Scattering from Deformed Cylinders and Cylindrical Shells

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True smooth surfaces can only exist in theory; thus every surface in nature has some kind of roughness that may affect its response to electromagnetic waves. Random roughness is very difficult to analyze; however, a specified class of roughness can be incorporated in many solution techniques to predict the corresponding electromagnetic response. In most of these attempts, it is cumbersome to compute the required data in a convenient time using moderate resources. In addition to the natural roughness, man made roughness involving specific patterns, usually called deformations or corrugations, are important to consider.

In this paper the scattering characteristics of periodically deformed cylinders and circular shells are presented. The scattering problem is two dimensional (2D) and the analysis is therefore suited to be investigated using scatterers that are generally constructed from a set of parallel circular cylinders. The problem of the scattering by parallel cylinders has been under continuous investigation for decades using different techniques. Among these, is the boundary value point matching technique which will be used for this investigation. Deformed scatterers of conducting, dielectric, or combinations of conducting and dielectric materials are examined. The excitation is represented by a plane wave, or a line source field for both TM and TE types of polarizations. For practical applications and experimental conditions, a bounded incident beam rather than the infinitely extended or omni-directional cylindrical wave should be considered. Therefore, this investigation is further extended to analyze the scattering from deformed scatterers excited by a 2D Gaussian beam. This type of excitation represents a more practical excitation than the plane wave or the line source field.

Sample of the numerical results obtained using this simulation procedure is shown in the Figure. The scatterer consists of a circular dielectric cylinder of radius equal to 0.45 $\lambda$ and $\varepsilon_r = 4$. The dielectric cylinder is partially coated by a corrugated metal sheet which is simulated by a circular arc deformed by a sinusoidal function and consisting of 63 perfectly conducting cylinders. The depth of deformation is 0.05 $\lambda$ and the thickness of the sheet is 0.015 $\lambda$. This composite geometry is excited by an incident plane wave propagating along the $x$ axis. The polar plot shows the scattered field pattern for the dielectric cylinder alone along with the pattern of the partially loaded cylinder. The effect of the loading is clearly shown, specially in the backward direction.