Abstract

Negative Refractive Composite Media

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We have demonstrated, using simulations and microwave experiments, that a composite medium possessing a frequency band over which the electric permittivity and magnetic permeability are simultaneously negative can be constructed. This composite medium, termed a "left-handed" medium by V. G. Veselago, has an index of refraction that is also negative, a property not found in naturally occurring materials. The fabricated material is a periodic array comprised of two interleaved composite arrays: a conducting rod medium and a conducting Split Ring Resonator (SRR) medium. Both of these constituent materials have been recently analyzed by J. B. Pendry et al., who showed that the rod medium has a negative permittivity below a cutoff (or "plasma") frequency, and that the SRR medium has a region of negative permeability. While not immediately obvious, combinations of these medium result in a composite in which the properties of each sub-array are retained that is, interaction effects between the rod and SRR arrays are minimal.

We have utilized a variety of techniques to characterize the composite media in terms of the bulk material parameters epsilon and mu. Typically, we perform finite-difference or finite-element simulations of either a finite or infinite structure, and then interpret the results by either averaging the local fields to find the "macroscopic" fields (for an infinite structure), or performing an S-parameters inversion (for a finite structure). Both methods provide a means of characterization, and produce results in agreement with each other and experimentally obtained data.

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