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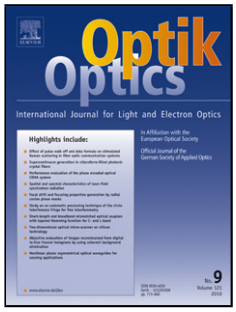

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Authors: Di Wu, Jinping Tian

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Study on the plasmonic characteristics of bow-tie type graphene-coated nanowire pair

Di Wu[2], Jinping Tian[1, 2, †]

[1] *College of Modern Education and Technology of Shanxi University, Taiyuan 030006, P. R. China*
[2] *College of Physics and Electronics Engineering, Shanxi University, Taiyuan 030006, P. R. China*

Abstract: A novel plasmonic waveguide composed of graphene-coated dielectric bow-tie type nanowire pair is designed in this paper. The finite element method (FEM) is used to study the dependences of the modal performances on the geometry and electromagnetic parameters. Simulation results show that strong enhancement of the optical field can be confined in the gap region formed by the bow-tie type nanowire pair coated by graphene. The minimum value of normalized mode area approaches to an order of 10^{-7} magnitude. Moreover, it has a good tolerance to practical fabrication errors. Thanks to these excellent optical characteristics, this kind of graphene based plasmonic waveguide can be used to fabricate various functional optoelectronic devices for the future nanoscale photonic integrated circuits and biosensors.

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Key word: Graphene; plasmonic waveguide; integrated photonic devices.

1 Introduction

Traditionally, people often use surface plasmon waveguides (SPWs) in guiding or modulating optical signals with the help of surface plasmon polaritons (SPPs), which can be excited and propagated along the interface of noble metal and dielectric medium. Graphene, known as a type of two dimensional material of which the carbon atoms are packed in honeycomb like crystal lattice[1, 2], has attracted particular attention in recent years due to its remarkable electronic and optical properties. In recent years, it has been widely studied as promising material to build highly integrated plasmonic devices and systems from near-infrared to terahertz regime [3-18]. Compared with the traditional noble metals, graphene has some major advantages [3], such as extremely low loss, extremely compact mode confinement and dynamic tunability of its surface conductivity. The tunability is often achieved by changing the carrier density which can be adjust with the help of external gate voltage or chemical doping. Owning to these unique properties, graphene has been considered to be a powerful alternative to other materials in realizing integrated nano-scale photonic functional devices, such as filters [4], lenses [5], absorbers [6], switches [7], and other types of waveguides [8-13]. Meanwhile, by using the technique of Chemical Vapor Deposition (CVD) and taking advantage of van der Waals forces, several experiments reveal that a graphene layer can be effectively covered on different types of dielectric waveguide structures to form graphene-coated microfibers, nanowire waveguides [8–9] and slab waveguides [10-13]. Then, the graphene surface plasmon polaritons (GSP) can be excited and propagated in these waveguide structures. In Ref. [14], the authors show that the field enhancement in the slot region of the graphene-coated nanowire pairs can be about six orders' magnitude larger than that in silver nanowire pairs. Similar investigation can be also found in Ref. [15-17].

In this paper, we propose a graphene-based surface plasmon waveguide structure, and which is composed of two graphene-coated triangular dielectric nanowires placed as bow-tie type. The numerical simulation results indicate that stronger optical field confinement and lower propagation loss can be obtained. Hence, the proposed waveguide structures may have potential

† Jinping Tian is the corresponding author with e-mail: tianjp@sxu.edu.cn

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