Guidance and Radiation of Metasurface-Waves

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Abstract

Metasurfaces constitute a class of thin metamaterials, which can be used from microwave to optical frequencies to create new electromagnetic engineering devices. At microwave frequencies, they are obtained by a dense periodic texture of small elements printed on a grounded slab. Changing the dimension of the elements, being the sub-wavelength 2D-periodicity equal, gives the visual effect of a pixelated image and the electromagnetic effect of a modulation of the equivalent local reactance. The modulated metasurface reactance (MMR) so obtained is able to transform surface or guided waves into different wavefield configurations with required properties. The MMR allows a local modification of the dispersion equation and, at constant operating frequency, of the local wavevector. Therefore, a metasurface modulation permits addressing the propagation path of a surface wave, according with a generalized Fermat principle, as happen in ray-field propagation in inhomogeneous solid medium. This may serve for designing lenses or point-source driven beam-forming networks. When the MMR exhibits a periodic modulation along the SW wavevector, the wave propagation is accompanied by leakage; i.e., a surface wave is transformed into a leaky-wave, and the structure itself becomes an extremely flat antenna. In every case, introducing asymmetry in the pixel allows for a polarization control. In this tutorial, the basic wave mechanisms will be reviewed showing several antenna applications.