Simulation Study of Split Ring Resonators for Electromagnetic Cloaking in X Band

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Abstract

Recently published theory has suggested that a cloak of invisibility is in principle possible, at least over a narrow frequency band. We present here the simulated realization of such a cloak. The cloak can construct using artificially structured metamaterials designed for operation over a narrow band of microwave frequencies. The cloak architecture involves coordinate transformation of constitutive parameters i.e. permeability (μ) and permittivity (ε) that squeezes incident field space volume into a shell surrounding the concealing volume; achieved via a cellular pattern. The incoming wave field gets coupled to the cellular pattern to pop-up magnetic or electric dipole, at the cell, depending upon charge dynamics within the pattern. This causes asymmetric reflection, or asymmetric transmission, or complete concealing of the incident field which in turn results into cloak.

The simulation work indicated concealing of radiated electromagnetic field at SRRs embedded on dielectric substrate generating a cloak-like response over the sub-wavelength (8.5-10GHz) regime. To simulate field scattered from SRRs, RF Module of COMSOL Multiphysics® was used by employing harmonic propagation analysis mode and parametric solver in X-band regime. In our study, we have used the longitudinal configuration was assumed for the propagation of wave. The configuration was homogenized and completely fills the cross section of the wave guide. The fundamental mode (TEz(10)) was propagating in the Z direction from air only TEz(m0) mode was supported by the longitudinal configuration changing with x and y to simulate radiated field around SRRs and S-parameters were determined from two port measurement. S-Parameters and field profiles were simulated, indicating concealing of radiated field at SRRs with S11 around - 20 dB and S21 ~ 0 dB, at 9.5 GHz showing cloak like response in microwave region. The present study has potential applications in the field of defense.

Figures used in the abstract

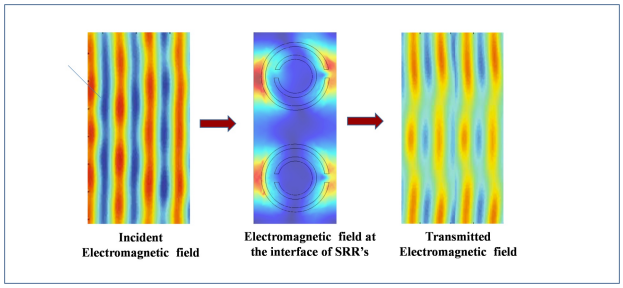

Figure 1: Simulation results of electric field distributions at SRR's showing cloak like response