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Book reviews

Semiconductor Optoelectronics

Proceedings of the Second International School, Cetniewo, 1978

Edited by M. A. HERMAN

PWN – Polish Scientific Publishers, Warszawa 1980
John Wiley and Sons, Chichester, New York, Brisbane, Toronto 1980
[pp. i–xii + 660]

This volumen contains 23 papers presented at the Second International School held at the Cetniewo Sports Centre in Władysławowo (Poland) from May 6 to May 13, 1978. It was organized by the Institute of Physics of the Polish Academy of Sciences under the sponsorship of the Polish Physical Society. Prof. Jerzy Kołodziejczak was the Chairman of the Program Committee and Dr. Marian A. Herman was the Chairman of the Organizing Committee of this meeting. The School was attended by over 220 participants from 13 European countries, USA, Canada, Japan and Brasil.

The papers presented in this book cover a broad field of topics, important for present-day semiconductor optoelectronics. It consists of five parts:

I Physical Phenomena in optoelectronic materials and devices,
II Technological problems,
III Optoelectronic devices,
IV Injection lasers,
V Optical communication systems.

Part I contains a review of IV–VI semiconductors used as materials for infrared optoelectronics, presented by L. SOSNOWSKI. The IV–VI compounds are narrow gap semiconductors. In this group the most promising materials for integrated optoelectronics are ternary alloys: $Pb_{1-x}Sn_xTe$ and $Pb_{1-x}Sn_xSe$.

Basic properties of lead salts which create the ternary alloys are also discussed.

The remaining papers included in this part concern:

a) The influence of doping and alloying of III–V semiconductor materials on their optoelectronic properties (presented by K. UNGER, GDR).

b) Deep-level impurities in semiconductors and their role in optoelectronic devices (presented by H. G. GRIMMEISS, Sweden).

c) Generation of dislocations in optoelectronic materials and their behaviour during optical excitation (presented by G. R. WOOLHOUSE, USA).

The papers presented in part II deal with technological problems of crystal growth of III–V compounds. Several growth methods are described, e.g. TDM, CVP (J. NISHIZAWA), LPE, electroepitaxy (T. BRYSKIEWICZ). The problems connected with multilayer LPE processes, for instance: interface morphology, lattice parameter matching are also discussed. At present the quaternary solid solutions play an important role in optoelectronic technology, thus in this part an extensive article about quaternary III–V systems can be found.

In part III physical investigations of heterojunctions and their application in optoelectronic devices are reviewed. One paper deals with the properties of rare-earth doped insulators and their applications to optoelectronic devices (presented by F. E. AUZEL, France).

Part IV is concerned with some fundamental problems of semiconductor laser theory. A new method of obtaining an approximate solution of mode problems which cannot be treated by the traditional methods is proposed by J. E. RIPPER et al.

One of the most fundamental parameters of semiconductor lasers is the optical gain. That problem is described in the paper presented by M. H. PILKUHN (West Germany). Experimental methods of gain measurement are there explained. The unsaturated gain, in particular, its dependence on wavelength, temperature and the doping level is discussed. Recent results on gain saturation are mentioned.

The possibility of applying injection lasers in coherent optics has led to investigations on the coherence of the radiation emitted by these light sources. In the paper presented by M. A. HERMAN in part III the coherence problems are discussed. A review of experimental data concerning coherence of radiation emitted by junction lasers is also given.

In the last part of this book the reader can find some information about the properties of optoelectronic devices used in optical communication systems.

This volume, being a collection of different papers and providing the reader with an excellent overview of the most recent developments, resembles rather a monograph, since all the articles deal with fundamental problems in semiconductor optoelectronics.

The arrangement of the material presented allows to find quickly the problems required.

The book should be of a particular interest to materials scientists and solid-state physicists.

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Dissipative Systems in Quantum Optics

Topics in Current Physics, Vol. 27

Edited by R. BONIFACIO

With contributions by: R. BONIFACIO, J. D. CRESSER, H. M. GIBBS, J. HÄGER, G. LEUCHS, L. A. LUGIATO, S. L. MCCALL, B. R. MOLLOW, M. RATEIKE, Q. H. F. VREHEN, H. WALTHER

Springer-Verlag, Berlin, Heidelberg, New York 1982
[pp. i–ix + 151, with 60 Figures]

The book deals with three very important cases of open systems, driven far from thermal equilibrium: resonance fluorescence, optical bistability, and superfluorescence. The first, accessible to a complete description in terms of a single atom, provides the simplest example

of a quantal system "driven" by an external field. The two others are typically cooperative effects.

The general and at the same time widely accessible *Introduction* by R. BONIFACIO and L. A. LUGIATO is followed by a Chapter in which R. MOLLOW deals with the interaction of two-level systems and the radiation field. Next, J. D. CRESSER, J. HÄGER, G. L. LEUCHS, M. RATEIKE, and H. WALTHER consider the theoretical and experimental aspects of resonance fluorescence. Their article is followed by two papers devoted to optical bistability: the first, theoretical, is by R. BONIFACIO, and the other, of an experimental nature, by S. L. MCCALL and K. M. GIBBS. The last Chapter concerning experimental studies of superfluorescence is by Q. H. F. VREHEN and K. M. GIBBS. In fact, the above cited names suffice alone to recommend the book, as the authors are outstanding specialists in their respective fields of research. Moreover, on a first reading, it is hardly an overstatement to refer to it otherwise than in the superlative. It is easily and clearly readable. Notwithstanding the advanced level of the subject matter, the various Chapters make the impression of lectures held at a quantal optics summer school. Since they presuppose no special preparation on the part of the Reader, they can be recommended to pre-graduate students too.

The book covers the essential, up-to-date theoretical and experimental results, presented in a strict, natural interrelationship. The theory avoids venturing into the realm of abstraction or eluding confrontation with experiment but is concerned with real effects, presently studied and accessible to experimental treatment in the near future, often with a view to application in practice. The Reader is immediately persuaded of the meaningfulness of the experiments. The complementarity and mutual harmony of the theoretical and experimental approaches create a closed whole. This, among others, is due to the excellent thematic construction of the book by its Editor R. BONIFACIO.

All in all, the high scientific and training value of the book make it invaluable to those in their first stage of work on quantal optics as well as to the more advanced research workers.

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Quantum Optics

Lecture Notes in Physics, Vol. 155

Edited by C. A. ENGELBRECHT

Springer-Verlag, Berlin, Heidelberg, New York 1982
pp. i–viii + 329]

Quantum Optics by C. A. ENGELBRECHT constitutes a subsequent volumen of the well known Springer-Verlag series *Lecture Notes in Physics*. The book contains four lectures given by distinguished experts in the respective fields at the Summer School in Theoretical Physics in Natal Drakensberg, South Africa, January 19–30, 1981. The idea of the editors to edit

this book under the title *Quantum Optics*, which is actually a new and very wide branch of optics, is slightly confusing. As a matter of fact, the book contains the problems which are usually understood to belong to some other fields of physical optics, while some important problems of true quantum optics have not been mentioned at all. The major part of the text (about two thirds) is devoted to non-linear optics. In particular, this concerns the following two lectures: *Non-linear optical phenomena and fluctuations* by A. SCHENZLE and *Non-linear optics* by F. A. HOPF and J. D. HEY. Consequently, both the fundamental problems in non-linear optics (like: Maxwell equations, boundary conditions, anisotropic media, higher harmonics generation) as well as much more advanced ones (like: role of fluctuations in optical non-linear processes) have been carefully discussed. Two other lectures on *The theory of lasers and laser light* by H. HAKEN and *Quantum statistical treatment of open systems, laser dynamics and optical bistability* by F. CASAGRANDE and L. A. LUGIATO discuss different problem in the theory of laser and optical bistability, both fields belonging to the most important research areas in optics. It should be emphasized that in these two lectures as well as in the lecture by A. SCHENZLE the dynamics of open systems is considered which, in turn, is one of the research problems in statistical physics. Thus, the lectures presented in the book are of interdisciplinary character.

In some places the book is written in a way not exhaustive enough. Also some small printing errors happen. This, however, does not lower the values of the book, being essentially a lecture notebook.

The book offers advanced and differential material as well as a recapitulation of some important results of research in laser physics, bistability and non-linear optics. This allows me to recommend the book to the Ph. D. students and the scientific workers specializing in the fields mentioned above as a publication of high scientific and didactic value.

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Magnetic Electron Lenses

Topics in Current Physics, Vol. 18

Ed. by P. W. HAWKES

With contributions by: P. W. HAWKES, E. KASPER, F. LENZ, T. MULVEY, W. D. RIECKE

Springer-Verlag, Berlin, Heidelberg, New York 1982
[pp. i–xi + 462 with 240 Figures]

The book entitled *Magnetic Electron Lenses*, edited in 1982 by Springer-Verlag in the series *Topics in Current Physics*, is a long expected monograph on magnetic lenses. Hitherto the magnetic lenses considered only in the text-books on the electron optics have been treated rather in short. This topic, however, is still alive so far as the theory, design and applications are concerned. In the course of the last years new calculation methods of magnetic fields and electron trajectories (in those fields) have been developed. Also, significant

attention has been paid to new approaches to the lens aberration theory and to new designs of lenses. Numerous reports concerning the applications to electron microscopy, electron beam processing devices, electron technology devices and different types of physical instrumentation were published independently. The fact that all those publications were scattered in various journals makes an orientation in the actual achievements in the field of magnetic electron lenses very difficult. Therefore, the efforts of both the editor and the contributing authors, which resulted in rendering this monograph accessible to all the interested workers is very welcome.

The book consists of five extended Chapters written by excellent experts in the respective fields, under the leadership and with contribution by Peter W. HAWKES. These Chapters are generally written from different viewpoints like theorem, experiment design, and so on.

The first Chapter offers a concise and modern lecture on magnetic electron lens with the application of a matrix notation facilitating significantly the analysis of aberrations. The second Chapter gives a critical review of the present state-of-art of the calculation methods of both magnetic fields and electron trajectories. This Chapter may be very valuable for numerous scientific workers and engineers interested in the magnetic lens design.

The other two Chapters being of more traditional character are devoted to the properties of magnetic lenses and give an extended review of the lens designs. Both the solutions of older and the newest types are presented. The magnetic lenses based on superconductivity are also discussed. The last Chapter is devoted to a discussion of a number of special, nonconventional solutions for magnetic lenses. Unfortunately, no mention about the multipole lenses including the quadrupole ones can be found in the text. This seems to be a shortcoming of such an extended monograph, the more that even the title of the series *Topics in Current Physics* might evoke such expectations.

A distinguishing feature of the monograph is the very rich literature given at the end of each Chapter as well as extended bibliography added at the end of book.

The book *Magnetic Electron Lenses* will be certainly read with interest by all workers specializing in the theory, design or/and exploitation of magnetic electron lenses which are used in so numerous and miscellaneous electron beam devices.

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Picosecond Phenomena III

Springer Series in Chemical Physics, Vol. 23

Editors: K. B. EISENTHAL, R. M. HOCHSTRASSER, W. KAISER, A. LAUBEREAU

Springer-Verlag, Berlin, Heidelberg, New York 1982
[pp. i–xiii + 401, with 288 Figures.]

The most important advantage offered by this book, being a selection of contributed papers admitted to presentation at the *Third International Conference on Picosecond Phenomena*, Garmisch-Partenkirchen, FGR, June 16–18, 1982, is its appearance only few months after

the conference has been ended. Therefore, the book is extremely actual. In many cases the problems being still investigated in most advanced laboratories all over the world are included. The contributed papers presented are only of introductory character, while the more complete and extensive papers should be expected in the nearest future. Thus, the book gives us an earnest information about the discoveries which were done mainly in the first half of the year 1982.

This review cannot be an obvious one since the editors of the book are responsible only to a small degree for its essential value. The book being a typical results of a collective work contains a wide range of problems on the one hand but suffers from serious nonuniformities on the other. This remains true in spite of the fact that the editors managed to introduce some elements of order by classifying the papers into the following groups:

1. Advances in the Generation of Ultrasonic Light Pulse (20 papers),
2. Ultrashort Measuring Techniques (13 papers),
3. Advances in Optoelectronics (6 papers),
4. Relaxation Phenomena in Molecular Physics (23 papers),
5. Picosecond Chemical Processes (7 papers),
6. Ultrashort Processes in Biology (10 papers),
7. Applications in Solid-State Physics (16 papers).

The book has 401 pages while a single paper contains about 4 pages. There were 250 participants of the conference while 100 papers were presented. Because of very restrictive volume of the papers their authors were forced to outline the problems by reporting the most important results only. That is why the book indicates the problems which are being currently solved without any deeper insight. Despite this fact the text is of great value for the physicists (optics community), chemists and engineers working in the field of ultrashort light pulses.

The new method of Colliding Pulse Modelocking (CPM) due to Fork, Greene and Shank has been reported and its extraordinary efficiency demonstrated. This method consists in a coherent interaction of two light pulses (travelling in opposite directions) in a dye absorber used to passive mode synchronization in a continuous wave dye laser. This absorber should be sufficiently "thin" which means not thicker than the desired duration of the light pulse.

The pulses create kind of a transient grating in the absorber population systems, which causes scattering of a part of one pulse in the direction of the other pulse. Since both the scattered and travelling waves are in phase the constructive interference results in narrowing the pulse generated in the laser system. Usually these conditions are realized with the help of a ring laser. The pulse durations of 100 fs are now commonly achieved. The further shortening of the pulse duration involves application of dispersive and nonlinear optics. These are essentially the methods of optical compression, discussed in several contributed papers. Most frequently the 100 fs pulse is directed to an optical fiber. Due to the phase automodulation effect the output pulse suffers from considerable broadening of its spectrum. After recollimation the output beam is directed to the so-called grating compressor, which narrows the pulse to tens of fs (as reported by SHANK et al., page 2). The relatively weak femtosecond pulse may be next amplified in a cascade of dyes which are optically pumped by the YAG : Nd^{3+} laser. The particular amplifying stages are isolated with the help of cells containing the absorber. In this way a femtosecond pulse of power of GW order can be produced (paper on page 2 and next). FORK et al. (page 10) reports the generation of continuum (from 0.19 to 1.6 μm) from a quasi-monochromatic femtosecond pulse. The pulse of duration 65 fs and power 1.2 GW concentrated in a glycol stream 500 μm thick. The femtosecond continuum that appeared due to the phase automodulation effect in glycol may find numerous applications in absorption spectroscopy. In the group of prof. W. KAISER (page 23) new dyes have been synthetized; they enable to generate the picosecond light pulses in the near infrared range (from 1.15 to 1.24 μm). The theory of the

subpicosecond light pulse generation is discussed in the papers by K. K. Li et al. (page 40) and W. Dietl et al. (page 45).

In the second group of papers devoted to the measurements within the ultrashort pulses range the report by W. Knox et al. (page 96) about jitter-free streak camera is worthy of special attention. In this setup an electro-optical converter (photochron II) has been used together with an EMI 4 four-stage light amplifier (of classical type with magnetic focusing) and an OMA-II multi-channel optical analyzer with vidicon tube. Here a novelty is the application of the stepwise deflecting voltage (applied to the converter) generated with the help of a picosecond high power solid (GaAs : Cr) switch. The transient behaviour of this switch does not exceed 2 ps, hence the stria camera works repeatedly with the transient state duration not greater than ± 2 ps. The work by Grischkowski and A. C. Balant (page 123) indicates significant advantages offered by an optical fiber when used as a nonlinear element giving the proper spread of the spectral pulse, accompanied with a time compression of the pulse in the suitable dispersive material. In the dispersive line of suitable length the group velocity of light depends upon the instantaneous value of frequency, therefore the different fragments of the spectrally broadened pulse travel with different velocities in this medium. If the front wing of the pulse suffers from a time lag such that it covers the descending wing of the pulse, the pulse is compressed to the value equal to a reciprocity of the spectral width of this pulse.

An interesting autocorrelation method of duration measurement in ultraviolet band was reported by P. H. Bucksbaum et al. (page 130). The arrangement consists of two photoconductive switches connected in series in a respective transmission line. The silicon-implanted sapphire was used as a photoconductive material. The signal from one photoconductive element acts as a basis for the other element, thus the whole unit shows the ability of sampling gate. The laser pulse is divided into two beams which illuminate both the photoelements. By changing the retardation τ of one beam with respect to the other the total charge $Q(\tau)$ flowing through the second photoelement is measured. Hence, the correlation function

$$Q(\tau) \propto \int_{-\infty}^{+\infty} I(t) I(t+\tau)\, dt$$

is obtained. The production of similar solid photoelement of rise time of order of 50 ps was reported also in papers by S. Thaniyavaran and T. K. Gustafson (page 137), by A. Andreoni et al. (page 141) and by M. G. Li et al. (page 145).

The next part of the book contains the works devoted to relaxation effects in molecular physics measured in pico- and femotosecond time scale. As a classical example of the possibilities offered by this method the paper by C. Kolmeder et al. may be mentioned (page 154) in which the life time measurements and effective channels of oscillation mode decay in liquids composed of multi-atom molecules are considered. This problem is next discussed more extensively in papers by H. Graener (page 159) and by S. F. Fisher (page 164).

The sixth part of the book deals with the applications of ultrashort light pulses in biology. The picosecond processes in CO, O_2 and NO derivatives of hemeproteins as well as transient processes in pico- and femtosecond scale in ligand hemeprotein which occur as a result of photolyses were examined. Also, the fluorescence spectroscopy in hemeproteins was studied (P. A. Cornelias and R. M. Hochstrasser, page 288, J. L. Martin et al., page 294, M. Yamashita et al., page 298). Several papers were devoted to rhodopsin which plays an important part in the process of seeing (J.D.Spalnik, page 307, T.Gillbro and V. Sundström, page 315), as well as to retinal in which the conformation changes were examined by using the method of linear dichroism spectroscopy (M. E. Lippitsch et al., p. 319).

Finally, the last eighth part of the book deals with the applications of picosecond light pulses to physical chemistry of solids. The paper by J. M. LIU et al. (page 332) reports the results of examinations of plasma creation and phase transitions in silicon. The dynamics of these processes was examined with the 30 ps resolution. The successive papers concern the picosecond spectroscopy in semiconductors, i.e. in silicon (D. von der LINDE, et al., page 336) and GaAs and CdS (H. SAITO et al., page 353). The processes of thermalization, recombination of excess charges and relaxation were examined. D. HUPERT et al. (page 360) investigated the picosecond dynamics of photoluminescence in photoelectrodes of CdS and CdSe of *n*-type. The paper by C. Y. LEUNG and T. W. NEE (page 380) dealt with the measurement of transmission (vs. the wavelength) in germanium excited by picosecond light pulses.

The discussion of a greater number of topics presented in this interesting book seems to be of no much sense because of its typically informatory character. I believe that this is an important editorial achievement also due to the distinguished graphical form of the particular papers. As already mentioned at the beginning, the scientific value of this book lies in the content of papers which is beyond the influence of the editors. In my opinion the book is very valuable. It may be only regreted that the editors did not manage to provide a slightly more extensive description of the CPM method and the contemporary autocorrelation method of femtosecond light pulse duration measurements. This shortcoming causes that the book is too specialized, becoming most useful to the participants of the Conference.

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Einführung in die

Optische Nachrichtentechnik

Physikalische Grundlagen, Einzelelemente und Systeme

RALF TH. KERSTEN

Springer-Verlag, Berlin, Heidelberg, New York 1983
[pp. i–xxii + 462, with 206 Figures]

The book by Ralph Th. KERSTEN, the English title of which would be "An Introduction to Optical Communication Techniques", is already the second book in German that has been edited in the course of last two years. The first one under a similar title was written

by Gerhard Grau and appeared in 1981 (comp. Optica Applicata **12** (1982), 510). This fact sufficiently proves how important is the field discussed and how great expectations are set on optical communication. Due to the relatively short time that elapsed between the two editions there exists an extensive area of coverage concerning the topics discussed. However, they differ so much in both the treatment of particular problems and didactic methodology used that the appearence of the second book seems to be fully justified.

To prove it let us summarize the content of the book reviewed.

The author starts with an introduction consisting of a very short historical review, which is immediately followed by a brief presentation of the basic mathematical tools and radiometric units. The first Chapter devoted to optical fundamentals continue to bear an introductive character. Here, such basic concepts are reviewed, like plane waves, phase and group velocities, Maxwell equations and wave equation, refraction and reflection laws (special attention being paid to the total reflection phenomenon and its detailed description), polarization of light and some mention of optical coherence. All these problems are presented in a very systematic and communicative way which facilitates the studying of the more essential parts of the book to the readers little advanced in the field of optical communication. The second Chapter, being still of introductory nature, is more specialized as it deals with the transferring media. The simplest lightguides of layer type are first discussed to provide, in a relatively simple way, the basic theoretical concepts and methodology which can be next exploited in the more complex fibre lightguide analysis, which is the main topic of this Chapter. To be more specific the author starts with geometrical optics approach to show the possible behaviour of a ray (and consequently that of a wavefront) in a layer lightguide. This is next used to derive (still within the geometric optics approach) the eigenvalue equation and thus to provide a very simple understanding of the latter. The mathematical derivation of eigenvalue equation based on wave description of the optical field and a discussion of field distribution in the planar lightguide and their properties complete the auxiliary considerations. The main topic of this Chapter is an extensive treatment of fibre lightguides of different types, starting with those of graded profile of refractive index. The wave equation is represented in cylindric coordinates and solved for E_z and H_z (z – the axis of the fibre) first for the fibre core and next for the outside region to obtain the typical solution forms expressed by Bessel functions of the first kind (core) and of modified second kind (coat). Since the other components (E_r, E_Φ, H_r, E_Φ) of the field are expressible by the first two ones, the whole field is thus generally described. The next stage is to solve the eigenvalue problem for the graded profile fibre lightguides to obtain the mode structure of the waves propagating in such a lightguide. This is done stepwise: by determining the eigenvalue equation in exact and approximate forms (the latter for modes being far from the cut-off), by calculating the modes for the case when approximate equality of mode parameter W and the structure constant V holds, by determining the number of propagating modes and by discussing the role of numerical aperture of the fibre lightguide. This analysis ends with the calculation of the modes, starting with the general eigenvalue equation (instead of its approximate version, which was suitable for the special case above). The evaluation of the transit time, mode dispersion and dispersion of material completes these considerations. The next topic considered concerns the initially general properties of the single-mode lightguides with the graded profile to be next generalized (at the expense of lower accuracy) to an arbitrary profile of rotational symmetry. This creates a good starting point to a comparative discussion of graded profile while the geometric optics method proves again to be of significant use. The next problems discussed for the gradient profile lightguide are: the WKBJ-approximation, the derivation and properties of meridional and helix rays, and the number of propagating modes. After a shotr mention of refractive index gradient of power profile the transit time is calculated. The fundamental problem of the attenuation in the lightguides is then considered while three attenuation sources are indi-

cated, i.e. absorption, scattering in the medium and radiation losses due to lightguide curvatures. Thereupon a convenient way of describing the light behaviours in the lightguide is shown by using the so-called phase space diagram proposed by Geckler. Somehow unexpectedly the Chapter ends with a very short review of the basic lightguide production technologies. This is mainly intended to provide a link to the further Chapters of the book.

The first of them is devoted to measurement of the preforms and the lightguides, the main attention being drawn to the latters. For the preforms the following measurement methods are briefly mentioned: the focussing method, the triangle mask method, the interferometric method, and the scattering measurement method. All they allow to measure the refractive index profile, provided that the lightguide is of rotational symmetry. Another limitation comes from a great number of measuremental data which usually are to be processed and creates the necessity of using a large-size computer. The relatively extensive discussion of the measurement methods applicable to the lightguides starts with the refractive index profile measurements. Here, the near field, modified near field and refracted near field measurement methods for refractive index profile are reported. The measurements of numerical aperture of the waveguide for the single mode and multimode lightguides are next mentioned. In turn, the attenuation measurement methods are reviewed on the assumption that the necessary condition of equilibrium mode distribution is fulfilled. Of the three basic methods, i.e. those of 70%-excitation, dummy fiber, and mode filter, the last one is described most carefully and in many versions including the optical time domain refractometry based on Rayleigh scattering. The transfer bandwidth and other parameters of fundamental importance in optical communication may be measured with the help of two methods: that in time domain or that in frequency domain, both of them being illustrated by the typical measuring setups used. It should be added that these methods can be applied to measurement of fibre cables as well.

The successive six Chapters are devoted to basic complementary devices of a typical optical communication system, including their properties and principles of operation. These are: electrooptic transducers (semiconductor light sources), detectors, couplers, receivers and modulators.

To explain the principle of operation of a part of these devices, an introduction to the quantum solid state theory must be made. This is offered at the beginning of the Chapter 4 in a very intuitive form, where a derivation of the Schrödinger equation is followed by a simple description of the band structure of solids. This is next used to introduce the recombination processes including band-band transitions, transitions at the presence of lattice defects, intraband transitions and Auger processes. Having formulated the fundamental physical concepts an explanation of light emitting mechanisms in III-V group semiconductors may be given. This, in turn, enables a short review of basic types and performance characteristics of both light emitting diodes (LED), and semiconductor lasers (HD-lasers SH-lasers, DH-lasers, strip lasers, distributed-feedback lasers, distributed-Bragg-reflection-lasers). The physical properties of the latters are shortly reviewed, special attention being given to the threshold current, P/i-characteristics, modulation bandwidth, spectral behaviour and ageing processes. Some fundamental information about the production technology completes this Chapter.

The particular importance of the semiconductor light emitters justifies a special Chapter 5 to be devoted to the respective measurement methods. They concern the basic parameters and effects, typical of these light sources, like P/i-characteristic, modulation bandwidth, harmonic perturbations and intermodulation, noise, statistical and dynamic spectral behaviour, and ageing processes. Most of the measurement methods reported are illustrated by the corresponding setup or electric schemes and by exemplified results of measurements.

The detectors being usually used as the last elements of the optical part of a communication line are expected to fulfill a number of requirements, e.g.: high sensitivity, wide

detection bandwidth, low noise, linearity of the response, compatibility and the like. These requirements are satisfied best of all by the semiconductor photodetectors, in particular by pin-diode used mostly in short-range communication systems, by avalanche photodiodes (PD-diodes), especially suitable for long-range communication systems, as well as by less frequently applied simple *pn*-diodes or phototransistors. The first three types of those detectors are described; the emphasis being laid on the APD-diodes. A review of commercially available quick detectors with specified spectral range, spectral sensitivity, rise time, type, and producer (complemented by some other measurement results) is the subject of the last Section of this Chapter.

One of the crucial points in many optical communication lines is the coupling efficiency. The author considers three basic types of coupling, i.e. light emitter-lightguide coupling, lightguide-lightguide coupling, and lightguide-photodetector coupling and discusses the conditions of their proper operation. Among others the designs of plungers used to lightguide-lightguide coupling are shown and the role of various deviations from the proper adjustment analysed. The modal noise consequences are also mentioned.

The role of the receivers in the optical communication system is to amplify the relatively weak electric signal obtained from the detector to make it strong enough to control the electronic units applied. This defines the desired properties of the receiver such as high limiting sensitivity and low signal-to-noise ratio. These problems are discussed in Chapter 8 where also the general structure of a receiver is shown.

The last but one Chapter 9 deals with modulation and coding methods. In principle all the traditional ways of modulation, i.e. the amplitude frequency and phase modulations may be applied to the optical part of communication systems, provided that special precautions are undertaken to reduce the "natural" spectral bandwidth of light emitters to the degree which enables the said types of modulations. Therefore, the intensity modulation, called also noise modulation, is the simplest to realize. If, however, any of the first three kinds of modulation is desired it may be realized by using a subcarrier of sufficiently narrow band (instead of the whole optical carrier). The two basic modulation techniques, i.e. the continuous and discrete modulations are discussed briefly in relation to time and value modulation methods to quickly pass over to the coding problems. Here, the source coding (which is used to transform the information to a possibly redundance-free form) and the line coding (which is applied to fit the code words optically to the transferring line) are mentioned.

The book is ended with two short Chapters 10 and 11 which provide a brief review of special communication systems, such as multiplex systems, heterodyne receivers, data bus loops and some others to illustrate the applicability of the ideas discussed in the text.

The book is supplied with the list of used symbols with their explanations which obviously facilitates the studying.

As may be easily seen from the above summary the author's intention is to introduce the reader into a very wide range of problems connected with optic communication systems and their applications. Obviously, such a serious task could not be fulfilled by considering each problem with the same deepness and accuracy. Therefore, different weights should be attributed to different problems and the main question is how to do it to achieve the aims intended. In the case of the book reviewed the aim is well defined already by its title. Thus the book is addressed to the readers being not much involved in the fields discussed. In my opinion this kind of readers may find almost all comfort and pleasure in studying this fascinating discipline, since they are offered a very systematic presentation of graduated difficulty, supported by intuitive argumentation, whenever necessary, and by a simple and clear language. Consequently, the necessary prerequisits are not very high. The book can be recommended to graduate students of Technical Universities and even to more

talented undergraduate students of physics. Also, the specialists working in the field may find this book interesting and helpful. Therefore it is kind of pity that the book has not been edited in English, as it would significantly enlarge the circle of potential readers.

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