Fabrication of a Triaxial Applicator for the Characterization of Conductor-Backed Absorbing Materials

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The electromagnetic properties of absorbing materials are often measured in situ to evaluate their performance in reducing scattered fields. Since these materials are usually adhered to a conductor backing, such as an airframe, special techniques are required to obtain two sufficiently different measurements to allow accurate determination of both the permittivity and permeability of the material. One promising approach is to use a pair of rectangular waveguide probes placed against the material coating. Measurement of the reflection coefficient from each probe and the transmission coefficient between the probes are sufficient to allow full characterization of the coating material (M. W. Hyde, et al., Radio Science, vol. 44, no. 3, pp. 3013-3026, June 2009.) Unfortunately, the coupling between the probes is relatively weak, and the numerical computation required to determine the theoretical reflection and transmission coefficients is cumbersome.

Recently, a novel triaxial applicator was proposed as an alternative to the dual waveguide probe system (Crowgey, et al., 35th Annual AMTA Symposium Proceedings, 2013). The applicator consists of nested coaxial cables terminating in a circular ground plane. The applicator is placed against the coating and the reflection coefficients from the inner and outer coaxial cables are measured, along with the transmission coefficient between the cables. Because of azimuthal symmetry, the theoretical analysis of the system is much simpler than with the dual waveguide probe. Numerical results show good coupling between the two coaxial cables, and validate the triaxial applicator concept.

Since there are no commercially available triaxial systems, an applicator must be fabricated to demonstrate the viability of the extraction process. Recent advances in three-dimensional printing allow the applicator to be fabricated in plastic, and then coated with copper to create a usable contact probe. The applicator design will be presented, and the fabrication process described. Measurements of the performance of the applicator when placed against a conductor-backed absorber will be compared to HFSS simulations and to the theoretical model.