

## **Application of the Method of Subregions to Measurement of Layered Materials**

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Layered material coatings are often applied to surfaces in order to reduce the scattered field strength within specific frequency bands. A full understanding of the transient behavior of the reflected field from layered materials can be used to diagnose the composition of these coatings. It has been shown previously (B.T. Perry, et al., URSI North American Radio Science Meeting, Washington, D.C., 2005) that the transient field reflected from a two-layer conductor-backed geometry can be broken into responses from subregions of the material stack. Experimental validation of the form of the reflected field from an N-layered material structure is of interest here.

The method of subregions is used to show that the transient plane-wave field reflected from an N-layer planar stack of materials consists of a series of late-time responses of subregions of the stack, with the k-th subregion consisting of the first k-material layers backed by a semi-infinite region with the material parameters of region k+1. Each of these late-time responses exist during time periods corresponding to the excitation of the different layers of the N-layered medium.

Measurements are made using the MSU Reflectivity Arch Range which is a circular structure 6.096 meters in diameter, standing 1.219 meters high with horn antennas mounted around the periphery. These antennas can be placed in various configurations around the arch, but for these measurements are placed side by side in order to approximate a mono-static arrangement. Scattering from the material stack, which is mounted in the center of the circular structure and at the same height as the horn antennas, is measured using an HP 8510C network analyzer with S parameter test set. A two-stage calibration method is utilized to mitigate the affects of the measurement system. This procedure utilizes a full two port calibration of the network analyzer, as well as a PEC plate calibration used to characterize the remainder of the system (cabling, horn antennas, etc.).

Results are compared in the time domain with simulated responses of various subregions of the material stack in order to show that each subregion can be characterized individually, disregarding the composition of the rest of the material stack, whose response will “turn on” once the incident wave has propagated further into the layered medium. This result is useful for evaluation of layered coatings on bodies whose underlying composition may be unknown or complex.

