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Multi-band Circuit Model of Tunable THz Absorber Based on Graphene Sheet and Ribbons

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Abstract

Terahertz (THz) absorbers due to the high potential of providing reliable applications in modern devices and technology are increasingly being investigated. Recently, a dual-band THz absorber based on a graphene sheet and ribbons has been proposed in which the results were obtained using Full-wave simulations and its authors have not provided any specific design method. In this work, we have proposed and investigated that tunable THz absorber by its circuit model. A developed transmission line method beside the analytical circuit model of graphene continues sheet and periodic arrays of graphene ribbons are used to obtain analytical expressions for the circuit model. Here, first of all, we have compared the results of the proposed method with the results of that paper and secondly, using impedance matching concept we have proposed multi-band tunable THz absorber with near-unity absorption by the same structure. Then, we have compared the results of our circuit method with the Full-wave simulations. In either case, our proposed method in addition to excellent performance in terms of runtime and memory sources, has an acceptable agreement with the results of the Full-wave simulations. The proposed method is general and can be applied to design and simulate the other sub-wavelength structures.

Keywords: Circuit Model, Transmission Line Method, Terahertz, Absorber, Graphene, Multi-band

1. Introduction

Nowadays, the essential element required on a wide range of electromagnetic devices called “Absorber” has faced a lot of interest in a wide range of frequency spectra including Microwaves (roughly from 0.3 GHz – 300 GHz) and Terahertz (roughly from 0.3 THz – 10 THz) frequency range [1]. The design of electromagnetic absorbers became easier by using the sub-wavelength artificial composite materials called “Metamaterial”. So, metamaterial absorbers have attracted considerable attention in both microwave and terahertz frequency range. Radar absorbing materials, electromagnetic interference and also radar cross section reduction are among the applications of microwave absorbers [2]. Some authors have used different geometric structures to design an absorber [3-5]. For instance, Circular rings [3], Multilayer [4], and periodic resistive surface [5] structures have been proposed to work at microwave frequency band. At higher frequencies, due to the high-quality and high-frequency applications of the THz technology, metamaterial absorbers have faced an explosion of research [6-7]. Solar cells, biosensing, thermal emitters, imaging, and communication devices are among the well-known applications of the THz metamaterial absorbers [8-10]. Some researchers have inspired the microwave