Ultrafast Effects in 3D Metamaterials

N. Katte[1], P. Evans[2]

[1]Wilberforce University, Wilberforce, OH, USA
[2]Oak Ridge National Laboratory, Oak Ridge, TN, USA

Abstract

The extraordinary electromagnetic response of nanostructured material, usually made up of a metallic structures distributed in within a dielectric matrix has attracted a lot of interest in recent years. These materials are technically called metamaterial since they possess different properties from their constituent materials. Several applications of metamaterials have already been demonstrated ranging from super-resolution imaging, invisibility cloaks, to enhancements of nonlinear optical effects. A primary reason why metallic structures have attracted considerable interest in transmittive optics, is because of the excitation the electrons oscillatory waves produced at metallic and dielectric known as plasmons .
In our previous work at ORNL, we have characterized numerically the linear optical properties of 3D metamaterial. The transmittance, and reflectance of three dimensional (3D) metamaterials have been calculated as a basis to understand the appropriate techniques and measures required to excite nonlinear effects within these materials.
Our numerical work with COMSOL Multiphysics® software and the Wave Optics Module simulates models which are fabricated using chemical synthesis which is better controlled process than conventional nanofabrication techniques such as sputtering and electron beam lithography. Our simulations captures the 3D character of these materials which is very crucial for nonlinear optical characterization. It goes beyond the common two dimensional (2D) model 2D which is limited at a practical level of fabrication and also with respect to the ways in which fields are excited and propagated within these materials. In the next step of our project we further explore the nonlinear optical properties of the metamaterial by simulating its optical limiting ability.

Figures used in the abstract

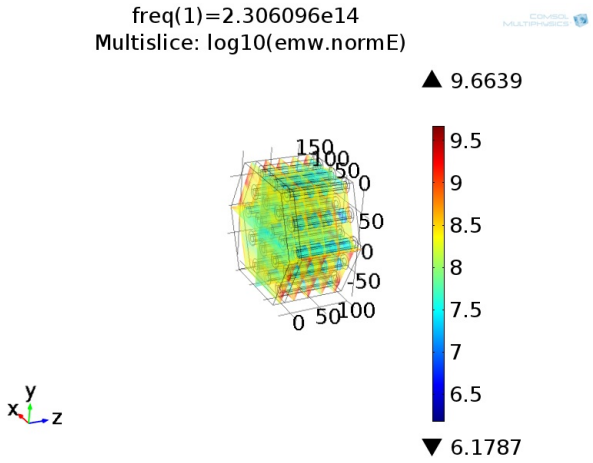

Figure 1: Hexagonal lattice