Anisotropic Metascreen: Coupling Between TE and TM modes

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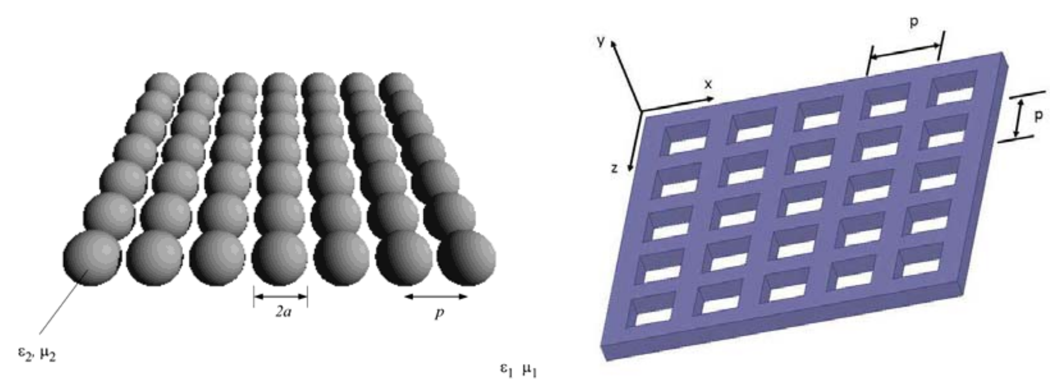
The simplicity and relative ease of fabrication of metasurfaces (a surface, or two-dimensional, version of three-dimensional metamaterials) makes them attractive alternatives to metamaterials and in many applications, metasurfaces can be used in place of metamaterials [Holloway et al., *IEEE Antenna and Propagation Magazine*, **54**(2), pp. 10-35, April 2012]. We will call any periodic two-dimensional structure whose thickness and periodicity are small compared to a wavelength in the surrounding media a metasurface. Within this general description, we can identify two important subclasses. Metasurfaces that have a "cermet" topology, which refers to an array of isolated (non-touching) scatterers, are called metafilms (see Fig. 1a). Metasurfaces with a "fishnet" structure are called metascreens (see Fig. 1b), which are characterized by periodically spaced apertures in an otherwise relatively impenetrable surface.

In recent work, we have derived the generalized sheet transition conditions (GSTCs) for electromagnetic fields at the surface of a metascreen [Holloway and Kuester, "Generalized Sheet Transition Conditions (GSTCs) for a Metascreen", *IEEE Trans. on Antenna and Propag.,* submitted *2017*]. The effective electric and magnetic surface parameters (i.e., the effective electrical and magnetic surface susceptibilities and surface porosities) that appear explicitly in the GSTCs are uniquely defined, and as such serve as the physical quantities that most appropriately characterize the metascreen. These surface parameters are related to the geometry of the apertures that constitute the metascreen, and can exhibit anisotropic properties if this geometry is sufficiently asymmetric. These anisotropic properties can result in the conversion between TE and TM modes when a plane-wave is incident onto a metascreen. Here, we use the GSTCs to derive the plane-wave reflection and transmission coefficients of an anisotropic metascreen, and illustrate the coupling between TE and TM modes.



a) metafilm b) metascreen

Fig 1: Metasurfaces: a) metafilm composed of an array of spherical particles, and b) metascreen composed of an array of square apertures.