Homogenization of Structured Metasurfaces and Uniaxial Wire-Medium Metamaterials for Microwave and THz Applications

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In this presentation, we review recent progress on the homogenization theory of structured metasurfaces and wire-medium based metamaterials, and discuss a variety of applications at microwave and THz frequencies. The analysis is based on spatially dispersive homogenization models for periodic surfaces formed with sub-wavelength printed/slotted elements, and for unloaded and loaded wire media with additional boundary conditions derived for different interface scenarios. The intention of this review talk is to demonstrate that the interaction of electromagnetic waves with complex metamaterial structures can be analyzed in a most elegant, physically insightful manner using the effective medium approximation, resulting in accurate analytical solutions for a wide range of frequencies.

Within the framework of homogenization models developed for metasurfaces and wire-medium structures, a variety of electromagnetic problems have been solved for applications at microwave and THz frequencies. These include the analysis of transmissivity in metasurface-dielectric and graphene-dielectric stacks, artificial impedance surfaces (reflection properties and natural waves of high-impedance surfaces, such as bed-of-nails and mushroom-type surfaces), negative refraction and subwavelength imaging with mushroom-type structures with lumped inductive/capacitive loads, broadband microwave absorbers with stable angle characteristics, among others. In all the cases the analytical results of homogenization models have been verified with full-wave commercial programs.

In the presentation, the basic concepts of the homogenization theory of metasurfaces and wire media will be discussed, with a variety of examples and applications demonstrating different physical phenomena and practical realization of devices.