Dual-Polarized Tunable Mantle Cloaking with a Metasurface Based on graphene Strips

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A metasurface based on graphene strips is proposed to cloak a dielectric cylinder under illumination of TE_z and TM_z polarized incident waves in terahertz range. According to the in plane effective surface impedance tensor for the considered metasurface and the required surface impedance for achieving invisibility under TE and TM polarized impinging waves, the geometrical parameters of the covering structure and characteristics of graphene are obtained. Numerical simulations show radar cross section reduction for both TE and TM polarizations. Furthermore, the introduced metasurface is able to cloak the cylinder for incoming waves with circular polarization. In addition, it is shown that by properly adjusting the chemical potential of graphene, the required surface impedance to have cloaking for the two polarizations in other frequencies can also be achieved, which results in a tunable dual polarized cloaking.

In [1], it was shown that different surface impedances are required to achieve invisibility for simultaneous TE and TM polarizations, therefore an isotropic metasurface is not able to cloak a dielectric cylinder for both polarizations. Instead, an anisotropic metasurface should cover the cylinder so that it is possible to design the surface impedance for each direction, independently. A tunable anisotropic metasurface based on graphene strips is proposed to achieve the tunable dual polarized cloaking for the dielectric cylinder [2]. Figure 1 shows the structure of the introduced metasurface. Tensorial surface impedance for the considered metasurface is derived in [3].

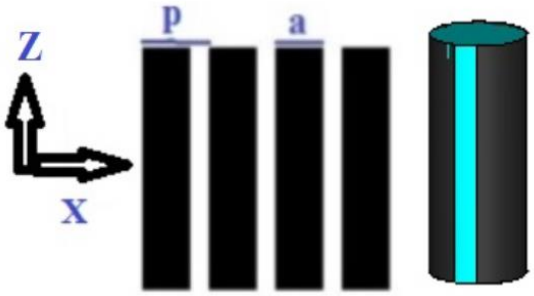

Figure 1. Structure of the metasurface based on graphene strips and a cylinder covered by the metasurface.

Scattered wave from the cylinder under illumination of circularly polarized wave can also decreases with the designed metasurface. Furthermore, by properly changing the chemical potential of graphene, tunable mantle cloaking has been achieved. To evaluate of the structure and to obtain high reduction in scattering, the numerical software including CST Microwave Studio and HFSS were considered. Numerical results show 2-11 dB reduction in scattering strength relative to the uncloaked configuration for 0.3eV variation of graphene chemical potential. We believe that the proposed model can open up novel avenues for practical applications of high resolution cloaking sensors.

1. A. Monti, J. C. Soric, A. Alu, A. Toscano, and F. Bilotti, “Anisotropic mantle” cloaks for TM and TE scattering reduction,” IEEE Transactions on Antennas and Propagation, vol. 63, no. 4, pp. 1775-1788, 2015.
2. Z. Hamzavi-Zarghani, A. Yahaghi, L. Matekovits, A. Farmani “Tunable mantle cloaking utilizing graphene metasurface for terahertz sensing applications”, *Optics Express*, 27, 24, 34824- 34837, 2019.
3. S. A. H. Gangaraj, T. Low, A. Nemilentsau, and G. W. Hanson, “Directive surface plasmons on tunable two-dimensional hyperbolic metasurfaces and black phosphorus: Greens function and complex plane analysis,” IEEE Transactions on Antennas and Propagation, vol. 65, no. 3, pp. 1174-1186, 2016.