# Preface

Since the 1960s, the waveguide optics has evolved into an emerging discipline and had a tremendous impact on our information society. It attracted considerable attention of scientists and technologists because of the potential applications for signal processing, biochemical sensing, etc. The parallel development of material science, optoelectronics, and micromachining technology has overcome several technical obstacles and made possible the implementation of optical waveguide system to perform those fascinating applications. In addition to this, optical waveguide devices with new principles, new materials, and new structures are constantly proposed, and some of them, including planar optical integrated circuits, photonic crystal structure, nano-array structure, and plasmonics, become the research hot spots in academic and industry. In one word, waveguide optics is an extremely promising and fast-growing field.

This book is intended to serve as a general text on planar optical waveguide structure for senior undergraduates. The Chinese version has published 7 years ago, and the idea of writing this book is a result of frequent enquiries about the possibility of publishing an English version. Because many significant advances on waveguide optics have been made during the intervening years, it is felt that a direct translation is hardly appropriate. Instead, a substantially new book is prepared, which I am now placing before the readers. This book is intended to summarize our recent research results and introduce the current progresses in optical waveguides. Therefore, some relatively old contents written in the Chinese version have been omitted. The following characteristics can be found in this book:

1. Some mature theories, such as optical fiber theory, coupled modes theory, and a number of numerical methods, have already analyzed in other equivalent books. These contents are not contained in this book because I designed to restrict its scope to a narrow field, which is only a collection of some of our researches on waveguide optics.

2. Both the analytical transfer matrix methods and the perturbation analysis are the mathematical basis of this book. By applying these two methods, several waveguide optics problems can be depicted with the formulae in the analytical form and the corresponding derivation processes are quite simple.
3. The field distribution function of the optical waveguide is not expressed by the conventional sine or cosine form, but the exponential form, and thus, a transmission-type dispersion equation with more clear physical insight is obtained. Moreover, a newly defined concept, i.e., the scattered subwaves, is firstly proposed. The neglect of the scattered subwaves in other semiclassical theories, such as WKB and SWKB, results in various confusions and paradoxes. Based on this new concept, an analytical dispersion equation for the graded-index waveguide is also given.
4. The Goos–Hänchen shift occurred at the total reflection is an interesting and important issue in waveguide optics. Several causality paradoxes originated from this issue have been discussed, and our debate to these paradoxes is presented in this book. The experimental applications of Goos–Hänchen shift and other non-specular effects are also added.
5. The surface plasmon wave, the metal-cladding waveguide, and the corresponding principle of attenuated total reflection are one of my top and main research topics. In this book, the basic theories and experimental applications of our proposed symmetrical metal-cladding waveguide, free-space coupling technology, ultrahigh-order modes, wideband slow light, conical reflection, and oscillating wave sensors are included.

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Although great care has been exercised, some errors may still occur in this book. Therefore, I appreciate any comments from readers.

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