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Broadband terahertz absorber based on sinusoidally-patterned graphene

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Abstract

Broadband terahertz absorbers have recently attracted considerable attention for their promising applications in terahertz trapping, sensing, imaging, and detecting. In this work, an efficient approach to achieve broadband terahertz absorber based on sinusoidally-patterned graphene with nearly 100% absorption is demonstrated [1]. As shown in Figure 1(a), the proposed absorber is composed of a net-shaped periodically sinusoidally-patterned graphene sheet on the top, a thin gating layer embedded dielectric spacer in the middle, and a metallic reflecting plate on the bottom. We assume the material of the dielectric spacer, the gating layer and metallic plate are the polyethylene cyclic olefin copolymer (Topas) with the permittivity of $\varepsilon_{rt} = 2.35$ [2], and the polysilicon with the permittivity of $\varepsilon_{rp} = 3$ [3], and gold, respectively. The surface conductivity of the single-layered graphene is obtained from the Kubo formula [4]. The polysilicon gating layer is placed beneath the graphene sheet to control the graphene conductivity via electrostatic doping of the graphene by applying a DC voltage V_g. By introducing such a unique gradient width modulation of the unit graphene sheet structure, the continuous plasmon resonances of the absorber can be excited, and over 65% normalized bandwidth of 90% terahertz absorbance can be achieved under normal incidence for both TE and TM polarizations. As one of the most exciting characteristics, the broadband absorption of this absorber are insensitive to the incident angles and the polarizations. The absorbance remains more than 70% even the incident angles reach 60° for both polarizations. Furthermore, compared to conventional multi-resonator or multi-layered structures, the continuous net-shaped single-layered graphene structure can greatly simplify the electrostatic gating structure in achieving flexible tunability. By controlling the chemical potential of the graphene, the peak absorbance can be continuously tuned from 14% to 100%, as shown in Figure 1(b). This work offers a new perspective on the design of graphene-based tunable terahertz broadband absorbers. The design scheme can be easily scaled to the infrared or visible regimes.

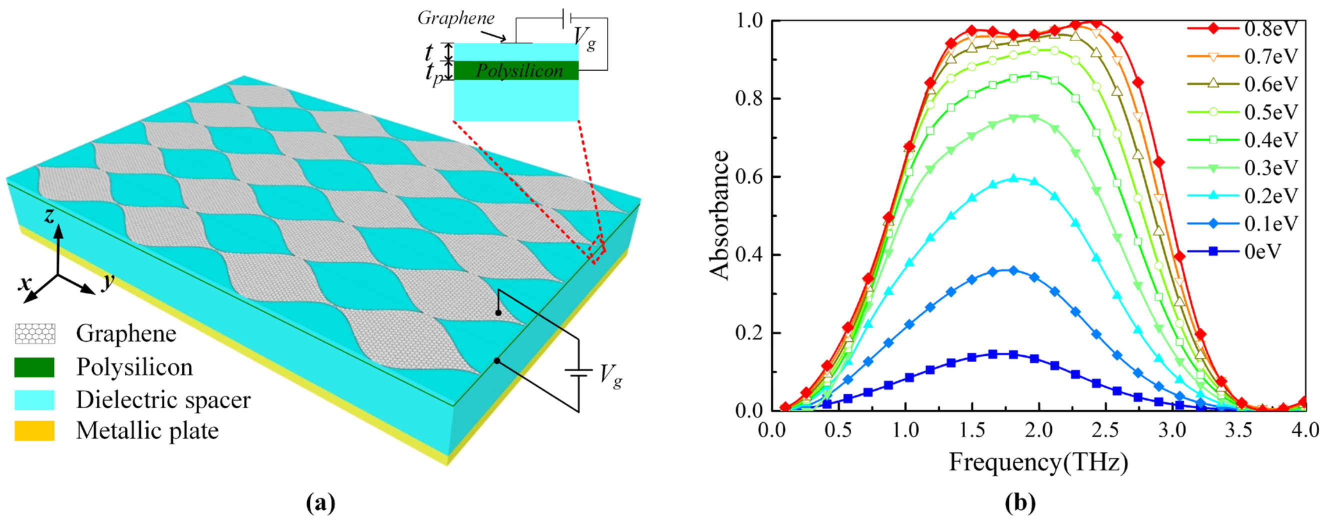

Figure 1. *(a) Schematic of the proposed graphene-based broadband terahertz absorber, where the net-shaped periodically sinusoidally-patterned graphene sheet is placed on a dielectric spacer supported on a metallic reflecting plate, where a thin polysilicon layer is placed beneath the graphene sheet as a gating layer to control the graphene conductivity via a DC votage V_g. (b)Normal-incidence absorbance in the TE polarization of the graphene-based absorber for various values of the graphene chemical potential m_c, where the peak absorbance increases from 14% to nearly 100% when m_c is tuned from 0 to 0.8 eV.*

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