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Efficient calculations of dispersive properties of photonic crystals using the transmission line matrix method

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Keywords

photonic crystals, transmission line matrix (TLM), dispersion relation, multigrid mesh

Abstract

In this paper, we present an analysis of the accuracy and efficiency of different approaches for the simulation of photonic crystals using the transmission line matrix method. The approaches that we present can be divided into two categories: complex- and real-valued algorithms using a uniform mesh, and complex- and real-valued algorithms using a multigrid mesh. The advantages and disadvantages of each approach are discussed and a brief comparison between these methods is made from the points of view of computational expense and accuracy. It is found that a combination of a real-valued method in a multigrid mesh results in the most efficient algorithm. However, while the complex-valued formulation is valid for the analysis of any photonic crystal, the applicability of the real-valued formulation is limited by structural constraints requiring cell symmetries. It is also found that a multigrid approach can considerably reduce the computational cost required for simulating photonic crystals and our results indicate that a good compromise between accuracy and computational cost can be found. Various photonic crystals are simulated by applying these approaches, and the results are validated using alternative methods.