Permittivity and Permeability Characterization of Engineered Composites

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A significant effort on the theoretical aspects of metamaterials has been undertaken in the last decade, focusing primarily on periodic metallizations printed on dielectric substrates. More recently, layered magneto-dielectric metamaterials, capable of supporting a frozen mode (G. Mumcu, et.al., IEEE Trans. Antennas and Propagat., vol. 53, pp. 4026-4034, 2005) were successfully used for antenna design. Layered ferromagnetic materials, with matched wave impedance ($\varepsilon_r=\mu_r$), were also used as antenna substrates and magnetic ground planes to recover the bandwidth of printed antennas in conformal installation (F. Erkmen, et.al. IEEE Antennas Wireless Propagat. Lett., to be published). That is, these engineered composites are increasingly being used to provide more flexibility in antenna design.

With the increasing use of composite materials and metamaterials in RF applications, there is a concurrent interest for their characterization (dielectric and magnetic constant, material loss, manufacturing tolerances, etc.). As can be understood, due to the inhomogeneous and periodic nature of these materials conventional characterization methods may not be applicable. Furthermore, composites in the form of a thin film preset us with even greater challenges in characterization. In particular, low loss ferromagnetic materials grown in crystal forms result in very thin magnetic layers on dielectric substrates. Textured forms of such thin films present a unique challenge for the characterization of their homogenized characteristics.

In this presentation we will discuss methods for the characterization of textured magneto-dielectric composites and thin films. Specifically, the characterization of a possibly multilayer magnetic thin film with strong uniaxial anisotropy is considered. We will present two new measurement setups, based on coupled microstrip lines and tapered stripline geometries.