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Title:Homogeneous negative refractive index materials
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Abstract:We examined materials which are homogeneous and which posses a negative index of refraction in (10-100) THz frequency range based on the following two ideas. Firstly, there are materials such as magnetic semiconductors (e.g. In2-xCrxO3,), and 3D transition metals (Fe, Ni), in which the high-frequency spin wave modes coexist with the plasmonic modes. Consequently, the spin wave mode, along with the plasmonic mode, are activated by the electromagnetic field of the light, with simultaneous negative permittivity and permeability responses at the edge of the Brillouin zone of the magnon spectra. This permeability response is weakly space-dispersive and anisotropic in the case of a single crystal, and is fully isotropic in a polycrystal with a small grain size. As a result, the polycrystalline material exhibits the negative refractive index effect within the narrow frequency band close to the ferromagnetic resonance. Secondly, based on methods of quantum optics, we investigated the possibility of achieving the negative index of refraction in a doped semiconductor. The quantum states of a hydrogen-like donor atom and states of an electron in the conduction band constitute a discrete-level atomic medium, and the coupling of an electric dipole transition with a magnetic dipole transition leads to coherent permeability and permittivity responses which results in the negative index effect. This scheme was implemented with tin-zinc-doped indium oxide, In2-xSn xO3:Zn, and calculations show feasibility of this effect with a figure of merit (FOM) greater than 10.
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