Preface

The great interest in photonic crystals and their applications in the last 15 years is being expressed in the publishing of a large number of monographs, collections, textbooks and tutorials, where existing knowledge concerning operation principles of photonic crystal devices and microstructured fibers, their mathematical description, well-known and novel applications of such technologies in photonics and optical communications are presented. They challenges authors of new books to cover the gaps still existing in the literature and highlight and popularize of already known material in a new and original manner.

Authors of this book believe that the next step towards wide application of photonic crystals is the solution of many practical problems of design and computation of the specific photonic crystal-based devices aimed at the specific technical application. In order to make this step, it is necessary to increase the number of practitioners who can solve such problems independently. The aim of this book is to extend the group of researchers, developers and students, who could practically use the knowledge on the physics of photonic crystals together with the knowledge and skills of independent calculation of basic characteristics of photonic crystals and modeling of various elements of integrated circuits and optical communication systems created on the basis of photonic crystals.

The book is intended for qualified readers, specialists in the field of optics and photonics, students of higher courses, master degree students and PhD students. As an introduction to the snopest, the book contains the basics of wave optics and radiation propagation in simple guiding media such as planar waveguides and step-index fibers.

Relying on fundamental laws and models, we give descriptions of physical principles of light propagation inside 1D, 2D and 3D photonic crystals and microstructured fibers. Detailed explanations of the basic terms used in photonic crystal physics, such as reciprocal lattice vectors, Brillouin zone, matrix eigen-vectors and eigen-states, basis functions, etc. are given.

The following chapters describe methods of the eigen-problems solution for 1D, 2D and 3D photonic crystals as well as methods for computation of field distribution inside nonuniform media. Solutions to several specific problems, such as field distribution and eigen-states of microstructured fibers and photonic crystal waveguides are given. In the last chapter, an example of the design of the photonic crystal-based wavelength division demultiplexer is considered.

For each case, models which allow to obtain fundamental characteristics of a photonic crystal are considered. Detailed descriptions of problems such as computation of the band structure and field distribution inside photonic crystal devices are given. Main attention is given to numerical implementation of the considered models. Algorithms and computation procedures for the plane wave expansion method and finite-difference time-domain method are given.

The important feature of this book is the combination of theoretical material and description of algorithms and program printouts based on the authors' experiences.

Each chapter of the book, except the first two, contains examples of a problem which includes computation techniques, algorithm description, and peculiarities of its implementation, as well as computed results reflecting all of intermediate and final stages of the computation, with a detailed analysis. Thus, after studying the theoretical material, the reader can use the programs provided for solving the examples recommended for knowledge consolidation as well as original problems.

Besides commonly considered problems on computation of photonic band structure and field distribution inside photonic crystals, the design method of wideband photonic crystal filters which can be used for WDM demultiplexing is given in the final chapter as an example of complex photonic crystal-based device synthesis. Such an example consolidate the knowledge and skills acquired the previous chapters together with described photonic band gap maps, photonic density of states maps and computed spectral characteristics.

We try teaching the reader to make a purposeful choice of a method and to understand its implementation algorithms. So we have provided convenient tools for unassisted solution of the problems described in a separate chapter. Program printouts can be directly used for modeling. Thus, we consider our book as an effective practical addition to the well known, widely distributed books.

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