Modeling of Layered and Corrugated Surfaces using Higher Order Generalized Impedance Boundary Conditions

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Metamaterial surfaces have been of interest for a variety of antenna and RCS-reduction problems. In this work, we use the general impedance boundary conditions (GIBCs) to enable fast modeling of these surfaces. Traditionally, GIBCs have been used to model angle-dependent reflection coefficients for certain canonical surfaces. Mostly, they have been used to model thin dielectric layers. For more complex structures, such as periodic surfaces, mushroom structures and corrugated metal surfaces, such calculation of GIBCs cannot be done analytically. Herewith, we present a method to solve this issue. Specifically, 2^{nd}, 3^{rd} and higher order GIBCs are considered for modeling complex periodic surfaces across several angles, and all the way to grazing. It is found that 4^{th} order GIBCs can be used to model rather complex corrugations, including electromagnetic bandgap structures across incidence angles. Surface waves can also be predicted by the numerically derived GIBCs as complex incidence angles are also recovered.

To derive the proposed GIBCs, we first use full-wave simulations to calculate the reflection coefficients for a few specified incidence angles (usually one or two angles or more, depending on the order of the GIBCs and the number of coefficients that must be determined). Using the calculated coefficients, the resulting GIBC is employed to determine the reflection coefficient at all angles and compared to reference numerical calculations for accuracy. Of course, using GIBCs, the reflection coefficient of the impedance surfaces is predicted at a tiny computational cost.

In the presentation, the theory and implementation of the proposed GIBC generation method will be shown for a variety of impedance surfaces and engineering periodic structures. We will further employ GIBC-based reflection coefficient to predict surface waves in these surfaces.