Simulation-informed rational design of 1D photonic crystals

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A one dimensional (1D) photonic crystal (PC) is composed of periodic dielectric layers with mismatched refractive indices, which can reflect electromagnetic waves at designated wavelengths. PC reflectance spectra are determined by the difference in refractive index and thickness of each layer. One common approach to describe the propagating waves through PCs at each interface is using Transfer Matrix Method (TMM). While modeling uniform PCs has been previously demonstrated using this method, a platform to model PCs that accounts for heterogeneity among the layers of the PC that may more accurately depict experimental development of a PC is still lacking. Herein, a MATLAB program is designed to model reflectance behavior of PCs with arbitrary layer thicknesses and refractive indices, as well as involving other user-definable parameters, such as a variety of methods for altering the layer thicknesses and interfacial roughness between distinct layers. Furthermore, this program is built with a Graphical User Interface (GUI) for simplicity and convenience, especially for users with limited programming backgrounds. The application is published alongside a standard operating procedure to help new users navigate the program efficiently. We believe this simulation platform would provide important fundamental insights for informing rational design of 1D PCs in various applications including military defense, advanced coatings, as well as optoelectronics.