High-Performance Tunable Multichannel Absorbers Couple with Graphene-Based Grating and Dual-Tamm Plasmonic Multilayer Structures

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Abstract

We present a tunable multichannel absorbers in a hybird optical Tamm system at near-infrared frequencies. The simulation results reveal the structure capable of exciting four perfect absorption peaks, which are generated by two types of resonance, namely a guide-mode resonance (GMR) in a graphene-based grating and optical resonance induced by Tamm states in metal-photonic crystal heterostructure-metal (M-PCH-M) composites based on transfer matrix theory (TMT). The numerical and theoretical studies show that the strong coupling between the two modes gives rise to mode hybridization by adjusting the grating period. Coupled mode theory (CMT) has been employed to explain the strong coupling phenomenon. Furthermore, the active modulation of the GMR-based peak can be manipulated discretely by tuning the polarization angle or continuously by changing the chemical potential of graphene. The presented optical absorption filter is going to satisfy high level of effectiveness when developing perspective high-performance optoelectronic devices including modulators, switches, solar cells, thermal radiation and wave filters.

Full Text

Figures

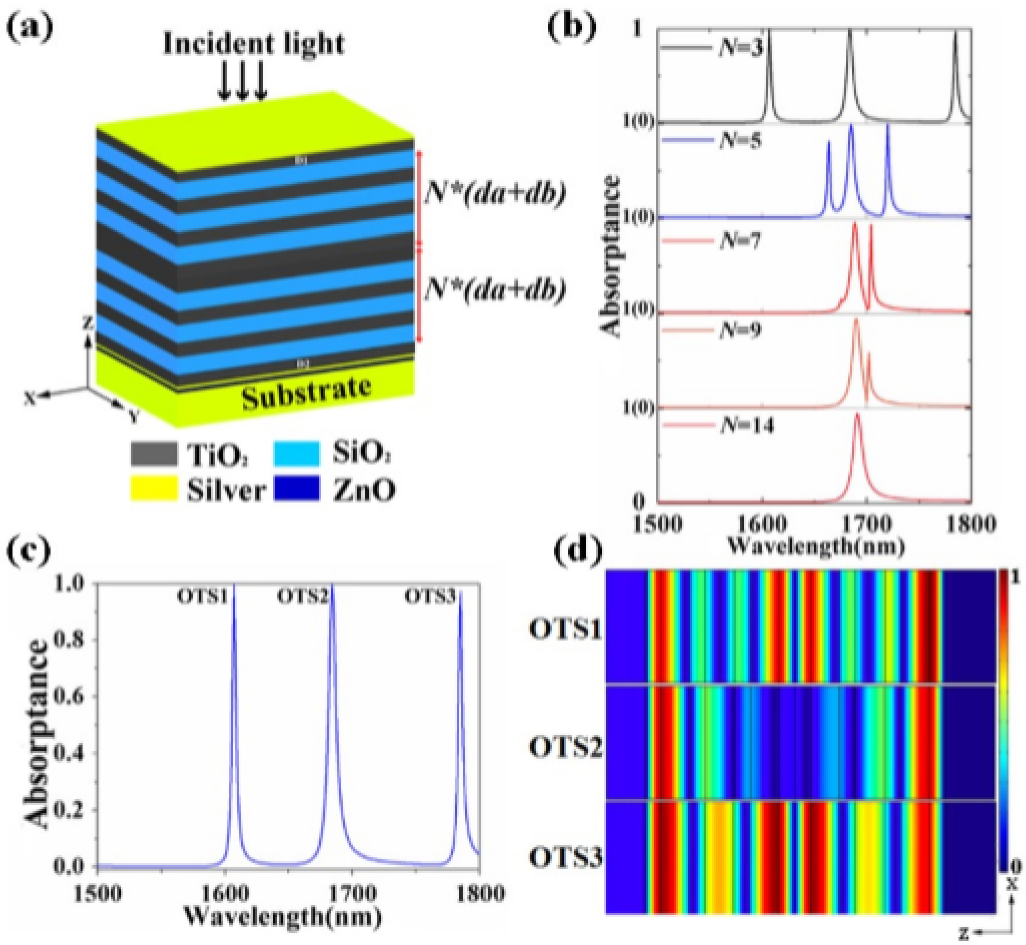

Figure 1

(a) Schematic diagram of the structure composed of upper silver film/PHC/lower silver film/ZnO/silver substrate; (b) The two side peaks can be eliminated by increasing the number of layers N of the dual photonic crystal; (c) The three perfect absorption peaks were realized for the depicted structure when N=3; (d) The electric field distributions for the three peaks corresponding to TPP modes: OTS1, OTS2, OTS3.

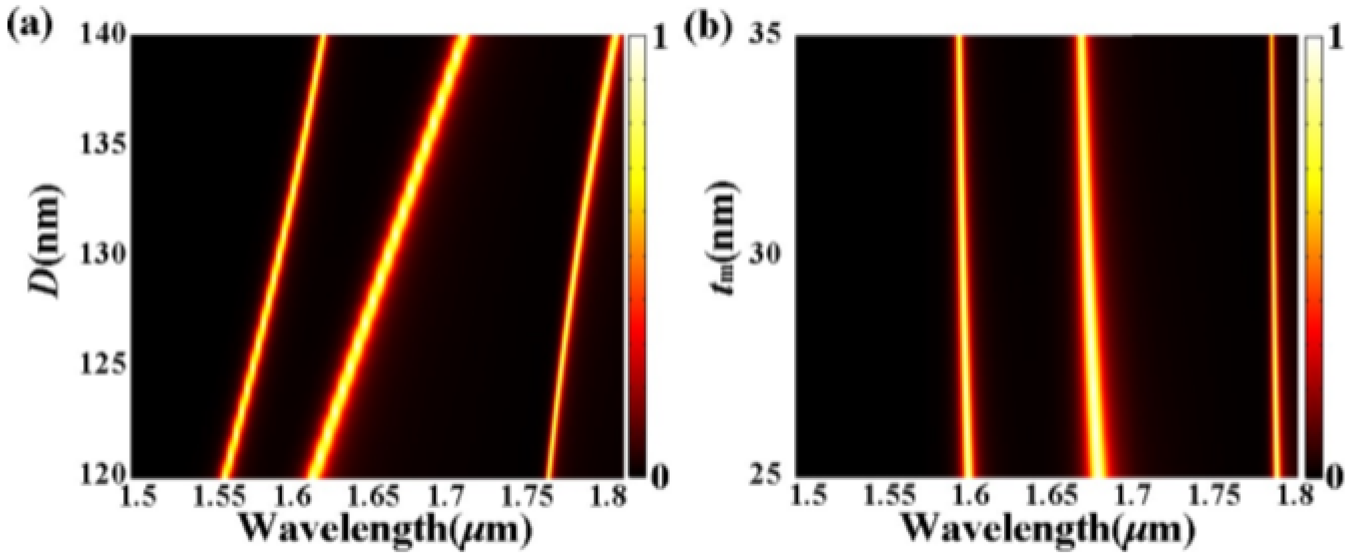

Figure 2

Spectral diagrams determine the absorptance peak positioning depending on: (a) the thickness D and (b) tm.

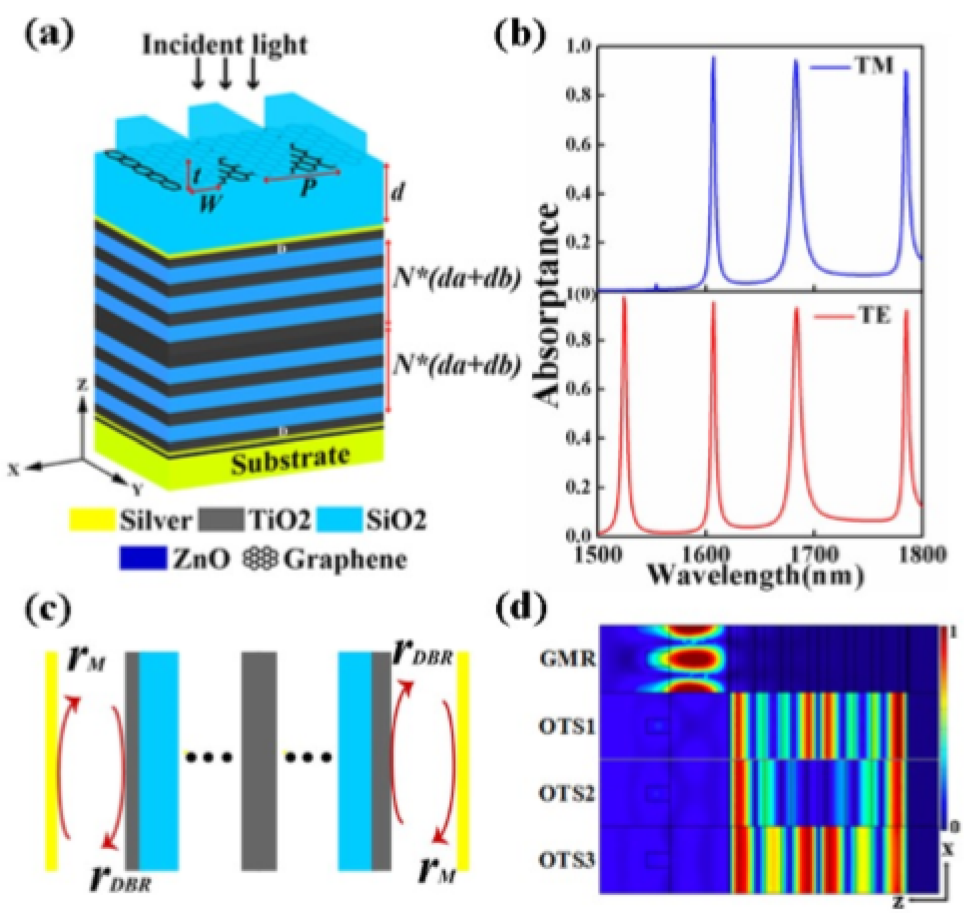

Figure 3

(a) Three-dimensional schema of of the multichannel absorption filter; (b) Absorption spectra when incident with TM and TE polarization respectively; (c) shows two identical cavities, both wrapped by silver film and DBR; (d) Electric field magnitude for the GMR and for three TPP modes when incident with TE polarization.

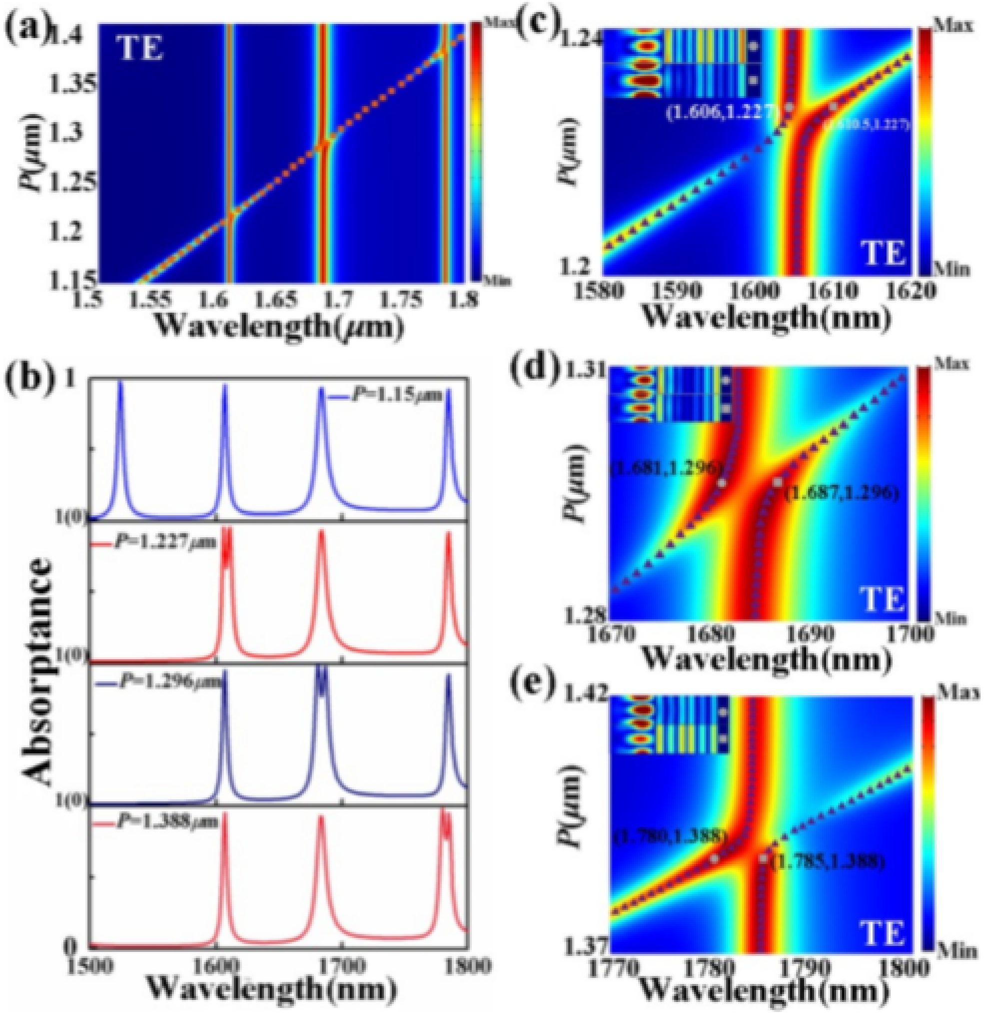

Figure 4

Evolution of absorption spectra of (a) the hybridized Tamm structure with the grating period length P, where the red square indicate the GMR; (b) Absorption spectrum at specific P; (c), (d), (e) are enlarged views of the absorption spectra at the three resonance coupling locationsare. The insets show the enhanced electric field resonance of GMR and TPP at the locations marked by hexagons and squares.

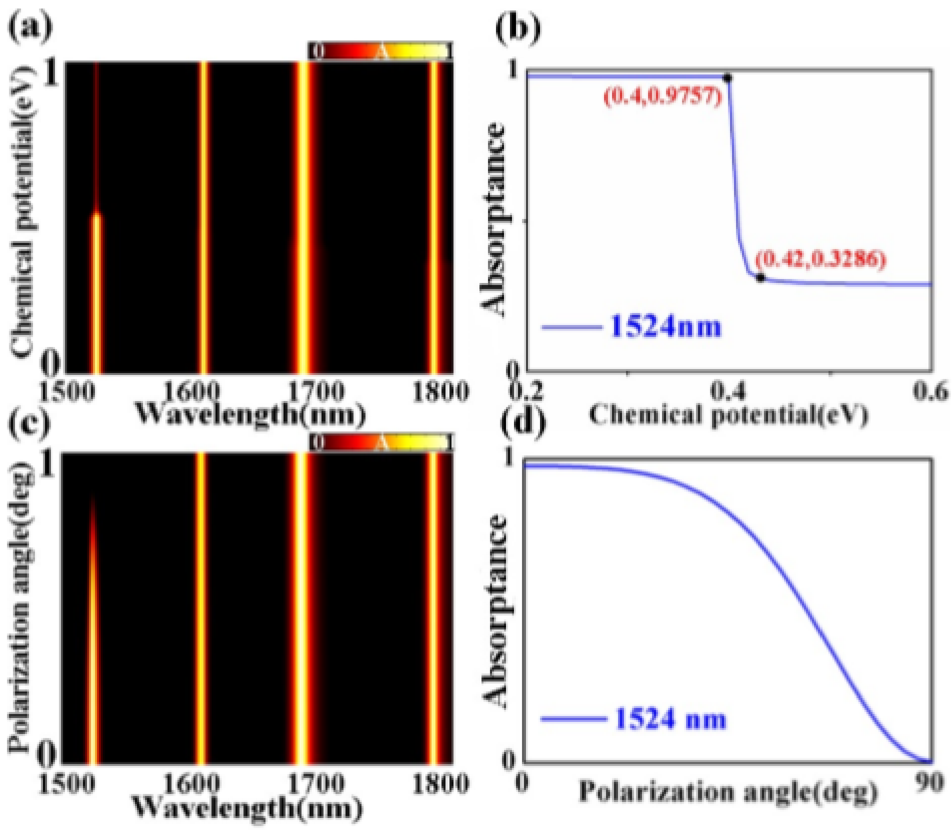

Figure 5

(a) Spectral diagram representing the dependence of the absorption as a function of the wavelength and the chemical potential of graphene under TE polarization. (b) The dependence of absorptance versus chemical potential at 1524 nm. (c) Spectral diagram representing the dependence of the absorptance as a function of the wavelength and the polarization angle at normal incidence. (d) The dependence of absorptance versus chemical potential at 1524 nm.