AN ORDERED COMPOSITE BASED ON DIMERS OF METAL NANOSHELLS AS A “LEFT-HANDED” MEDIUM

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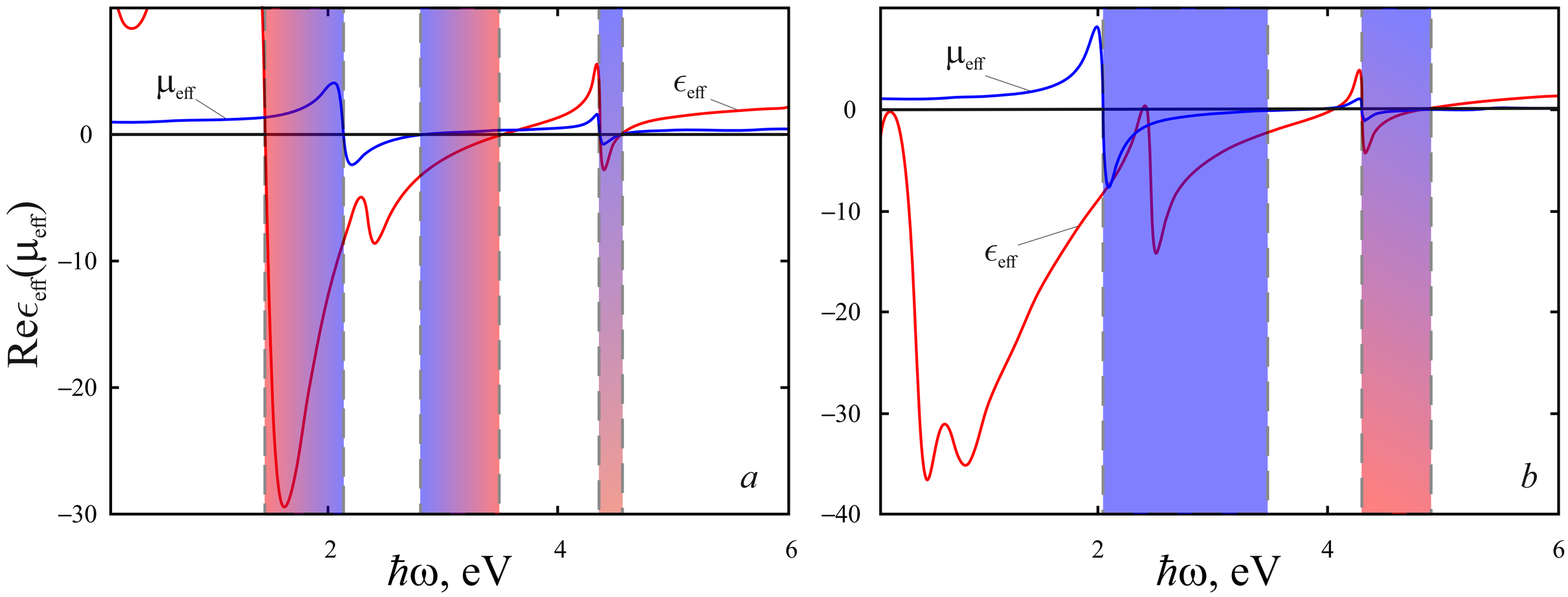
Abstract

Currently, there is an intensive search for architectures of synthetic materials with unique optical properties, including negative refraction, the inverse Doppler effect, and superresolution. Such materials are metal-dielectric composites consisting of periodically arranged subwavelength unit cells (meta-atoms). In [1], a cubic cell with dimers of spherical metal nanoparticles located on its faces was considered as a meta-atom in an ordered composite. A drawback of the architecture proposed in this work is the extremely narrow spectral range in which the nanocomposite has a negative refractive index. Finding the shape and size of structural elements that make a nanocomposite become a “left-handed” medium is a pressing task.

Statement of the problem

This paper examines the optical properties of an ordered nanocomposite based on cubic unit cells with dimers of spherical shell particles, which represent a dielectric core covered by a metal shell. Using effective medium theory, the frequency dependences of the permittivity and magnetic permeability, as well as the absorption coefficient, of this composite are obtained. The evolution of the extremes of the real and imaginary parts of the dielectric and magnetic polarizability for a cubic unit cell with dimers of shell particles on its faces is studied. Spectral ranges are found in which nanocomposites with dimers of particles of different sizes and made of different materials exhibit the properties of a “left-handed” medium.

Figure 1

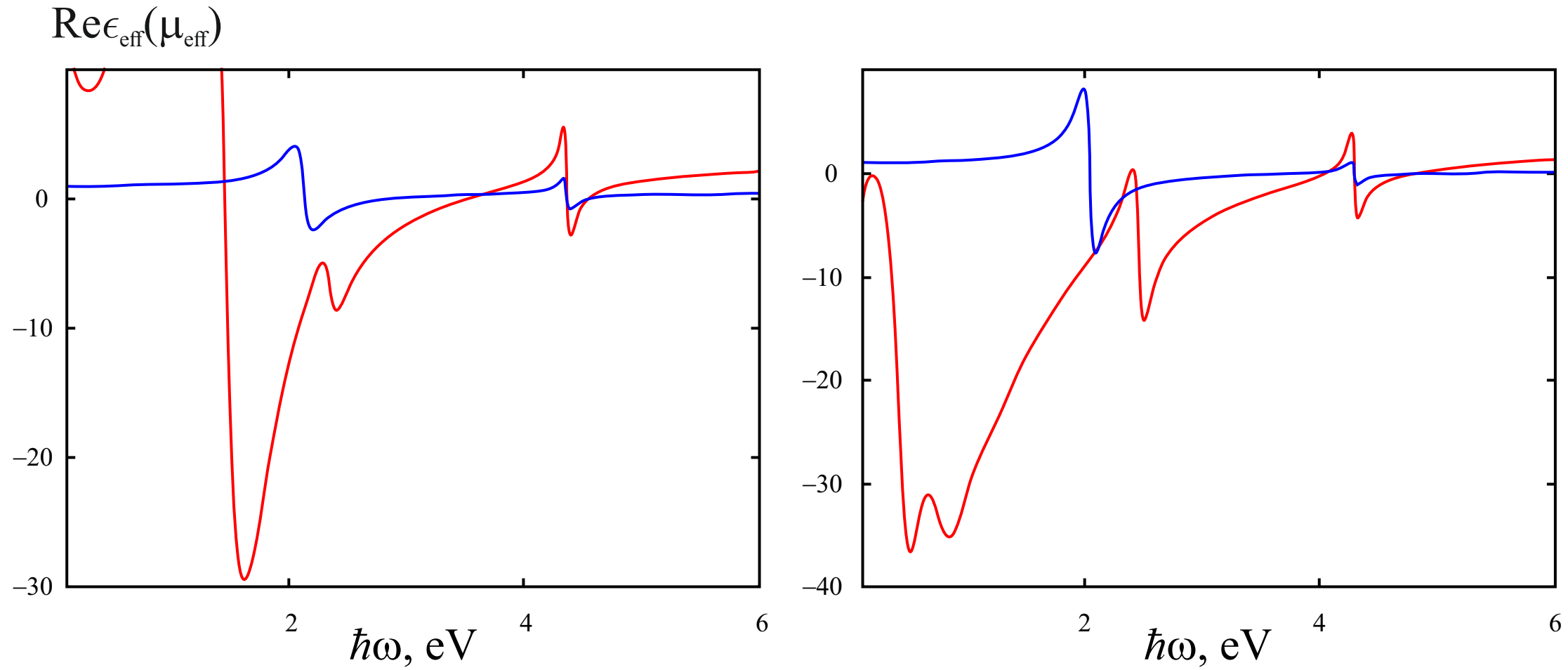


Frequency dependences of the real parts of the effective permittivity and permeability of a composite based on a lattice of SiO_2@Ag dimers in CaO at different thicknesses of the metallic shell: *a* – *t* = 10 nm; *b* – *t* = 15 nm

Results of calculations and conclusions.

The calculation results (Fig. 1) indicate the existence of frequency intervals in which the composite based on spherical shell dimers behaves as a left-handed medium. Moreover, the number and width of these intervals are sensitive to the thicknesses of the metallic shells.

1. L. O. Abramenko, V.M. Matiushyn, and A. V. Korotun, Funct. Mater., 32, 21 (2025).


Re$\epsilon_{eff}(\mu_{eff})$
0
−10
−20
−30
2
4
6
$\hbar\omega$, eV
0
−10
−20
−30
−40
2
4
6
$\hbar\omega$, eV