Optically Transparent Planar Composite Structure Containing Metals and DNG Metamaterials

Piergiorgio L. E. Uslenghi
Department of Electrical and Computer Engineering
University of Illinois at Chicago, USA
uslenghi@uic.edu

The two-dimensional planar structure under consideration consists of one or more cells, each containing two materials: a metallic portion made of two parallel thick strips of the same finite width and infinite length, and three parts made of a DNG metamaterial that is anti-isorefractive to the infinite medium (e.g., free space) in which the structure is embedded. (Anti-isorefractive means that the propagation constant of the DNG metamaterial has opposite sign to the real propagation constant of the embedding medium, whereas the intrinsic impedances of the two media are identical).

Two of the DNG parts are parabolic-cylinder radomes that cover the slots at each end of the parallel strips. The radomes are of thickness equal to the strip thickness where they meet each strip, and the focal lines of the radomes are parallel to, and in the same plane of, the strip edges. The third DNG part is a slab perpendicular to thr strip surfaces and parallel to the strip edges, whose thickness equals twice the thickness of each radome in the plane containing the focal lines of the radomes. The slab may be positioned anywhere between the two ends of the strips.

A structure made of cells such as the one described above may be constructed. Allowed variations among cells are the width of the strips, the spacing between cells, and the position of the slab between cells.

The primary field is a plane electromagnetic wave incident perpendicularly to the edges of the metal strips and at grazing incidence to the faces of the strips. The electric field is polarized perpendicular to the strip edges. It is shown that at very high frequencies the described structure is asymptotically invisible to the incoming wave. A rigorous, full-wave analysis of the boundary-value problem provides a precise bound on this approximate result.