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An iterative solver combined with extrapolation for steady-state Maxwell problems

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We present an iterative finite difference frequency domain (FDFD) solver for a large scale time-harmonic Maxwell problem. The solver is based on an explicit leap-frog power iteration and is enhanced by a Prony method extrapolation scheme to speed up convergence. We take a look at the algebraic formulation of the problem, iteration and extrapolation schemes, and discuss challenges and results. The primary application is a thin-film solar cell simulation that consists of both layers of positive and negative permittivities with textured interfaces in between. Electrical permittivity parameters of the layer media as well as the textured interface profiles are important model parameters. Resulting quantities of interest are the simulated solar cell's absorption behavior, specifically its short circuit current density and its characteristic frequency dependent quantum efficiency. Considered boundary conditions are periodic or of Dirichlet type in connection with a perfectly matched layer (PML) to simulate free space propagation. The periodicity of the domain with respect to textured interfaces can be enforced either by a reformulation of the periodic boundary condition or a transition layer that extends on the classical approach to achieving periodicity by means of symmetrical domain extensions. The discussed method scales to large problem sizes, and obtained results are in good agreement with physical measurements of manufactured structures.