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A High Order Method for Electromagnetic Scattering from Penetrable Rough Surfaces

The problem of evaluating the electromagnetic response of a periodic surface to an incident plane wave is of great importance in science and engineering. Applications of the theory exist in several fields of study including solar energy research, optical instrument design, and remote sensing. A fast solver for the forward problem, as we describe here, often forms the basis of an iterative solver for the inverse problem. We discuss the extension of our previous methods (J. Opt. Soc. Am. A 26(3): 658–668, 2009; Waves in Random and Complex Media 20(4): 530–550, 2010) to treat the problem of scattering from penetrable surfaces with a complex refractive index. The generalization of our methods is not straight-forward, and involves the careful treatment of certain hyper-singular operators which arise in the formulation of the problem in terms of surface integral equations. We demonstrate the rapid convergence of our methods for classically difficult cases in the optical sciences.