# Measurement of the Electromagnetic Properties of a Conductor-Backed Material Using a Waveguide-Iris Technique

Benjamin R. Crowgey*, Korede Akinlabi, and Edward J. Rothwell
Department of Electrical and Computer Engineering, Michigan State University,
East Lansing, MI 48824-1226 E-mail: rothwell@egr.msu.edu

Magnetic radar-absorbing materials (MagRAM) are often applied to the conducting surfaces of air vehicles to reduce radar cross-section. To ensure proper aircraft design, the electromagnetic properties of these materials must be accurately characterized. Unfortunately, certain spray applications for MagRAM produce a coating that is inseparable from the PEC backing and thus it is crucial that the absorber be characterized while still attached to the conductor backing.

Rectangular waveguide methods are popular for measuring the electromagnetic properties of materials because of ease of sample preparation, high signal strength, and wide bandwidth. Typically a sample is placed into the cross-section of the guide and the transmission and reflection coefficients are measured, providing the two necessary data to find both the permittivity ($\varepsilon$) and permeability ($\mu$) of the sample. If the sample is conductor-backed, and occupies the entire cross-section, a transmission measurement is not available, and thus a method must be found for providing two sufficiently different reflection measurements. The technique proposed here is to place a waveguide iris in front of the sample, exposing the sample to a spectrum of evanescent modes. By measuring the reflection coefficient with and without an iris, or using two different irises, or with the sample paced into two positions behind a single iris, the necessary two data may be obtained to determine $\varepsilon$ and $\mu$.

In this paper, a mode-matching approach is used to determine the theoretical response of a sample placed behind a waveguide iris. This response may be used in a root-searching algorithm to determine $\varepsilon$ and $\mu$ using measurements of the reflection coefficient. Monte Carlo techniques will be used to characterize the sensitivity of the technique to typical measurement uncertainties, thereby providing a basis for the design of the waveguide applicator. Measured results will be presented using commercially-available absorbers to establish the efficacy of the technique.