Design of a Broad-band Tunable Absorber Using Geraphene-Metal Metasurfaces

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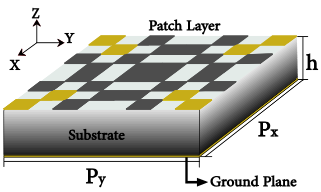
Abstract Using well established evolutionary optimization techniques, THz absorbers based on graphene frequency selective surfaces (FSSs) are designed and presented. Graphene plays the essential role in the introduced designs for making the absorbers tunable. Random hill climbing (RHC) algorithm is applied to find the design with the broadest bandwidth. During the optimization, each design is characterized by a bit string. While presence and absence of a decided material, represented by 1 and 0 respectively, is a typical assignment for a single pixel, combination of graphene and traditional materials like metals increases the possibility for obtaining new structures which are not taken into account in a complete graphene based FSS. Therefore, four options are provided for a single pixel: gold, two types of graphene, one of which will be biased while the other have the same chemical potential and will be fixed by chemical doping modification, and air. Two bits are adopted to represent these materials. Pixels to which biased graphene is assigned need to be connected in order to apply bias voltage only at one single location [1, 2]. These pixels can also be connected through gold ones. This way, we end up with a bias chain which consists of biased graphene and gold pixels and must be isolated from unbiased graphene pixels. Optimum structure has the broadest bandwidth of about 1.65 THz around 2 THz central frequency (about 83% fractional bandwidth).

References

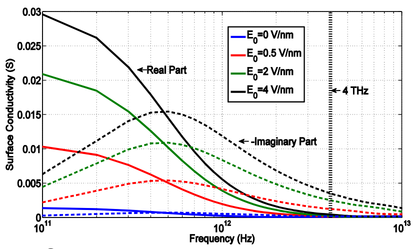
[1] A. Fallahi and J. Perruisseau-Carrier, "Design of tunable biperiodic graphene metasurfaces," *Physical Review B,* vol. 86, p. 195408, 2012.

[2] A. Andryieuski and A. V. Lavrinenko, "Graphene metamaterials based tunable terahertz absorber: effective surface conductivity approach," *Optics express,* vol. 21, pp. 9144-9155, 2013.

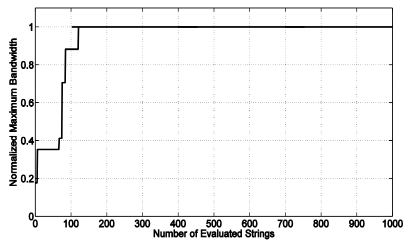
Figures



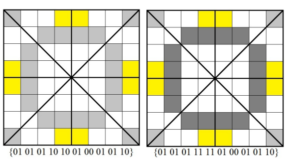
1. The unit cell of the FSS absorber.



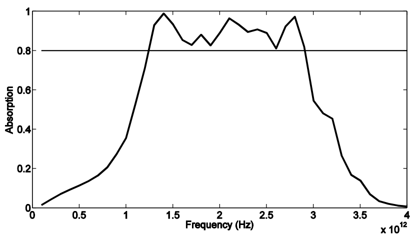
2. The surface conductivity of graphene versus frequency.



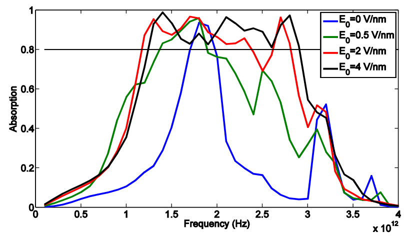
3. Convergence of the optimization.



4. Schematics of the optimum designs; Dark gray, bright gray and gold pixels represent biased graphene, unbiased graphene and gold respectively.



5. The absorption versus frequency of the optimized structure.



6. Different absorption levels are obtained by applying various bias voltages to the optimum design of the structure.