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Independently tunable dual-band coherent perfect absorption based on metal-graphene metasurface

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A dual-band polarization-independent device based on metal-graphene nanostructures is proposed to realize coherent perfect absorption(CPA) at mid-infrared frequencies, which is composed of golden nanorings with two different sizes placed on graphene finger set. By controlling the relative phase of two incident countering-propagating beams, the coherent absorption at two resonant frequencies can be tuned from 0% to 98.3% and 0% to 98.4% separately. Besides, the coherent absorption can be tuned by the Fermi energy of corresponding graphene finger set, without changing the geometrical parameter of the nanostructures. The finite-difference time-domain (FDTD) solutions are employed to simulate the characteristics of the hybrid metal-graphene dual-band device. Distinguishing from the conventional graphene CPA devices, multiple CPA resonances in the hybrid metal-graphene CPA device are independently modulated by changing bias voltages applied on graphene finger set, which can be widely used in practical applications such as sensors, filters and switchers.

Image: The designed metamaterials for dual-band light CPA of monolayer graphene is sandwiched between the designed nanostructure and the SiO_2 substrate. The designed metal nanostructure is composed of golden nanorings with two different sizes within a unit cell. The small size of nanoring is in the center of the unit cell and the big size of nanoring is at the four corners of the unit cell.

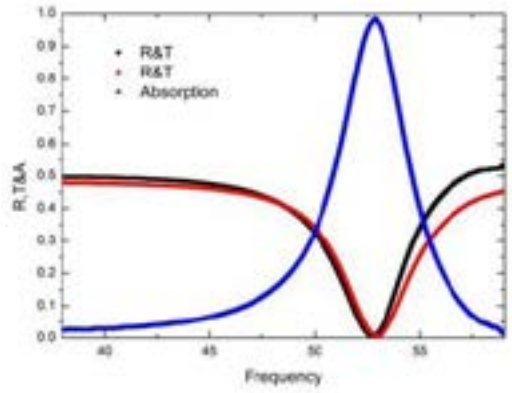

Figure 1: (a) The simulated absorption, reflection and transmission spectra of the small size of golden nanoring on graphene finger set when the Fermi energy EF=0.35eV and the two coherent beams with the same intensities and phases. (b) The simulated absorption, reflection and transmission spectra of the big size of golden nanoring on graphene finger set. (c) The simulated absorption spectra of two sizes of golden nanorings on graphene finger set.

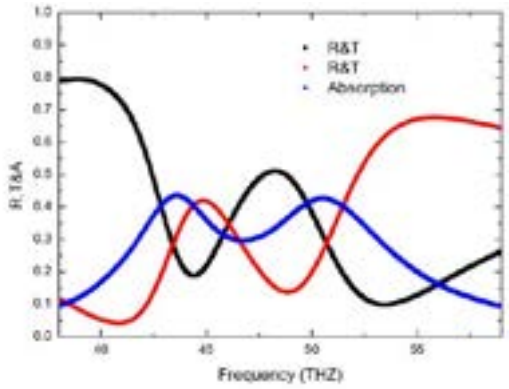

Figure 2: (a) When the phase difference between two countering-propagating coherent beams is 90°, the simulated absorption, reflection and transmission spectra of two sizes of golden nanorings on graphene finger set. (b)When the phase difference between two countering-propagating coherent beams is 180°, the simulated absorption, reflection and transmission spectra of two sizes of golden nanorings on graphene finger set.

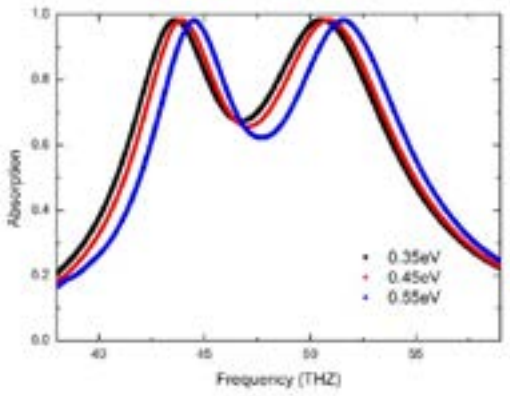

Figure 3: The simulated absorption of the designed metal-graphene nanostructure with different EF=0.35eV, 0.45eV and 0.65eV.

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- Hu X, Wang J (2015) High-speed gate-tunable terahertz coherent perfect absorption using a split-ring graphene. Opt. Lett. 40(23):5538-5541.

Biography

Jiangnan Si attended Shanghai Jiaotong University in China from 2011 to 2015 and received Bachelor's degree in Physics. Since 2015 she is pursuing PhD in Optical Engineering at Shanghai Jiaotong University. Her main research interest concentrates on the area of hybrid metamaterials and graphene 2D materials nano structures in PIT (plasmonically induced transparency), EIT (electromagnetically induced transparency) and CPA (coherent perfect absorption), which mainly work in the mid-infrared region.

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