Partial Overlay Technique for the Waveguide Characterization of Conductor-Backed Absorbers

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Absorbing materials that are used to control the radar cross section of air vehicles are often chemically adhered to the conducting surface. The performance of the coating depends on the electromagnetic properties of the absorber, which are usually determined through measurement. A typical approach is to excise a sample, place it into a waveguide system, and extract the necessary parameters from network analyzer measurements. Unfortunately, removing the absorber from the underlying conductor may alter the material properties of the absorber, and thus a technique is required to measure the properties with the bond to the conductor intact. Since transmission through a conductor-backed sample is precluded, the classic Nicolson-Ross-Weir method cannot be used, and an alternative method is sought. Any such method must provide two independent measurements so that both the permittivity and permeability can be found.

A potential approach is to obtain one measurement using the reflection from a conductor-backed sample that completely fills the cross-section of the guide. A second measurement is then made by applying a known material layer in front of the conductor-backed sample. This method has been shown to be effective for contact probe systems (G. Dester, et al., Progress in Electromagnetic Research B, Vol. 26, pp. 1-21, 2010.) However, the method fails in the case of rectangular waveguide systems. It has been shown theoretically that adding a planar, isotropic overlay that fills the cross-section of the guide provides no additional information about the properties of the sample (R. Fenner, et al., Radio Science, 47, pp. 1004-1016, January 2012.)

This paper examines an alternative approach in which the overlay only partially fills the cross-section of the guide. The partial overlay generates higher-order modes with fields that probe the sample differently than the dominant mode fields produced by an overlay that completely fills the guide. The effectiveness of the proposed technique is evaluated by comparing the extraction error to standard reflection-only techniques such as the two-thickness method. In particular, the dependence of the extraction error on the width and material properties of the overlay are explored.