

Tunable function from tunable metasurfaces

F. Liu^{*1}, D.-H. Kwon^{1,2} and S. A. Tretyakov¹

¹*Department of Electronics and Nanoengineering, Aalto University, P.O. box 15500, FI-00076 Finland.*

²*Department of Electrical and Computer Engineering, University of Massachusetts Amherst, Amherst, Massachusetts 01003 USA.*

While metasurfaces have shown powerful ability in manipulating electromagnetic wave propagation, tunable metasurfaces will give more possibilities in realizing tunable and multifunctional devices. In this talk, we will discuss the tunable and multifunctional capability of a tunable metasurface with adjustable resistor-capacitor load. As shown in Fig. 1(a), the metasurface unit cell consists of a pair of copper patches that printed on a grounded dielectric substrate and connected by a series R-C load with resistance R_{load} and capacitance C_{load} . The tunability of the metasurface comes from the variable R_{load} and C_{load} values which are to be adjusted from external applied voltages. Such a tunable metasurface can show both tunable perfect absorption and tunable perfect anomalous reflection for transverse electrically (TE, with electric field parallel to y direction) polarized plane waves. For example, for perfect absorption function, the two load values R_{load} and C_{load} are adjusted so that there is no reflected wave for a TE plane wave incidence with different incidence angles. Fig. 1(b) and (c) show the reflection amplitude for normal incidence and oblique incidence. We can see that perfect absorption happens at different R_{load} and C_{load} combinations for different incidence angles. Therefore tunable absorption can be achieved by tuning the load values.

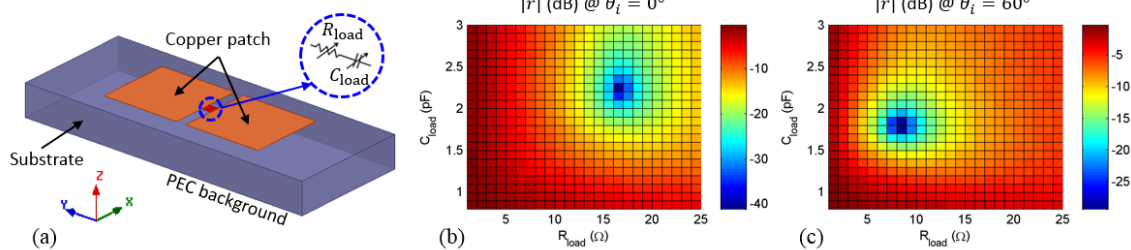


Fig. 1 (a) Schematic of the tunable metasurface unit cell. (b, c) Tunable perfect absorption. The color maps show the reflection amplitude in terms of different values of R_{load} and C_{load} , for normal incidence (b) and for oblique incidence with 60 degrees (c).

Anomalous reflection means that the reflection angle is different from the incidence angle. To achieve anomalous reflection, we need the collective behavior of several unit cells forming a supercell. If we keep the incidence angle, e.g. zero degree for normal incidence, then the reflection angle will be determined by the number of unit cells in the supercell. While the tunability of the unit cell comes from the adjustable R_{load} and C_{load} while the unit cell geometry is unchanged, it is naturally feasible to achieve tunable anomalous reflection. For example, with 8 or 9 unit cells in a supercell, we can obtain perfect anomalous reflection at 55 degrees or 47 degrees, as shown in Fig. 2.

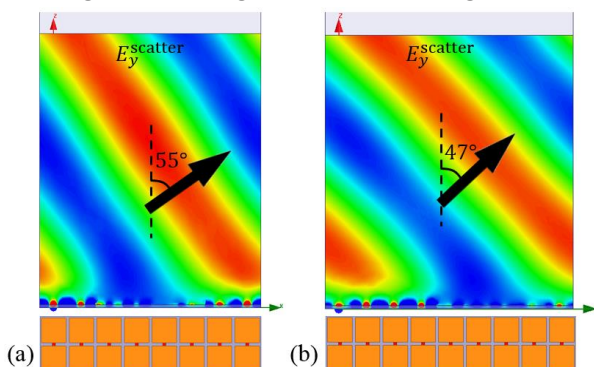


Fig. 2 Tunable perfect anomalous reflection. A supercell consists of 8 (a) or 9 (b) unit cells will give perfect anomalous reflection at 55 degrees (a) or 47 degrees (b).

Acknowledgement: This project has received funding from the European Union's Horizon 2020 research and innovation programme-Future Emerging Topics (FETOPEN) under grant agreement No 736876.

* Corresponding author: Fu Liu (fu.liu@aalto.fi)