Broadband transparency observation in different topologies

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Anar Ospanova1, Maria Cojocari1, Grigorii Matveev1, Mikhail Bukharin1, Polina Kuzhir1, Ladislau Matekovits2 and Alexey Basharin1

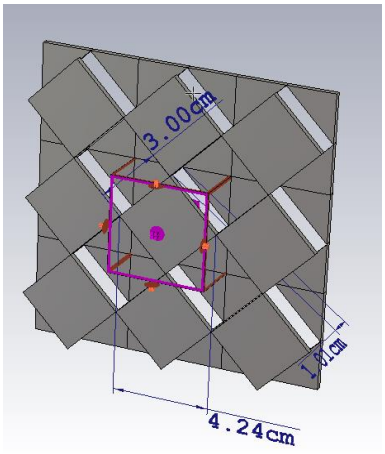
1 Department of Physics and Mathematics, Faculty of Science, Forestry and Technology, University of Eastern Finland, 80100, Joensuu, Finland

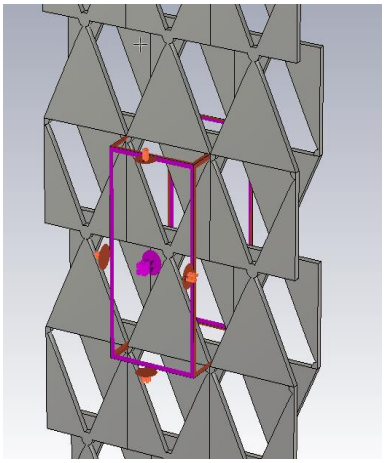
2 Department of Electronics and Telecommunications, Politecnico di Torino, 10129 Torino, Italy

Double layered metamaterials on the base of Babinet principle previously have been stated to show ultra-broadband transparency in microwave range. As shown in Ref [], checkerboard patterned planar metamaterials due to match of surface impedances ensure total transmission,, i.e., T=100 % of impinging linear wave (Fig. 1 c, green curve). Reasonable question is “does it work for another kind of simple geometries?”. Moreover, in case of manifestation of transparency in these geometries, it is crucial to study how it is related to their symmetry range. Here we demonstrate complementary metasurfaces comprising unit cells of rhombic and triangular symmetry. We examine transparency phenomena and attempt to clarify their dependence on the symmetry of unit cell, i.e., number of angles (nods), scale and other.

Firstly, we shifted already known geometry of square unit cells by tilt of 45 degree and study its transparency properties (Fig. 1 (a)). For these purposes, CST Microwave Studio was utilized. As it seen from the graph, such rhombic structure provides almost 100% transparency between 3-6 THz (Fig. 1 c, black curve). We assume the same dimensions as in case of square unit cells.

(a) (b)





(c) -

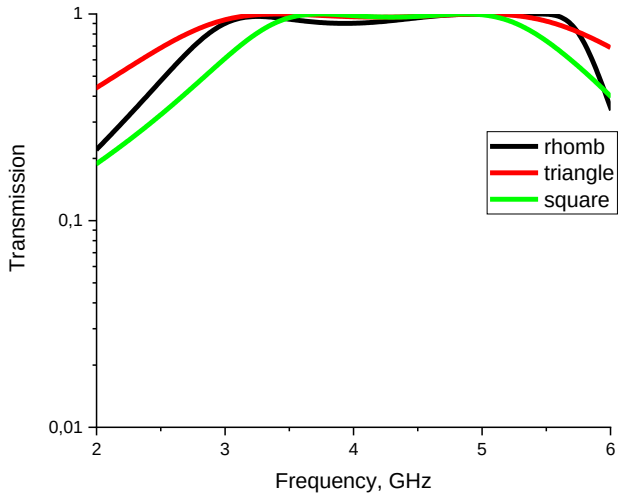


Figure 1. Babinet metasurfaces on the base of rhombic (a) and triangle (b) unit cell. Transmission spectrum (c).

Then, we examined the metasurfaces comprising triangular unit cells. Notably, triangular unit cells itself were thoroughly investigated by Y. Urade et al in Ref []. Here we exploited complementary metasurfaces on the base of complementary triangular unit cells and simulated their transmission spectrum (Figure 1 c, red curve). Apparently, such unit cells based metamaterials supports almost total transparency in wide range of 6-8 GHz.

Here, we examined triangular and rhombic unit cell based metamaterials and simulated their transmission properties. As it can be seen such symmetry range metamaterials also supports broadband transparency. Obviously, it is in strong dependence on the multipolar interaction between unit cell and their geometrical shape, therefore need further in-depth study.

[1] A Ospanova, M Cojocari, P Lamberti, A Plyushch, L Matekovits, Yu Svirko, P Kuzhir, A Basharin Broadband transparency of Babinet complementary metamaterials. Applied Physics Letters 122, 23 (2023)

[2] Yoshiro Urade, Electromagnetic Properties of Checkerboard-like Metallic Structures at Terahertz Frequencies. Thesis submitted for the degree of Doctor of Engineering, Kyoto University, 2017