Optical properties of planar metamaterials with chiral meta-atoms

Author: A. A. Pavlov
Supervisor: V. V. Klimov, Yu. V. Vladimirova

Diploma thesis abstract

Recently, there have been intense studies of optical properties of metamaterials — artificial materials that are composed of nanoparticles (meta-atoms), which serve as ordinary atoms. Planar metamaterials are of particular interest. Planar metamaterials are metamaterials, formed by one or several layers of periodically placed nanoparticles. However, one can experience big difficulties describing them theoretically, because of the very complex share of meta-atoms as well as the complexity of longitudinal fields which are of great influence on nanoscale.

In the present work it is shown that one can perform a qualitative analysis of optical properties of planar metamaterial, which is composed of nanoparticles of an arbitrary shape. Latter is achieved by numerical calculation of multipole moments of meta-atoms and following calculation of far fields.

The main point of the suggested method is to consider currents, induced by the incident wave, as oscillating multipoles, which by-turn are radiating scattered field. Knowing this multipole moments one can derive the expressions for scattered field in the wave zone, and thus obtain properties of the transmitted and reflected waves, including Stokes coefficients (which is of great interest for investigation of chiral metamaterials), effective electric permittivity and magnetic permeability.

Method of far-field calculation of planar metamaterials was developed and then implemented in the study of metamaterials composed of H-shaped and N-shaped meta-atoms. The suggested method was shown to be accurate and can be used in the analysis of far-fields of planar metamaterials with meta-atoms of arbitrary shape. Also, polarization transformation by metamaterial with chiral N-shaped meta-atoms was studied.