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Title:An overview of the theory and applications of metasurfaces: The two-dimensional equivalents of metamaterials

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Abstract:Metamaterials are typically engineered by arranging a set of small scatterers or apertures in a regular array throughout a region of space, thus obtaining some desirable bulk electromagnetic behavior. The desired property is often one that is not normally found naturally (negative refractive index, near-zero index, etc.). Over the past ten years, metamaterials have moved from being simply a theoretical concept to a field with developed and marketed applications. Three-dimensional metamaterials can be extended by arranging electrically small scatterers or holes into a two-dimensional pattern at a surface or interface. This surface version of a metamaterial has been given the name metasurface (the term metafilm has also been employed for certain structures). For many applications, metasurfaces can be used in place of metamaterials. Metasurfaces have the advantage of taking up less physical space than do full three-dimensional metamaterial structures; consequently, metasurfaces offer the possibility of less-lossy structures. In this overview paper, we discuss the theoretical basis by which metasurfaces should be characterized, and discuss their various applications. We will see how metasurfaces are distinguished from conventional frequency-selective surfaces. Metasurfaces have a wide range of potential applications in electromagnetics (ranging from low microwave to optical frequencies), including: (1) controllable smart surfaces, (2) miniaturized cavity resonators, (3) novel wave-guiding structures, (4) angular-independent surfaces, (5) absorbers, (6) biomedical devices, (7) terahertz switches, and (8) fluid-tunable frequency-agile materials, to name only a few. In this review, we will see that the development in recent years of such materials and/or surfaces is

bringing us closer to realizing the exciting speculations made over one hundred years ago by the work of Lamb, Schuster, and Pocklington, and later by Mandel'shtam and Veselago. © 2012 IEEE.

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