

Preface to the 2nd edition

Fibre optic communications continues to be a key enabler for industrial development, economic progress and the shaping of modern society. Despite the tremendous achievements over the past twenty years there is a strong demand for further advances. Overall data traffic will continue to grow strongly, optical communication technologies will move closer to the end user, optical technologies will take a central role in (intra) data centre information exchange. However today's communications and data centres already account for a few percent of the world's total usage of electrical energy and this is projected to continue increasing. Going forwards, the cost of optical communication has to go down and energy efficiency must improve. In order to achieve these goals, significant R&D effort is being spent on improving performance of key components as well as lowering device size and fabrication cost, and this trend is predicted to go on in the years to come.

As a consequence of the significant progress made in virtually all fields during the last few years, we considered a 2nd updated edition of the book *Fibre Optic Communication—Key Devices* appropriate some four years after the appearance of the 1st edition. We would like to recognise the great engagement of the many contributors and the publisher in making this revised book available. Existing chapters have been appropriately updated and a few new chapters have been added in appreciation of topics that have received particular attention and have made substantial progress during the past few years.

Spatial division multiplexing (SDM), including mode division multiplexing, is among the fields which have experienced rapid development recently. Its promise is to enable improved cost and energy efficiency, and its implementation requires specific device developments, in particular SDM fibres and dedicated fibre amplifiers and de/multiplexers. SDM is treated in a chapter in its own right and in SDM-related sections in the chapters on optical fibres and fibre amplifiers as well.

Higher order modulation (HOM) formats represent another topic which has witnessed tremendous advancement. Dedicated optical devices combined with extensive electronic signal processing have lead to spectral efficiencies in the tens of bit/s/Hz. As a result of the remarkable achievements related to HOM formats, the corresponding chapter has been rewritten rather than updating the respective chapter of the 1st edition.

Photonic integration is considered a promising approach towards realizing higher device functionality at lower cost and with lower power consumption, and various paths are currently being pursued:

Hybrid photonic integration, which is essentially an optical micro-assembly technology, has been pursued for about two decades already and has achieved remarkable results using different dielectric waveguide platforms, and therefore a new, dedicated chapter has been included in this 2nd edition.

A particular hot topic in photonics is ‘Silicon Photonics’, i.e. silicon-on-insulator (SOI) based chips with optical functionality. A large number of exciting results have been reported recently including improved performance of individual subcomponents as well as higher levels of integration. Promising applications have emerged in various fields, amongst them optical rack-to-rack-, chip-to-chip, and optical on-chip interconnects. The corresponding chapter of the 1st edition focusing on silicon photonic sources has been updated including a new section on modulators, and a new chapter addressing key passive devices and detectors has been added to the book.

A third path towards higher functionality and lower chip cost is monolithic integration using III–V semiconductors, primarily indium phosphide along with its lattice-matched ternary and quaternary compounds. In contrast to Si Photonics this approach enables the full monolithic integration of lasers and related device structures with detectors, modulators and passive functionalities. A newly written chapter is devoted to this integration platform, particularly highlighting generic fabrication of photonic integrated circuits following a foundry model.

“Optical switching” is a generic term which covers an extremely wide range of techniques and solutions, ranging from simple and slow network protection to all-optical switching. It is a topic which justifies corresponding books in their own right, and an in-depth treatment would have been beyond the scope of the present book. However, the range of devices treated in the 1st edition has been complemented by a new chapter on optical switches. The chapter covers generic aspects such as larger switching matrices and wavelength selective switches, and implementations including opto-mechanical-, liquid crystal-, planar lightwave- and in particular MEMS based switches. Beyond these expansions of the scope of the 1st edition, two topics have no longer been considered in the 2nd edition: optical signal processing for high-speed data transmission. In the editors’ opinion the corresponding concepts have not experienced major progress during the last few years, and there are no signs that such techniques may find practical applications in the near to medium future. The chapter on optical networks is also no longer included in the book, as there is currently significant development across multiple network domains, and it is difficult to do the subject justice in one chapter. Access networks are seeing new standardisation for NG-PON2, new concepts are emerging for SDM fibre, and increasing levels of software defined and data centric networking. Covering all these topics requires a book in its own right and so the editors have decided to leave this field out.

The overall structure will essentially be similar to that of the 1st edition: The introductory chapter on space division multiplexing is followed by a chapter on the

optical fibre, the fundamental building element of any fibre optic communication system. The chapter covers fundamentals, key properties of all relevant kinds of fibre and most recent developments for SDM applications as well.

The next three chapters focus on InP semiconductor based lasers. The first of them covers fundamental aspects and various kinds of 1.3–1.6 μm laser structures including recent results on vertical cavity surface emitting lasers (VCSELs), and a section on semiconductor optical amplifiers (SOA) as well. The latter replaces the SOA chapter of the 1st edition and takes advantage of many common aspects between lasers and SOAs. The following two laser related chapters treat ultrafast laser sources and widely tunable laser diodes.

A chapter on photodetectors as the key elements on the receiver side is followed by chapters on those elements which enable advanced fibre optic communication systems with highest spectral efficiency and transmission capacity: semiconductor-based modulators and higher order modulation formats.

The next few chapters are dedicated to wavelength filters, optical switches, passive devices including optical circulators and optical isolators, and fibre amplifiers. The four chapters focusing on photonic integration conclude the book.

Altogether, the book follows the same principles as in the case of the 1st edition: the treatment of the topics of the individual chapters start from the fundamental physics before moving on to generic devices and commercially available implementations, and covers solutions under current development before highlighting new research directions.

The editors would like to express their deepest thanks to all the renowned authors for their extreme engagement and their valuable time spent on writing the individual chapters. It is them who made it possible to edit a book covering such a wide range of diverse topics and presenting a high-level, up-to-date overview with the most recent accomplishments. We are also very grateful to the publisher Springer Verlag, and in particular Claus Ascheron, for their continuous support and encouragement.

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<http://www.springer.com/978-3-319-42365-4>

Fibre Optic Communication

Key Devices

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2017, XXXV, 847 p. 552 illus., 330 illus. in color.,

Hardcover

ISBN: 978-3-319-42365-4