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Efficient Analysis of Complex Modes in Cylindrical Photonic Crystal

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Cylindrical photonic crystal is a topic of active research because of its potential importance in fiber-optic communications [1], nonlinear devices [2]. The modal properties of cylindrical photonic crystal have been extensively investigated using the finite element method combined with PML [3], the finite difference frequency domain method, the multipole method [4]. These numerical methods could be versatilely applied to various microstructured configurations but they are computationally intensive.

In this paper, we shall present a novel full-wave rigorous approach for the vector fields in cylindrical photonic crystals, which consists of layered cylindrical arrays of circular rods symmetrically distributed on each of concentric (eccentric) circular cylindrical surfaces. The method is computationally fast and easy to implement for a wide class of cylindrical photonic crystals. The proposed approach introduces a cylindrical layer model to the array, extracts the reflection and transmission matrices of a cylindrical periodic layer, and then obtains the characteristics of the whole layered structure by using a recursive algorithm [5, 6]. In our formalism we take into account all cylindrical Floquet modes and their interactions through the scattering by each cylindrical layer. In the case of the modal analysis of the guided waves without any initial excitation, we could assume a unique symmetric property of the mode field distribution inherent to the periodicity of the circular rods. In the work we calculate the complex propagation constant for hexagonal arrays and the results will be presented at the symposium.

References

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