

Preface

Phononic crystals (PnCs) are novel synthetic periodic materials for controlling and manipulating the propagation of elastic (or acoustic) waves. The periodic nature of PnCs gives them novel properties that cannot be found in bulk materials. For example, PnCs can exhibit acoustic (or phononic) bandgaps, which are frequency ranges in which the propagation of acoustic waves inside the PnC is prohibited. The addition of defects to a perfect PnC with a phononic bandgap allows for the design of devices like waveguides and cavities to control the propagation of acoustic waves inside the bandgap and to enable novel functionalities in a very compact structure.

Imminent impact of PnCs is expected in the near future in applications like wireless communications, sensing, acoustic signal processing, and ultrasound imaging. Novel devices (such as acoustic filters, resonators, sources and lenses) with outstanding performance measures are being enabled by the use of PnCs. In addition, the use of these structures to form acoustic metamaterials can uncover novel effects like negative refraction, acoustic invisibility, or superlensing. This, in turn, can enable researchers to design functional structures with such performance that cannot be obtained with conventional acoustic materials.

While the research in the field of phononic crystals and acoustic metamaterials is at the early stages, their optical counterparts (i.e., photonic crystals) have already been demonstrated to possess unique properties that are not achieved using conventional bulk materials. The properties of photonic crystals have been the subject of intensive investigations in the last decade, and several successful books have been published to address their unique properties and applications. Knowing that the research in PnCs is in its infancy, and more attention is given to this field lately, the field is expected to expand considerably in the next few years.

The purpose of this book is to present a detailed overview of the state of the field from material, device, and application perspectives, and provide the necessary tools for researchers to explore the field. To achieve this goal, this book covers the simulation, fabrication, and characterization methods used to design and experiment with PnCs to the level that is accessible for both the experienced and beginner in the field. The book also reports the most important advances in the field in the last few years.

The idea for this book first came up in summer 2009, where we co-chaired the first International Workshop on Photonic Crystals (Nice, France, 2009), in which all experts in the field were invited. The need for an all-encompassing reference in the field of phononic crystals was recognized in the meeting. After that meeting, we spent an extensive amount of time looking into the needs of the community to form the structure of the chapters in the book and to convince the experts in the field (who were among the participants in the workshop) to write their respective chapters.

The authors of these chapters are among the world leaders in their respective fields with years of experience in performing cutting-edge research and educating young scientists and engineers. In addition to presenting the landscape of the research in this field, we hope that this book can provide interested readers with an in-depth knowledge of the field. The individual chapters are written in such a way that they can be used as the text material for enhancing graduate-level courses in mechanical or electrical engineering disciplines.

At the end of this journey, we would like to thank all those who helped us in forming this book through their discussions, contributions to the book, and reviews of the different sections. We also like to thank the many researchers (students, postdocs, members of technical staff, and professors) whose contributions are covered in this book. Our special thanks go to Dr. Ali A. Eftekhar for his key role in forming the idea of the book, his help in defining different chapters, and his excellent feedback at different stages of forming the book.

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