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Characterization of Double-Positive Metamaterials for Advanced Applications

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A new type of metamaterial has been developed at the University of Missouri for use in pulsed power and high power microwave systems. These materials also have direct applications in dielectric-loaded components and nonlinear transmission lines. We present a double-positive metamaterial that incorporates high permeability, high resistivity nickel-zinc ferrite powers into a dielectric matrix. The ferrite powers were diagnosed using XRD and SEM analysis. A bimodal particle distribution was investigated with particles 5μm and 30nm in diameter. The 3D models of composites were constructed using a custom Monte-Carlo algorithm to investigate the effect of particle distribution and density on material electromagnetic properties. Simulations are compared with experimental results in order to validate the models. Testing the electromagnetic frequency response showed materials with near equal values of positive relative permeability and permittivity that were between 3.0-6.0 for frequencies between 200MHz and 1GHz. Power handling and dielectric strength were also examined with a 100kV, 60ns pulse derived from a PA-80. A maximum electric field of 300 kV/cm was measured before breakdown using 0.2cm thick disks, 2.54cm in diameter. This work presents a statistical analysis of the dielectric strength, power handling, and electromagnetic response of the composites with varying particle distributions.

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