Design of an Ultra-thin Hepta-band Metamaterial Absorber for Sensing Applications

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Abstract

An ultra-thin metamaterial absorber (MMA) comprises of a split-ring-cross (SRC)-shaped resonator coupled with graphene and dielectric layer backed by metallic ground plane is presented for hepta-band applications. The proposed absorber demonstrates multiple absorption peaks at 2.33, 5.24, 7.74, 8.25, 10.05, 10.97 and 12.61 THz with average absorption more than 96 % . The physical mechanism of the hepta-band absorption is analyzing by electric field distribution and attributed to the combination of dipolar and LC resonance. Furthermore, the effect of geometric parameters is analyzed to validate the optimal selection of the structural parameters. In addition, proposed MMA is analyzed for different incident and polarization angles suggesting that absorption response is insensitive to polarization angles. Compared with the previously reported MMAs, proposed design is ultra-thin (0.036λ) and compact (0.21λ) at the lowest operational frequency. The absorptivity at 12.61 THz is 99.81 % and the corresponding quality (Q) factor is 31.52 for a bandwidth of 0.40 THz. The proposed absorber can be potentially utilized in detection, sensing and imaging. Moreover, sensing performance of the proposed MMA has been investigated using overlayer thickness and overlayer permittivity.

Full Text

Due to technical limitations, full-text HTML conversion of this manuscript could not be completed. However, the manuscript can be downloaded and accessed as a PDF.

Figures

Figure 1

Perspective view of the proposed metamaterial absorber (MMA) is depicted with geometrical dimensions: $a=28$, $d=20$, $b=2$, $r=7$, $w=1$, $g=2$ (all dimensions are in μm) and (b) absorption response of the proposed MMA

Figure 2

(a) Real (Re) and imaginary (Im) normalized impedance, (b) real parts of ϵ_{eff} and μ_{eff} and (c) imaginary parts of ϵ_{eff} and μ_{eff} of the proposed absorber.

Figure 3

Absorption response at different polarization angles (ϕ) from $0-90^\circ$.

Figure 4

Simulated absorption response at different incident angles (θ) from $0-60^\circ$.

Figure 5

Electric field distribution at 2.33 (a), 5.24 (b), 7.74 (c), 8.25 (d), 10.05 (e), 10.97 (f) and 12.61 THz (g).

(a)

(b)

Figure 6

Absorption response of the proposed absorber with (a) different substrate thickness from 4.7 to 5.0 μm and (b) different unit cell dimension from 27.2 to 28.8 μm

Figure 7

Absorption response with the change in thickness of the overlayer

Figure 8

Absorption response with the change in permittivity(ϵ) of the overlayer