

## COMPACT BLUE-GREEN LASERS

This book describes the theory and practical implementation of three techniques for the generation of blue-green light: nonlinear frequency conversion of infrared lasers, upconversion lasers, and wide-bandgap semiconductor diode lasers.

The book begins with a discussion of the various applications that have driven the development of compact sources of blue-green light. Part 1 then describes approaches to blue-green light generation that exploit second-order nonlinear optics, including single-pass, intracavity, resonator-enhanced and guided-wave second harmonic generation. Part 2, concerned with upconversion lasers, investigates how the energy of multiple red or infrared photons can be combined to directly pump blue-green laser transitions. The physical basis of this approach is thoroughly discussed and both bulk-optic and fiber-optic implementations are described. Part 3 describes wide-bandgap blue-green semiconductor diode lasers, implemented in both II–VI and III–V materials. The concluding chapter reflects on the progress in developing these lasers and using them in practical applications such as high-density data storage, color displays, reprographics, and biomedical technology.

*Compact Blue-Green Lasers* provides the first comprehensive, unified treatment of this subject and is suitable for use as an introductory textbook for graduate-level courses or as a reference for academics and professionals in optics, applied physics, and electrical engineering.

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W. P. RISK  
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## Preface

Since the mid-1980s, the development of practical, powerful sources of coherent visible light has received intense interest and concentrated activity. This interest and activity was fueled by twin circumstances: the realization of powerful, efficient infrared laser diodes and the emergence of numerous applications that required compact visible sources. The availability of these infrared lasers affected the development of visible sources in two ways: It stimulated the investigation of techniques for efficiently converting the infrared output of these lasers to the visible portion of the spectrum and it encouraged the hope that the fabrication techniques themselves might be adapted to make similar devices working at shorter wavelengths.

Within the visible spectrum the blue-green wavelength region has demanded – and received – special attention. The demonstration of powerful red diode lasers followed relatively soon after the development of their infrared counterparts – in contrast, the extension to shorter blue-green wavelengths has required decades of wrestling with the idiosyncrasies of wide-bandgap materials systems. The first blue-green diode lasers were not successfully demonstrated until 1991, and it has only been within the past year or two that long-lived devices with output powers of tens of milliwatts have been achieved.

As this field emerged and began to grow, it quickly became evident that it would necessarily be a very multi-disciplinary one. On one hand, a variety of approaches were being pursued in order to generate blue-green light. The three main ones – nonlinear frequency conversion, upconversion lasers, blue-green semiconductor lasers – are the focus of this book. The common goal of developing laser devices capable of emitting as much as several watts in the 400–550-nm spectral range brought together experts in nonlinear optical materials, diode-pumped solid-state lasers, guided-wave optics, rare-earth spectroscopy, semiconductor material processing and laser diode device physics. On the other hand, the range of applications for such devices attracted experts from such diverse fields as biomedical

engineering, display science and technology, optical data storage, and undersea communications.

Capturing this broad range of both approach and application in a book of reasonable length has been challenging, as has been writing clearly for readers that we expect will come to this book from a wide variety of disciplines and backgrounds. In the interest of clarity, we have included some material introducing and explaining basic concepts of nonlinear optics, rare-earth spectroscopy, and semiconductor device physics. Some readers will already be completely familiar with this material and may wish to skip directly to sections that explain in greater depth the application of these basic principles to specific approaches for generating blue-green light. Other readers may appreciate a brief refresher in some of these concepts – the reader who is fully conversant with nonlinear optics, rare-earth spectroscopy, and semiconductor device physics is probably a rare creature! Still other readers may wish to consider some of these basic ideas in greater depth – for these, we have recommended where possible other books that treat these subjects and have also made available some supplementary material on the Cambridge University Press website at <http://publishing.cambridge.org/resources/0521623189>.

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