Waveguides Composed of Metafilms/Metasurfaces

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In this talk, we illustrate how metafilms or metasurfaces (the two-dimensional equivalents of metamaterials) can be used to design novel waveguiding structures. Metamaterials are commonly engineered by arranging a large number of small scatterers in a regular array throughout a region of space in order to obtain some desirable bulk electromagnetic behavior. This concept can be extended by arranging electrically small scatterers into a two-dimensional pattern at a surface or interface. This surface version of a metamaterial has been given the name metafilm (Kuester, Mohamed, Piket-May and Holloway, *IEEE Trans. Ant. Prop*., 51, 2641-2651, 2003) or metasurface. Like that of a metamaterial, the behavior of a metafilm can be characterized by the electric and magnetic polarizabilities of its constituent scatterers. It is shown in (Holloway, Mohamed, Kuester and Dienstfrey, *IEEE Trans. on EMC*, 47, 853-865, 2005) that with certain conditions imposed on the scatterers, it is possible to design a metafilm in which total reflection occurs (i.e., the transmission coefficient through the film is zero). We can use this property to create a metafilm waveguide. Consider the structure in Figure 1, where two metafilms are placed above one another and are separated by a distance *d*. If the scatterers of the metafilm are chosen properly, total internal reflection will occur for energy launched between the two metafilms, and as a result, energy will be guided along the structure. Metafilm waveguides can be flexible and have low material and radiation losses. They are attractive alternatives to traditional core-cladding types of surface waveguides and as such could have potential applications at terahertz frequencies. We show comparisons to full-wave numerical results in order first validate the proposed waveguiding structure, and second to validate the technique used for the analysis of the waveguide.

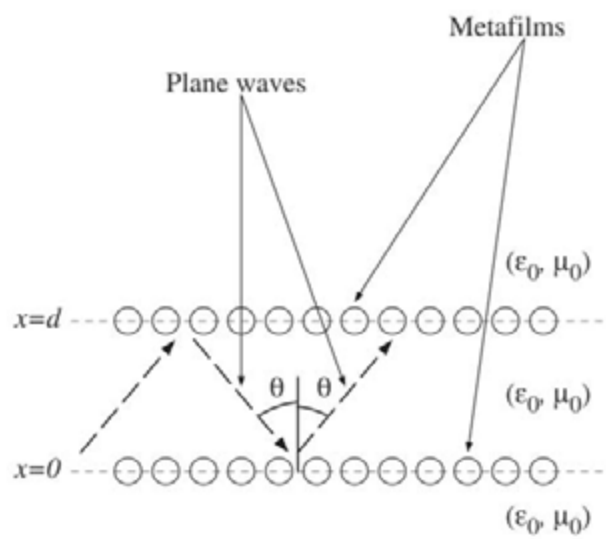

Figure 1: Illustration of a metafilm/metasurface waveguide.