Highlights

Light-matter interaction and non-equilibrium dynamics in advanced materials and devices - 2018

Suboptimal Coding Metasurfaces for Terahertz Diffuse Scattering

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SCIENTIFIC REPORTS 8 (2018) 11908

In 2014, the concept of "coding" meta materials has been proposed, in which meta materials are characterized by digital coding particles of '0' and '1' (Cui et al., Light: Science & Applications 3, e218, 2014). It was demonstrated that the Electro Magnetic (EM) waves can be manipulated by changing the coding sequences of '0' and '1'. The coding particles provide a link between the physical and digital world, leading to digital metamaterials and field programmable metamaterials, which can control EM waves in real time.
In the present work, we apply these concepts to the design, fabrication and experimental characterization of digital meta surfaces to attain diffuse scattering - one of the most important features of coding metamaterials - at Terahertz (THz) frequencies. In particular, the study proposed a scaling law to reduce the radar cross sections (RCS), which essentially consists of maintaining the meta surface directivity independent of its electrical size. These new results extend the experimental validation of a general design approach to the THz band and to electrically large (~32-wavelength-sized) structures. Overall, they confirm the possibility to effectively design electrically large diffuse-scatterers via a simple, deterministic and computationally cheap algorithm, with performance comparable with that attainable via computationally expensive brute-force optimization. Our findings may have a potentially broad impact in several fields of optics and photonics, including diffusive imaging, computational imaging and light-trapping mechanisms for photovoltaics.

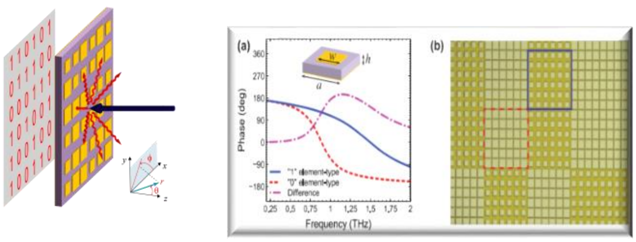

Fig. 1: Diffuse scattering on a coding metasurface under normally incident plane wave illumination (left) is realized exploiting the phase difference (0/π) (right, (a)) between two types of "supercell" (right, (b)).

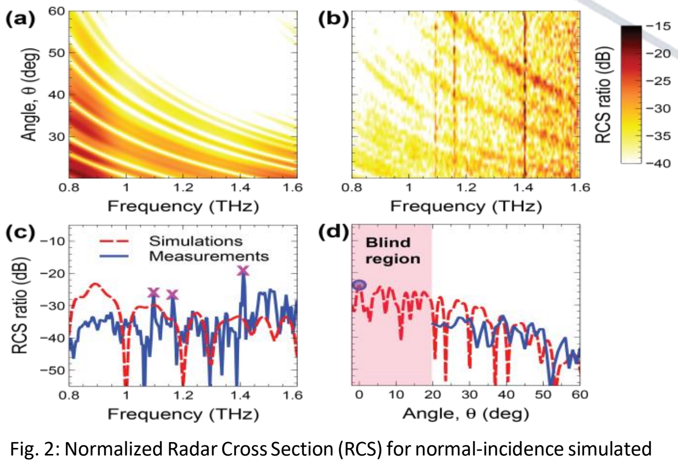

Fig. 2: Normalized Radar Cross Section (RCS) for normal-incidence simulated (a) and measured (b) in false-color scale as a function of frequency f and observation angle θ; RCS vs f (c) @30° and vs θ (d) @1 THz.