Complementary Frequency Selective Surfaces for Waveguide Dielectric Measurements

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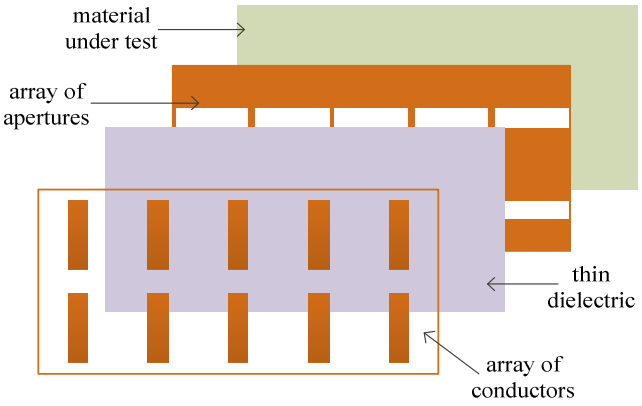
The use of dielectric materials is a popular method to decrease the antenna size. Accurate knowledge of the permittivity and losses of the materials is essential to understand and optimize antenna design. Various methods of measuring the dielectric properties exist including the use of waveguides, resonators and plane wave excitations. They all have advantages and disadvantages. Complex or heterogeneous materials are inherently difficult to measure. The authors have previously addressed the idea of creating artificial dielectrics using small scale metallic inclusions embedded in a host medium [Njoku et al. IEEE TAP, Vol. 60, No. 5, pp. 2194–2202, 2012]. This work may well be beneficial for characterizing such mixtures.

This paper will consider a new method of waveguide measurements by using a complementary frequency selective surface (CFSS) to create a sharp pass band resonance which could lead to more accurate measurements, see [Njoku et al. EuCAP 2013] for more details. The CFSS consists of an array of dipoles and an orthogonal array of apertures separated by a thin dielectric material – see image. The material under test (MUT) can then be placed behind the CFSS. The change in the pass band frequency with and without the MUT can be used to calculate the effective dielectric properties of the MUT. Knowledge of the frequency shift and the Q of the CFSS can be used to calculate the loss tangent of the MUT.



The method has been validated via simulations using EMPIRE XCcel Finite-Difference Time-Domain (FDTD) software with three homogeneous samples of known permittivity: 2.2; 4.5 and 12. The MUT increased the dielectric loading and reduced the resonant frequency. The consequent extracted permittivity values were 2.21; 4.47 and 11.64 which showed good agreement with the expected values. The presentation will include measured results of the frequency shift and hence the extracted dielectric properties.