In Situ Material Characterization of Curved Samples using Analysis of Gaussian Beam Reflection from a Convex Cylindrical Shell

Kai Du and Vasundara V. Varadan*
Center for the Engineering of Electronic and Acoustic Materials and Devices
Department of Engineering Science and Mechanics
The Pennsylvania State University
University Park, PA 16802, U.S.A.

ABSTRACT

A method to invert S-parameter data from curved samples is presented using an analysis of Gaussian beam reflection from a convex circular cylindrical shell. The scattering of Gaussian beam by a layered cylinder can be formulated rigorously using the Fourier expansion method. It is proposed here that if only incoming waves, instead of standing waves, are used in the series expansion for the fields in the inner region, the result is a good approximation of the fields scattered by a convex cylindrical shell. Physically this means an infinite sink (perfectly absorbing column) is placed on the axis of the layered cylinder so that the reflection from the far side of the closed cylinder is eliminated. Such a modification is validated by a comparison with the complex ray tracing method for the special case of a Gaussian beam scattering by a half circular cylinder. As another verification, the reflected fields are used to calculate an equivalent "reflection coefficient" as measured in a free space material characterization system using spot-focusing antennas. Computation results are compared with experimental data and the agreement is as expected. The analysis can be used in an inversion algorithm for characterization of material samples in the shape of circular shells.

Additional Information:

1. Commission A (Electromagnetic Metrology), A8. Antennas and EM-field metrology
2. Using this formulation, an inversion technique is developed for the electromagnetic characterization of curved samples.
3. In previous work, curved samples were characterized, using the free space method consisting of spot focusing antennas, by assuming that samples were locally flat. These measurements are valid only for samples with large radii of curvature.