Modeling Isotropic DNG Media for Microwave Applications

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In this review presentation we will discuss various possibilities to realize isotropic artificial backward-wave materials. Different structures and models are suggested and discussed.

1) A composite medium consisting of two sublattices of dielectric spherical particles of high permittivity and different radii embedded in a dielectric matrix of smaller permittivity are considered. It has been shown [1] that such a composite medium reveals properties of an isotropic double negative media (DNG) in the frequency range where resonance oscillations of H_{111} mode in smaller spheres and E_{111} mode in larger spheres are excited simultaneously. The E_{111} resonance and the H_{111} resonance give rise to the magnetic dipole momentum and the electric dipole momentum, correspondingly. Averaging the magnetic momentum and the electric momentum over the cells belonging to the appropriate spherical particles reveals the negative permeability and the permittivity.

2) An improved mixing rule [2] for the effective permittivity and permeability of a composite material consisting of two sets of resonant dielectric spheres in a homogeneous background is presented. The equations are validated using the Mie theory and numerical simulations. The effect of a statistical distribution of sphere sizes on the increasing of losses in the operating frequency band is discussed and some examples are shown.

3) A new technique [3] is presented for the accurate computation of the effective constitutive parameters of lattices containing particles with complicated shape. This technique is based on the periodic unfolding method. The method is based on the decomposition of the fields in a main part without micro-oscillations, and a remainder part taking them into account. The idea of this decomposition is inspired by the method of Finite Element approximations. Verification data is presented for lattices of dielectric cubes obtained with the Maxwell-Garnett method. Corrector results are also studied as a function of frequency.

REFERENCES

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