SpringerBriefs in Physics

More information about this series at http://www.springer.com/series/8902

Haiyin Sun

A Practical Guide to Handling Laser Diode Beams

Springer

Haiyin Sun
ChemImage Corporation
Pittsburgh, PA
USA

ISSN 2191-5423 ISSN 2191-5431 (electronic)
SpringerBriefs in Physics
ISBN 978-94-017-9782-5 ISBN 978-94-017-9783-2 (eBook)
DOI 10.1007/978-94-017-9783-2

Library of Congress Control Number: 2012939640

Springer Dordrecht Heidelberg New York London

Printed on acid-free paper

Springer Science+Business Media B.V. Dordrecht is part of Springer Science+Business Media (www.springer.com)

Foreword

Since the invention of the laser in the 1960s, lasers have found extensive applications in many areas and the laser market has grown rapidly. According to a report published in January 2013 in *Laser Focus World* [1] the global laser market was worth $8.62 billion in 2013, an increase of 62 % from $5.33 billion in 2009, and the laser diode market constantly accounts for about 50 % of the dollar amount. Laser diodes are also the most widely used lasers from an application point of view. Below is an incomplete list of applications:

Alignment	Bio cell detection	CD data record and reading
Confocal microscopy	Capillary electrophoresis	Display and entertainment
DNA analysis	Flow cytometry	Genomics
Gas detection	High-speed printing	Holography
Imaging on film	Inspection	Interferometry
Laser-induced fluorescence	LIDAR	Lithography
Machine vision	Materials processing	Metrology
Particle counting	Raman spectroscopy	Rangefinding
Remote optical sensing	Reprographics	Telecommunications

Compared with other lasers, laser diodes have unique characteristics and offer a number of advantages:

1. A wide range of wavelength selection from ultraviolet (375 nm) to middle infrared (10.4 μm).
2. A wide range of power selection from mW to kW.
3. Operation either in continuous wave or pulsed mode, with pulses as short as picoseconds, or modulated up to gigahertz rates.
4. As small as a needle tip.
5. High electrical to optical power conversion (efficiency of over 30 %) and capable of battery operation.
6. Long lifetime of about 10,000 h.

However, laser diodes also have a number of shortcomings:

1. Highly divergent, elliptical and astigmatic beams.
2. Unstable wavelengths and powers.
3. Sometimes have multi-single modes and/or multi-transverse modes.
4. Large manufacturing tolerance.
5. Vulnerable to electric static discharge.

These shortcomings often make the application of laser diodes a challenging task. A good understanding of the unique properties of laser diodes, and particularly of how to manipulate and characterize diode laser beams, is essential for the effective use of laser diode systems.

Many optical design technical books have been published. These books mainly deal with imaging optics design based on geometric optics using the sequential raytracing technique. Some books touch briefly on the subject of optical design as related to laser beam manipulation. On the other hand, many books on laser diodes have been written. These books all extensively deal with laser diode physics with little or no discussion of laser diode beam manipulation or characterization. Some internet resources dealing with laser diode beam manipulation can be found online. However, in this author's opinion, these resources do not provide enough material or sufficient detail on laser diode beam manipulation and characterization.

This book intends to address this vacancy and provide a practical guide and reference to those scientists and engineers who are still new to laser diode applications, and to those undergraduate and graduate students who are studying lasers and optics. The author hopes that the readers will be able to quickly and easily find the most practical and useful information about laser diode beams from this book without having to search through a sea of information.

This book *A Practical Guide to Handling Laser Diode Beams* is a revised and significantly extended version of the book *Laser Diode Beam Basics, Manipulations and Characterizations* written by the author and published by Springer in 2012. Since the publication of the previous book, the author has received much useful feedback from readers, and was motivated to write a follow-up book to address these comments. Compared with the previous title, the book contains about 75 % more content, covers many more topics, discusses the subject matter in more detail, and has been extensively reorganized. The new topics include: laser diode types and working principles, non-paraxial Gaussian beams, Zemax modeling of Gaussian beams, numerical analysis of laser diode beam characteristics, spectral property characterizations, and power and energy characterizations. Much of the existing text has also been revised to include more detail, and many graphs have been redrawn.

Nowadays, a lot of information can be found by online keyword search. Therefore, in this book we list only some references that are rather specific and not easy to find through a general search. We also list some Internet resources. A few references are recommended for those readers who are interested in learning more

about laser diodes: References [2] and [3] for laser diode physics, Rreference [4] for general questions about laser diodes, and Reference [5] for a concise review of laser diode history and applications.

References

1. Laser Market Place: Laser markets rise above global headwinds. http://www.laserfocusworld.com/articles/print/volume-49/issue-01/features/laser-marketplace-2013-laser-markets-rise-above-global-headwinds.html (2013)
2. Coldren, L.A., Corzine, S.W.: Diode Lasers and Photonic Integrated Circuits. John Wiley and Sons, Inc., New York (1995)
3. Pospiech, M., Liu, S.: Laser diodes. An Introduction. http://www.matthiaspospiech.de/files/studium/praktikum/diodelasers.pdf
4. Sam's Laser FAQ. http://www.repairfaq.org/sam/laserdio.htm
5. Welch, D.: The laser diode 50 years and counting. http://www.infinera.com/technology/files/Infinera-Celebrating-50-years-of-Diodes.pdf

Contents