Characterizing Dense Distributions of Spheroidal Particles in Random Media

Benjamin E. Barrowes*
Department of Electrical Engineering and Computer Science
Research Laboratory of Electronics
Massachusetts Institute of Technology
Cambridge, MA 02139-4307

Monte Carlo simulations are used to derive the effective permittivity of a random medium consisting of densely packed spheroids. Previously, characterization of ϵ_{eff} has been performed for the 2-D case [2] and for collections of spheres [3] but not for 3-D collections of spheroids. In this work, effective permittivities are derived by comparing scattered intensities from two cases: 1. scattering from a collection of randomly distributed spheroidal particles contained in some predetermined boundary, and 2. scattering from homogeneous media contained of the same shape.

Scattering from the random medium is based on the volume integral equation which is solved by the method of moments (MoM) using dipole basis functions or dipole and quadrapole basis functions for spheroidal particles [1]. A sphere is chosen as the boundary shape for the random medium in order to facilitate comparison to Mie scattering in the homogeneous case. The effective permittivity (ϵ_{eff}) is derived for media with fractional volumes (f_v) of 5-50%, ellipsoidal elongation factors (e) of 1 (sphere) to 3, particle sizes from .1 to 3 wavelengths (λ), and with various levels of sticky particles included.

A shuffling process based on the Metropolis Shuffling method is used to generate the positions and orientations of the densely packed particles. Many realizations are performed and the results averaged in order to model the random media. Up to 2000 particles and 50 realizations have been used to derive ϵ_{eff} for the above cases. A standard routine based on Gauss-Newton optimization method is used to find ϵ_{eff} given the scattering from each particular distribution.

Results indicate that the scattering from random media consisting of densely packed spheroids is different from the scattering from random media consisting of spheres.

Topics: electromagnetic scattering, random media

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[3] - L. M. Zurk, L. Tsang, D. P. Winebrenner, "Scattering properties of dense media from Monte Carlo simulations with application to active remote sensing of snow," Radio Science, Volume 31, Number 4, Pages 803-819, July-August 1996.

*E-mail: barrowes@mit.edu