Book reviews

Laser-Induced Dynamic Gratings

H. J. EICHLER, P. GÜNTER and D. W. POHL

Springer Series in Optical Sciences, Vol. 50

Springer–Verlag, Berlin, Heidelberg 1986
[pp. i–xi + 256, with 123 Figs.]

The present volume covers a more specific range of topics than some previous issues in this *Springer Series on Optical Sciences.* It has been prepared by a triumvirate of specialists in holography and/or nonlinear optics and related fields. Professor HANS JOACHIM EICHLER is at Technische Universität Berlin, Optisches Institut, Dr PETER GÜNTER is at the laboratorium für Festkörperphysik, Eidgenössische Technische Hochschule, Zürich, and Dr DIETER W. POHL is at the Research Laboratory, IBM Zürich.

When two or more overlapping light beams interact with a suitable photosensitive material, a diffraction grating-like interference pattern arises which can be permanent or dynamic (transient). The dynamic gratings, which are covered by this book, became an attractive object of research when the laser was invented as a powerful light source that led to the observation of unexpected and fascinating phenomena. Among these are the dynamic gratings generated by laser beams.

In the introductory chapter the concept of laser-induced dynamic gratings is introduced and a historical background is given. It is then described how these gratings are produced and detected (Chapter 2). As mentioned above, the dynamic gratings are produced by interfering light beams usually derived from a laser. Basic properties of laser beams and of two-beam interference are therefore discussed. Materials in which gratings of this kind can be produced are then reviewed from the phenomenological point of view. Obviously, grating structures are detected by diffraction of light. Some important results of such a detection are considered and, in addition, the relevance of dynamic gratings in light scattering experiments and in the framework of nonlinear optics are discussed. Emphasis is mainly put on phenomenological aspects of these problems which are also treated in more detail in some sections of Chapters 3 and 4.

Chapter 3, the longest one, is, however, mainly devoted to the mechanisms of the formation of the dynamic gratings and to the grating materials. It is shown that the different mechanisms of light-induced changes of optical material properties are responsible for the generation of these gratings. In general, the material is changed or excited in different ways and the various excitations are coupled with each other, and can be separated, at least partially, by using short excitation pulses. This chapter is an excellent overview of many different techniques and mechanisms of grating formation; moreover, it is supplied with a long bibliography (194 references in relation to about 650 for the entire volume).

Diffraction at permanent or dynamic gratings and four-wave mixing theory are covered by Chapter 4 which is a rather tutorial presentation with a short and selective discussion of the subject. This is a good summary of the problem, especially for the reader who is not familiar with the light diffraction at gratings. By contrast, Chapter 5 is concerned with the investigation of physical phenomena by forced light scattering. This term denotes in fact the diffraction of a light wave at a laser-induced grating and has been accepted in analogy to classical spontaneous light scattering. By measuring the diffraction efficiency, this scattering gives information on changes of the refractive index and on the magnitude of the corresponding excitations produced in the material. On the other hand, the observation or recording of the time dependence of the diffraction efficiency gives information on the dynamics of the material excitation. The techniques of investigation of the dynamics of the diffraction efficiency are described.

Four-wave mixing in dynamic recording media is also discussed in Chapter 6 in relation to the nonlinear optical phase conjugation. The latter is produced by using cw lasers and photorefractive materials (e.g., $BaTiO_3$ or $KNbO_3$); the possibility of self-pumping a phase-conjugate mirror using such materials is also presented. Moreover, the application of the phase-conjugate mirrors in optical resonators is described. Real-time holography using laser-induced dynamic gratings, which is included in this chapter, is discussed rather elementarily, and this fragment of the volume cannot be qualified as an impressive text.

The penultimate chapter deals with gratings in laser devices and some experiments, e.g., spatial hole-burning in lasers, distributed-feedback lasers, optical light deflection and modulation, optical diodes and one-way viewing windows, optical filtering by nearly degenerate four-wave mixing, coherence measurements of laser beams, coherence peaks in picosecond sampling experiments, Doppler-free spectroscopy by degenerate four-wave mixing.

A two-page final chapter, *Conclusion and Outlook*, ends this book, which can generally be qualified as a useful volume for a large community of readers who exploit optics, optoelectronics, laser technique, holography, materials sciences, and other fields of science and practice. The volume is, however, not completely coherent, its style is "modulated", many explanations are given in a hermetic jargon. Nevertheless, I recommed this book for everybody who is interested in contemporary optics and related fields.

According to the intention of the authors, the aim of this book is twofold. First, "because of the increasing amount of work spent on the subject of laser-induced gratings, it is necessary to collect the most important results to facilitate further work" in this field. Secondly, "a unified treatment of the subject starting from simple principles will help to spread the knowledge and to stimulate applications in science and technology". I think that this aim has been achieved.

Maksymilian Pluta
Central Optical Laboratory,
Warsaw, Poland

Chemical Processing with Lasers

DIETER BÄUERLE

Springer Series in Materials Science, Vol. 1

Springer–Verlag, Berlin, Heidelberg 1986
[pp. i–ix + 245, with 88 Figs.]

The *Springer Series in Sciences* (e.g., Optical Science, Physics) are commonly known around the world. Individual monographs edited as parts of these series, distinguish themselves by the importance and high scientific level of the topics discussed.

As a result of the amazing development of laser techniques in the last three decades, recent years have witnessed an extremely wide and rapidly expanding application of lasers to materials processing. New, sometimes even unexpected, very convenient possibilities of materials processing, with the use of lasers, attract the increasing attention of not only scientists but also engineers and industry workers.

The monograph *Chemical Processing with Lasers* by D. BÄUERLE is the first of three volumes of the *Springer Series in Materials Science*. All the three volumes concern interactions of lasers with materials.

The presented monograph is focused on a new, rapidly developing field of laser-induced chemical processing of different kinds of materials, here, practically almost only inorganic materials. Besides a short introduction (Chapter 1), the book consists of eight chapters. Chapter 2 deals with fundamental mechanisms of reactions divided into two categories: photothermal (pyrolytic) and photochemical (photolytic). Temperature distributions, for laser-induced chemical processing (LCP), mainly in deposition and etching (pyrolysis) and dissociation of molecules based on single- or multiphoton processes (photolysis) are discussed in this chapter. In Chapter 3 the outline of fundamentals of the kinetics of laser-induced chemical reactions is given. Homogeneously and heterogeneously (mainly) activated reactions with examples of different types of such processes (absorbed layers, gas-solid, liquid-solid and solid-solid interfaces) and spatial confinement of heterogeneous reactions are subject of a short discussion. Chapter 4 presents very concisely experimental techniques used in laser chemical processing for microchemical and large-area chemical treatment. Typical experimental setups and commonly applied lasers are given. The most commonly known experimental techniques for measuring deposition or etch rates and temperature are briefly summarized. Laser assisted deposition of inorganic materials performed from adsorbed gas, liquid and solid phases is outlined in Chapter 5. A great number of materials deposited mainly with the aid of cw lasers are listed with main characteristic parameters of the processing. The material deposition in the form of microstructures and thin extended films is described. Physical and chemical properties of the deposits in relation with various techniques used for the layer production are also discussed. Surface modifications (oxidation, nitridation, reduction, metallization and doping) induced by laser are presented in Chapter 6. Large area surface and local modifications are considered here. In a very short Chapter 7, laser-induced alloying and formation of metastable materials, silicides and compound semiconductors are reviewed. Chapter 8 entitled *Etching, cutting, drilling* is, as a matter of fact, devoted to laser-induced chemical etching of materials. Dry-etching (in the gas phase) and wet-etching (in the liquid phase) processes are described for various materials, such as metals, ceramic materials, inorganic insulators, semiconductors, organic polymers and biological materials. In addition to a number of applications of laser chemical processing, which have been shown throughout the book, actual and potential possibilities of the use of LCP in different areas of technology and technique are shortly summarized and discussed in Chapter 9. New and often unique processing possibilities offered by LCP are compared with corresponding standard technologies and techniques.

Most of the cited original references (nearly 900 papers) have been published after the year 1980. The book is certainly a very up-to-date monograph concerning extremely important, modern techniques. The main aim of the author to serve scientists, engineers and manufacturers an overview of today and future applications of chemical processing with lasers has been accomplished, although not all applications and potential of LCP have been presented in the book. Etching and deposition processing belong to the topics described exhaustingly, but some problems are described in a very short form (even marginally) or omitted.

The book is, first of all, a very comprehensive review of publications devoted to some major applications of LCP and reflects the wide and great possibilities of laser chemical processing, the new branch which develops rapidly and elementally. The latter may be the reason for the fact that the presented topics are sometimes not well arranged and only shortly, without going into details, discussed. It is also a pity that authors index has not been included (as has been done in *Laser-Induced Chemical Processes* edited by J. I. STEINFELD). Despite the last critical remarks, this is in my opinion a very good, desirable and helpful guide which I recommend to a variety of workers both scientists and technologists in the field of laser-induced chemical processes.

Wiesław Żyrnicki
Institute of Inorganic Chemistry
and Metallurgy of Rare Elements,
Technical University of Wrocław, Poland

The CO_2 Laser

W. J. WITTEMAN

Springer Series in Optical Sciences, Vol. 53

Springer–Verlag, Berlin, Heidelberg 1987
[pp. i–xii + 309, with 135 Figs.]

Considering the popularity of research on different kinds of lasers, carbon dioxide lasers seem to be in the most outstanding position, because of various applications. These lasers, particularly their technology and applications, are still in strong development. Although, more than twenty years have passed since the first Patel's CO_2 lasers, so far no books devoted generally to CO_2 lasers have appeared.

Hence, the book *The CO_2 Lasers*, written by W. J. WITTEMAN, Professor of Quantum Electronics, Department of Applied Physics, Twente University of Technology, The Netherlands, should be much welcome to many specialists dealing with carbon dioxide or molecular lasers. The author was actively engaged in basic problems of carbon dioxide lasers. He made significant contributions to the area of molecular lasers, doing research on spectroscopy of CO_2-molecules even before Patel's laser, and next – as a leader of the research group – doing many original theoretical and experimental investigations on dc sealed-off CO_2 and pulse TEA CO_2 lasers. The book contains fundamental problems of continuous and pulse CO_2 lasers, including their technology, mode-locked pulses and the amplification of short pulses. It gives a comprehensive basis of the molecular physics, gas discharge kinetics, excitation and relaxation processes essential to gas mixture of CO_2 lasers. The book is divided into ten chapters.

Chapter 1, *Introduction*, is a short review of application of CO_2 lasers as atractive tools in material processing, such as cutting, welding, micromachining, microsoldering, or in medicine. High-energy pulse laser systems are developed for laser fusion. CO_2 lasers have found common application in military systems. Maximal efficiency, output powers and pulse energies are discussed. The question of what kind of resonator (stable or unstable) should be chosen for different systems is considered.

Chapter 2, *Rotational-Vibrational Structure of CO_2*. This chapter includes the main spectroscopic features of the CO_2-molecule. It starts with the description of vibrational and rotational modes. Basic low-lying vibrational levels of the CO_2-molecule are discussed. Regular, hot and sequence laser bands are distinguished. The thermal Boltzmann distribution of rotational levels and the degeneracy caused by Fermi resonance of nearly the same energies of different vibrations are explained. The regular bands being the most important for the operation of CO_2 laser, the selection rules of the transitions between vibrational-rotational levels and absorption spectra are given for 9.4 μm and 10.4 μm bands of carbon dioxide molecules. The spectra of CO_2 isotopes differ from one another, due to isotopic shift and Fermi resonance. The absolute frequencies of CO_2 isotope lines of the regular bands (*P* and *R* transitions) measured by precise heterodyne technique provide useful data for experimental physicists and engineers.

Chapter 3, *Laser Processes in CO_2*. The fundamental processes and parameters of laser action are widely discussed. First of all, for the transitions from the upper vibration-rotational states to the lower ones, Einstein spontaneous and stimulated emission coefficients, are introduced *P* and *R* branches being substantially distinguished, hence the laser gain of emission lines for these branches has been also distinguished. The shape of emission lines and their broadening mechanisms for CO_2 laser mixtures, the ranges of inhomogeneity and homogeneity of line broadening are well explained. The saturation intensity, as one of the most important parameters of the laser medium, is defined. The difference between theoretical and experimental saturation intensities can be interpreted physically as follows. A CO_2 laser has many rotational levels closely coupled by collisions, among these levels there is a continuous exchange of energy. The relaxation and excitation processes in CO_2 laser discharge are given. A wide physical description and the necessary conditions for obtaining an efficient population inversion are presented. The mixture of CO_2, N_2 and He is usually enriched with H_2O and Xe. Therefore, the role of these additives in the improvement of lasing conditions is explained. The theory of output power and laser efficiency (based on Rigrod theory modified by Shindler) as a function of laser parameters (small signal gain, loss coefficient, laser length, reflection of mirrors and saturation intensity) is completed by practical conclusions.

Chapter 4, *Continuous Discharge Lasers.* This chapter is devoted to the most practical and popular lasers, i.e., the continuous discharge ones. It starts with the description of current-voltage characteristic of the laser discharge and its supply conditions. The elementary theory of the positive column plasma, the largest part of the glow discharge in a cylindrical tube, forms a wide introduction. The fundamental formulae for electron density distribution, current distribution, and for temperature variation across the laser tube are introduced. For high-power Gaussian laser beams, the variation of the refractive index caused by heat production in the discharge should be taken into account. The inhomogeneity of the gain and dispersion of the active medium may produce the radiation in the laser tube. Therefore, theoretical aspects of Gaussian beam parameters in the medium with the quadratic term of refractive index variation are widely discussed. Many technological procedures are devoted to the long-term operation of sealed-off CO_2 lasers and their output power maximization. Particular attention is put to single-mode operation conditions. Lasing of sequence or hot bands can be obtained by inserting an additional hot CO_2 cell into the laser cavity. So, an explanation of higher bands generation is discussed. The basic system of transition selection (by means of grating) and the tuning of the CO_2 laser (by piezoceramic driver) are presented. A three-mirror configuration, as a very practical set-up for high power tunable molecular lasers with line-selection, is described and the results of the tuning are illustrated. Opto-galvanic and opto-voltaic effects which lie in changing the resistance of the laser discharge due to changes of output power are described. The opto-galvanic or opto-voltaic detection (so-called photodetectorless one) is presented. Opto-voltaic signal can be detected in cooling water-jacket as a result of plasma discharge and cooling water-jacket capacitive coupling. A simple model of the above phenomena is described.

Chapter 5, *Fast Flow Systems.* A substantial improvement of the laser output power can be obtained by applying a fast flowing of the discharge medium. This chapter gives a basic description of the fast flow lasers. When the time of gas flow transit is much shorter than that of the diffusion to the wall, the excess heat absorbed by the gas can be removed and the laser medium is cooled convectively. The fast flow of medium may increase the power unit length of discharge by several orders of magnitude. Two practical systems: axial-flow and transverse-flow are distinguished. A few discharge techniques for transverse-flow systems with a discharge stabilization are specified. The basic parameters of the flowing medium, i.e., the gain and saturation intensity, are modified as a result of the fast flow. The influence of the flow velocity on these parameters is determined and experimental results are presented.

Chapter 6, *Pulsed Systems.* The technology of pulse TEA CO_2 lasers differs qualitatively from the dc ones. Optimization lasing conditions of this kind of laser require the knowledge of fundamental gas kinetics, as well as of excitation and relaxation processes. The solution of Boltzmann equation presented in this chapter permits us to calculate the electron distribution function of the CO_2 laser discharge. Methodical steps for calculating transport coefficients in the laser mixtures (drift velocity, diffusion and ionization coefficients) are made and completed additionally with useful computing plots. Theoretical analysis permit us to predict the optimum power and laser efficiency, as well as the shape of current and laser output pulses. The results of calculations are compared with the data obtained for real laser system. A reader not familiar with basic problems of laser gas discharge kinetics may find a wide introduction to this subject in *Computer Modeling of Gas Lasers*, by K. Smith and R. H. Thompson, Plenum Press 1978.

The description of supply set-up of TEA CO_2 laser (multi-stage Marx-generator) with ultraviolet preionized system gives a good deal of practical information. The problems of uniform-field electrode profile (so-called Chang profile) and minimum width electrode (Ernst profile) solved by analytic approach are discussed. Common features of these profiles and that of Rogowski, used earlier, are shown. Basic mechanisms of the dielectric corona preionization technique, as a particularly useful system of self-sustained discharge, are described. The main conditions of optimal uv preionization from the surface of dielectric plates placed between the electrodes (voltage rate, gas composition, pressure, thickness of dielectric plates, gap distance and materials of dielectric plates) are described in details. The operation and lasing conditions of electron-beam controlled TEA CO_2 lasers are supported by elementary calculations and rich experimental results of output energy, current and voltage plots.

Chapter 7, *Mode Locking of TEA Lasers.* The idea of laser mode locking with an internal modulator, treated as commutation of laser pulses synchronized with the repetition period equal to the round-trip time, is the comprehensive basis to the subject. The mode-locking is particularly usable for pulsed TEA CO_2 lasers with the wide homogeneously broadened emission lines. Two active mode-locking techniques, i.e., amplitude and frequency modulation are distinguished. In both cases, short circulating optical pulses are formed within the cavity. This chapter deals with the modulation of cavity losses by means of acousto-optic Bragg modulator. Firstly, the acousto-optic Bragg modulator with a standing ultrasonic wave is described, showing its optical, electrical and acoustical properties, as the optical intensity modulator. The time- and frequency-domain analysis of the short pulse generation with the AM modulator, as well as self-consistency conditions of AM mode-locking, are treated theoretically. Experimental systems of mode-locked TEA CO_2 lasers and essential methods of their stabilization (intracavity low-pressure CO_2 laser, external injection of cw radiation) are described and completed with the examples of 1-nanosecond pulses obtained by means of Bragg cell with 40 MHz modulation frequency.

Chapter 8, *FM Mode Locking of TEA Lasers.* The phase modulation of an optical beam by means of electro-optic effect is discussed. The effective application of CdTe crystal as the phase-modulator in so-called Lecher system is presented. Similar approach to that used in the case of AM mode-locking, i.e., time and frequency domain analysis of FM mode-locking, is applied. Experimental data of FM mode-locking with CdTe crystal modulated at 120 MHz are presented.

Chapter 9, *Passive Mode Locking.* This kind of mode-locking can be obtained when the absorption properties of a saturable absorber placed in a laser cavity are synchronized with the round-trip time of a laser resonator. Basic principles of passsive mode-locking and the main conditions for effective operation of saturable absorbers are specified. Fundamental analysis of saturation intensity of absorbers, laser gain, and pulse shape are presented. Particular attention is put to mode-locking of TEA CO_2 lasers by *P*-type germanium as a saturable semiconductor.

Chapter 10, *Short-Pulse Amplification.* This chapter is devoted to propagation of short pulses and to optimization of short-pulse and high-power amplification. Two aspects are emphasized: the change of the gain due to saturation of the amplifying medium and the influence of the rotational levels on the pulse being amplified. The formulae for pulse shape and pulse amplification in two-level system are introduced and next, modified by the influence of rotational relaxation. The influence of the amplifying medium on the laser pulse shape is discussed. The techniques of multiline short pulse generation and single pulse selection by fast electro-optic switchout system and rich experimental illustrations are presented. The ways of pulse system protection against prepulse, retropulse and parasitic radiation are discussed.

As the author writes in the preface, he devotes his monograph to the well established constructions of CO_2 lasers. It should be noticed that during the last few years a new generation of CO_2 lasers, the so-called transversely RF excited CO_2 lasers, has been developed. This kind of laser seems to be very perspective as efficient sealed-off or fast-flow systems. This subject is not considered in the book. Also the monograph does not deal with gasdynamic lasers, but the reader may find a wide treatment of this subject in the book *Gasdynamic Lasers*, by A. A. Losev, *Springer Series in Chemical Physics*, Vol. 46, 1981.

Summing up, the book reviewed is destined for experimental physicists and engineers dealing with CO_2 or generally molecular lasers. The systematic presentation of theoretical and technological problems with comprehensive interpretation of basic phenomena makes it highly interesting. The readers are expected to be familiar with the fundamentals of laser physics and molecular spectroscopy.

Krzysztof M. Abramski
Institute of Telecommunication and Acoustics,
Technical University of Wrocław, Wrocław, Poland

Laser Physics and Technology: Gas Flow and Chemical Lasers

Proceedings of the 6th International Symposium, Jerusalem, September 8–12, 1986

Editor: S. ROSENWAKS

Springer Proceeding in Physics, Vol. 15

Springer–Verlag, Berlin, Heidelberg 1987
[pp. i–xiii + 579, with 479 Figs.]

The book *Gas Flow and Chemical Lasers*, edited by S. ROSENWAKS contains two years old lectures coneentrated on narrowly specialized problems of the new trends and achievements in the field of gas flow lasers, their technology and applications. In editing the book, a deductive approach was attempted. It starts with some fundamental issues on fluid dynamics and optics dealing with basic principles for the present and future development of the gas flow lasers. Then, it deals with the design, diagnostics, propagation and applications of various laser systems, covering the wavelength spectrum from XUV to infrared. In the closing section of the proceedings there are gathered the up-to-date developments of general interest to the laser community concluding with notions indicating the possible-to-deduct achievements expected in the near future, i.e., with a section on short wavelength chemical lasers.

The book contains twelve parts.

Part I, *Fluid Dynamics*. In this part E. BAUM et al. describe the problems of the homogeneity control in repetitively pulsed gas lasers. It is an important problem as numerous laser applications require a highly collimated output beam. To achieve this collimation in gas lasers the fluctuations and/or variations of the gas density ought to be carefully controlled. S. KAIZERMAN et al. describe the aerodynamic curtains design for gas flow laser cavities. The mentioned curtains permit to significantly improve the flow-field characteristics within the laser cavity. Special attention in designing the supersonic aerodynamic jet curtain device was given to reduce the disturbances in the cavity flow-field improving thus the output beam quality. S. H. BAUER et al. analyse the kinetics of condensation in supersonic expansion (Ar). The calculations base on the method of characteristics. The effects of inlet pressure on chemical laser flow-field are presented by D. ZEITOUN et al. The complete system of Navier–Stokes equations is solved in nozzles and cavities and the structure of flow-field in a DF chemical laser has been determined. O. BIBLARZ and J. L. BARTO describe the fluid dynamics effects (including turbulence) on high-pressure discharge, looking for means of stabilization of this discharge which for years constitutes a partly open important problem mainly in CO_2 discharge excited flow lasers. The analogous problems of the characteristics of turbulent flow stabilized DC-discharges for CO_2 flow lasers are considered by H. BRUNET et al. The aim of their papers is to achieve uniform axial discharges in CO_2 gas-mixtures. W. O. SCHALL et al. carry out the flow investigation of pulsed arc discharge recombination lasers of the highly interesting family of segmented plasma excitation and recombination levels.

Part II, *Optics*, I. J. BIGIO et al. present the new developments in optical phase conjugation. W. T. WHITNEY et al. have demonstrated for the first time the stimulated Brillouin scattering of hydrogen fluoride laser radiation and applied their discovery to nonlinear optical phase conjugation of HF laser radiation field. A. FLUSBERG and D. KORFF present a short paper on the theory of wavefront replication in the Dirac bracket operator formalism. It is a very stimulating paper from the theoretical viewpoint. E. MARGALITH's work deals with the high efficiency Raman conversion of UV to blue-green light (308–459 nm) via lead vapour. W. JÜPTNER et al. present an extensive lecture on mirror optics for high power laser beam. It is an extremely important problem because of extended, and still growing interest in these lasers as tools of their industrial and similar applications. M. BERGER and W. KOTTLER present the measurements of deformation on CO_2 laser output coupler in operating high-power laser systems.

W. Bohn and Th. Hall give interesting new results concerning the effect of beam quality on the scaling of high-power flow lasers. The growing output power of CW flow lasers creates many technological problems with the laser windows. E. Wildermuth et al. describe the experimental investigation of a free-vortex aerodynamic window for such lasers.

Part III, *Short-Wavelength Lasers.* This is a relatively new topic in the field of flow lasers which makes of all the papers contained in this part an interesting subject for laser community. R. Sauerbrey presents new VUV and XUV laser systems. Z. Rozenberg et al. describe the direct measurements of the electron density in the active medium of *e*-beam pumped argon fluoride lasers. A. Gevaudan et al. concentrate on modelling of the X-ray preionized XeCl self-sustained discharge lasers. M. Sentis et al. in view of the potential application of high average power of ultraviolet lasers present high-pulse repetition limitation problems in a high average power XeCl lasers. The blue-green laser at 495 nm of the mercury trimer Hg_3 is described by S. Spyrou et al. H. J. Baker and A. M. Feltham analyse the pumping mechanism dependence of emission spectra in mercury bromide lasers.

Part IV, *Chemical Oxygen-Iodine Lasers.* R. Bacis and S. Churassy describe the chemical oxygen-iodine lasers mechanisms and high resolution spectroscopy studies. The high vibrational levels of iodine as intermediate states in the iodine dissociation by $O_2(^1\Delta_g)$ are extensively studied by D. David et al. E. Georges et al. present the theoretical and experimental studies on singled delta oxygen generation and transfer. The same authors present also the theoretical modelling problems and experimental analysis of chemical oxygen-iodine lasers.

Part V, *Chemical Vibrational-Transition Lasers.* New problems and achievements concerning these lasers are presented in this section of the symposium. F. Voignier describes the combustion driven cw HBr chemical laser. R. A. Meinzer and G. M. Dobbs describe HBr combustion driven laser successfully operated in a purely chemical manner by using H_2, Br_2, F_2 and He as the reactants. The described device operated supersonically and produced a total power of 1.5 watts. K. Waichman et al. deal with an interesting problem of experimental studies and kinetic modelling of HF chemical laser at low temperatures. The same author et al. paid their attention to the supersonic, pulsed chain-reaction pumped HF lasers. D. J. Spencer and D. A. Durran present the results of their studies of chemical laser F_2 flow distribution. A. Ya. Temkin deals with those chemical lasers which are pumped by hot atom reactions with bulk molecules, presenting a paper on translationally strongly non-equilibrium hot atom assemblies and chemical laser pumping.

Part VI, *CO Lasers.* H. Kanazawa et al. present the development of a multikilowatt closed cycle CO laser. The paper gives a new insight into years-studies of CO gasdynamic and flow laser. M. Iyoda et al. present computer simulation and parametric analysis of a cw CO EDL. The effects of RF preionization in a transverse discharge excited cw CO laser are described by K. Terunuma et al. The CO laser in question operates in a closed cycle subsonic system. W. Mayerhofer et al. present also the problem of optimization of discharge stability of an *e*-beam sustained supersonic CO laser by optical diagnostic measurements. W. Masuda et al. give an interesting review of the kinetic modelling of a supersonic flow CO chemical lasers.

Part VII, *CO_2 Lasers.* The CO_2 flow and gasdynamic lasers are the oldest subject presented on each Gas Flow and Chemical Lasers International Symposiums during fourteen years of their existence. In spite of high level of the reached "know-how" the new ideas in this field always do appear. S. Yatsiv describes the conductively cooled capacitively coupled RF excited CO_2 lasers. H. Hügel succeeded in operating the RF driven CO_2 flow laser. 20 kW fast axial flow CO_2 laser with high frequency turboblowers is described by H. Sugawara et al. P. Agmon et al. describe the multikilowatt industrial CO_2 laser. B. Walter et al. present the results of the measurements of current fluctuations in a 1 kW gas transport laser. C. D'Amrosio et al. presented a very interesting information on high-power cw discharge multikilohertz repetition rate Q-switched CO_2 lasers. B. Walter and D. Schuöcker developed new corona preionization technique for medium pulse repetition rate TEA lasers. The new developments of a combustion drived after mixing gasdynamic laser utilizing liquid fuel and liquid oxidizer are presented by S. Yamaguchi et al. Sh. Sato et al. present their studies of gain of gasdynamic laser utilizing products of liquid benzene and O_2 combustion. In two above papers the Japanese scientists have again shown that for years their contribution to the gasdynamic laser development is growing. R. F. Walter presents instructive comparison of vibrational kinetics models for the combustion driven CO_2 gasdynamic lasers.

Part VIII, *Beam Diagnostics.* I. J. Spalding, W. M. Steen and W. M. Weerasinghe in two separate parts give the very extensive results concerning the fundamental problem of the high power laser diagnostics. R. Kramer et al. describe a novel diagnostic system for measurement of the focused beam diameter of a high power CO_2 laser. W. Jüptner et al. describe the problem of high power laser beams diagnostics having in view the possibility that the laser beam material processing has a big potentiality to be automated.

Part IX, *Laser Propagation and Interaction.* This section – as the previous one – is strictly connected with flow laser industrial application. D. Dufresne describes the interaction of high energy pulsed CO_2 laser with material, concentrating his attention mainly on problems connected with the nature of material. D. Schuöcker studies the laser material processing and its phenomenology – theoretical modelling. M. Hugenschmidt presents the method of improving energy transfer in laser target interaction processes by using repetitively pulsed lasers. The problem of deep penetration of HF laser light into glass and of its possible industrial application is presented by R. Joeckle and A. Sontag. P. E. Cassady et al. concentrate on the degradation of optical beam passing through turbulent media, presenting an aero-optical analysis of a compressible shear layer. B. T. Vu and D. Chuchem describe the high frequency turbulence diagnostics by measurements of scintillation. M. Autric et al. give their attention to the phenomena of atmospheric propagation of pulsed high power laser beam increase in energy transmission using a precursor pulse. N. Yackerson and N. S. Kopeika present non-ortogalvanic signal characteristic times in prebreakdown discharges. K. Horioka et al. present the problem of initiation processes and development of laser induced low pressure spark channels.

Part X, *Applications.* In previously reviewed sections the problems of application were mixed with basic research problems. This part of the book deals with strictly understood applications of the lasers. D. Basting and B. Nikolaus present for the first time the industrial application of the excimer lasers. Up to now, only CO_2 and Nd:YAG lasers have been considered for such applications. K. Hashimoto gives a paper on verification and modification of metal surfaces by laser for chemical applications. The paper constitutes an extensive study of the problems concisely stated in the paper title. D. Fishman and A. Shachrai present the problem of the laser cladding of heat treated steel. The influence of processing conditions on surface melting of steels is described by M. Carbucicchio et al. Z. Mucha et al. deal with the generation and application of a pulsed CO_2 laser of high average power. R. Baumert and A. Gukelberger describe industrial application of high power CO_2 lasers operating in the range of 1–5 kW outputs. D. Tordella and D. Cruciani present an interesting set of data concerning the influence of the external pressure on laser material interaction during the welding process. P. Savorelli et al. concentrate on the old, but still not fully solved problem of the plasma control during welding processes at high power and low target velocity. Z. Aberman and M. Koren describe a robolaser for the car industry.

Part XI, *Recent Developments.* L. C. Marquet describes in, by necessity, limited manner certain scientific and technical aspects and prospects of high power for the SDI. In spite of some moral aspects of these problems, the paper is worth to be read remembering that L. C. Marquet is one of the scientific promoters of the SDI project. Recent advances in metal vapour lasers and their applications are presented in the review paper by C. E. Webb. J. L. Bobin, having in view the future of the elementary particle accelerators, presents a paper on elementary particle acceleration in laser plasma interaction. A. Yogev et al. undertake the problem of the IBr photodissociation laser as a simulation for a solar pumped system.

Part XII, *Short Wavelength Chemical Lasers.* The state of the art in this field is presented by S. J. Davis in his paper entitled *Short wavelength chemical lasers.* For more than decade numerous research groups sought the possibility to develop a $\lambda < 1.0$ μm chemical laser. The reviewer shares the hope that at the next 7th GCL Symposium to be held in Vienna in August 1988 this problem will be successfully solved. L. Torchin et al. investigate the $C + N_2O \rightarrow CN(A, X) + NO$ reaction as a possible candidate for near infrared electronic transition chemical laser. The explosive decomposition of tetramethyldioxetane in the solid phase treated as a potential for high density short wavelength chemical laser is described by M. A. Tolbert et al. H. V. Lilenfeld and G. R. Bradburn deal with kinetics of production of electronically excited IF. The experimental study of the level-to-level rotationally inelastic transition rates of iodine monofluoride during collisions with noble gases is presented by E. A. Dorko et al. P. J. Wolf et al. study the interhalogen collisional dynamics of the $B^3\Pi(O^+)$ state of BrCl. H. Brunet et al. describe the formation of $I(^2P_{1/2})$ atoms in $F + I_2$ and $H + I_2$ reactions. The last paper presents the panel discussion – with R. D. LEVINE as a moderator – on the future development of gas-flow and chemical lasers, indicating that at present the main attention is given to short wavelength chemical laser systems and their possible extension on cw regime of operation. Summing up, all meetings indicate the trend to extend the wave-length spectrum generated by gas-flow, gasdynamic and chemical lasers. This tendency is very interesting as some of these lasers are the unique devices operating in cw regime and are able to give spectacularly high output power. It suffices to mention the case of cw 10.6 μm CO_2 gasdynamic lasers operating at the output power level of the order of megawatts.

The reviewed book is highly interesting. The treatment is clear throughout and presented in logical way. The book should interest physicists and engineers dealing with molecular lasers and their applications. It is obvious that the reader ought to be familiar with fundamentals of optics, quantum mechanics and theoretical and experimental problems of gas lasers.

Marek Brunné
Institute of Fluid-Flow Mechanics,
Polish Academy of Sciences,
Gdańsk, Poland