

Preface

Materials processing with lasers is an expanding field which is captivating the attention of scientists, engineers, and manufacturers alike. The aspect of most interest to scientists is the basic interaction mechanisms between the intense light of a laser and materials exposed to a chemically reactive or non-reactive surrounding medium. Engineers and manufacturers see in the laser a tool which will not only make manufacturing cheaper, faster, cleaner, and more accurate but also open up entirely new technologies and manufacturing methods that are simply not available using standard techniques. The most established applications are laser machining (cutting, drilling, shaping), and laser welding, surface hardening, annealing, recrystallization, and glazing. Laser *chemical* processing which includes micropatterning and extended-area processing by laser-induced etching, material deposition, chemical transformation, etc. has actual and potential applications in micromechanics, metallurgy, integrated optics, electronic device and semiconductor manufacture, optoelectronics, sensor technology and chemical engineering. Increasingly, lasers are also being used in biotechnology, medicine, and in art conservation and restoration.

This book concentrates on various aspects of laser–matter interactions, in particular with regard to laser material processing. Special attention is given to laser-induced chemical reactions and non-equilibrium processes at gas–, liquid–, and solid–solid interfaces. The intention is to give scientists, engineers, and manufacturers an overview of the extent to which new developments in laser processing are understood at present, of the various new possibilities, and of the limitations of laser techniques. Students may prefer to read the book selectively, not troubling themselves unduly with detailed calculations or descriptions of single processes.

The book is divided into seven parts, each of which consists in turn of several chapters. The main symbols, conversion factors, abbreviations and acronyms used throughout the text are listed in Appendix A. For convenience, some mathematical functions and relations of particular interest are listed in Appendix B. Tables I, II, III, IV and V are intended to encourage the reader to use the formulas presented for rapid estimation of various quantities. An extensive subject index can be found at the end of the book.

The publication of this fourth edition was motivated by both the excellent reviews and responses from colleagues and students and, importantly, the fact that the third edition was almost sold out within only 3 years. In the present edition I

have included some of the most fascinating new developments in the field. Among those are fundamental investigations and applications using ultrashort laser pulses, the synthesis of metastable materials, and the increasing importance of lasers in nanotechnology, including nanopatterning and the synthesis of both nanoparticles and nanocomposite films. More attention is also given to fields of practical interest such as 3D-microfabrication and rapid prototyping, different types of surface functionalizations covering applications in microtechnology, chemical analysis, combustion engines, etc. Two additional chapters have been added. These summarize new developments and applications of lasers in medicine, biotechnology, and art conservation and restoration.

Finally, I wish to thank my students and all my staff for valuable discussions. Many of our “own” results incorporated in this book have been achieved together with colleagues and friends during world-wide cooperations within various different national and international projects. In particular I would like to thank M. Aspelmeyer, M. Dinescu, C. Grigoropoulos, P. Leiderer, T. Lippert, A. Pikulin, and many others for valuable discussions and N. Bityurin, J.D. Pedarnig, and B. Rethfeld for critical reading and comments on parts of the present manuscript. Valuable discussions and contributions to several chapters of the previous edition, in particular by B. Luk’yanchuk, N. Arnold, and N. Bityurin are gratefully acknowledged. Our close cooperation over many years, mainly on theoretical aspects of laser-material interactions, is reflected in numerous publications cited throughout the text. Last but not least, I wish to express my deep gratitude to my outstanding secretary, Irmengard Haslinger, for her tireless assistance in preparing this new edition.

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Dieter Bäuerle



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Bäuerle, D.W.

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