et. al. [6] show that the transmittance is only function of the fine structure constant and found that the transmission amplitude is 97.7% independent of frequency. This result is very important because it relates a macroscopic transmission with a universal constant. There are different studies about the graphene optical properties [6-10] and their applications in photonics and optoelectronics such as optical filters, modulators, light-emitting, photodetectors devices and solar cells [4, 5, 11-14].
The study of the transmission properties of a unidimensional photonic crystal with graphene sheets inserted between each pair of dielectrics reports that the band structure depends on the