Laser engineering

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W. Koechner. *Solid-State Laser Engineering.* Springer-Verlag, Berlin; Heidelberg; New York; London; Paris, Tokyo, 1988.-606 pp. (Springer Series in Optical Sciences, V. 1)

The turning point for modern optics was the creation in 1960 of a laser which fundamentally altered our concepts concerning sources of light. This was T. Meiman's ruby laser–the first example of a generator of a coherent beam working on the basis of a crystal of synthetic ruby and emitting a red beam of a hitherto unknown brightness. A large family of lasers based on dielectic crystals and glasses (in the form of rods, bars, plates, fibers, etc.) are now commonly called "solid-state" (semiconducting lasers usually are not included among them, although formally they also can be called solid-state lasers in the broad sense of this term). In addition to the already mentioned ruby other precious crystals—alexandrite, sapphire, garnets and a number of other beautiful crystals and glasses came to be used as the working substance of solid-state lasers. This family of lasers was fated to be the working lasers. Already for many years dozens of laser devices based on crystals and glasses with an admixture of neodymium ions are operating in industry and in medicine. They are capable of carrying out both precision operations in microelectronics, where micron accuracy is required, and also ultrapowerful processes in experiments on thermonuclear plasma where one deals with laser beams of diameter up to 1 m.

The second revised and expanded edition of W. Koechner's book on the physics and technology of solid-state lasers appeared during the period when the need for such references has grown enormously. This is explained first of all by the fact that thousands of new engineers and technologists have entered the field of development and application of these lasers. All the remaining doubts and objections have been overcome—it became clear that without a widespread use of lasers it is impossible to avoid many technical obstacles and technological stagnation. Secondly, discoveries and developments of the last decade provided new remarkable possibilities for people. Here are the directions of rapid development that are noted by W. Koechner who published the first edition of the book already in 1976:

–creation of tunable lasers based on alexandrite, Ti-sapphire and other crystals, in particular, for applications in spectroscopy and ecological monitoring;

–increase in efficiency of lasers as a result of combined doping, for example, by addition of Cr and Nd in order that the absorption of pumping radiation would be due to both admixtures, while at the next stage the energy would be transferred to the working ions (Nd);

–increase in the efficiency and creation of compact devices as a result of utilizing semiconducting laser straightedges ("diode pumping");

–increase in the average power of laser radiation, in particular, as a result of new geometry of the active element;

–improvement of the quality of the laser beam as a result of development of lasers with an "unstable" resonator and mirrors with wavefront reversal;

–broadening of the range of wavelengths being covered as a result of a big variety of nonlinear optical elements and materials (this permits one to carry out frequency transformation with an acceptable level of efficiency);

–creation of highly coherent systems, for example, stable ring lasers with diode pumping;

–creation of laser "superstructures" (one has in mind putting in operation gigantic multicascade lasers based on neodymium glass for experiments on laser thermonuclear fusion).

W. Koechner's book is aimed at engineers and specialists of applied science working on development and application of solid-state lasers, but the systematic and complete presentation in the book makes it useful also for a wider circle of readers–undergraduate and graduate students and specialists in adjacent fields to whom the book provides a possibility of obtaining rich information both on the fundamental bases and also on the practical features of solid-state laser technology.

W. Koechner points out that he had as his aim to present the subject in as clear a manner as possible, even at the expense of reducing the amount of mathematical calculations. He preferred phenomenology and graphical models, even though this involves many simplifications. Nevertheless, instead of abstract details (i.e., those details which have not yet become pressing), he gives comprehensive lists of references (including many to Soviet authors), provides many tables and practical drawings, diagrams and graphs.

The following aspects are presented in the book in a consistent manner: theoretical introduction–processes of optical amplification, properties of laser materials, physics of generators and amplifiers, resonators, pumping and heat removal systems, devices for modulating the quality factor and mode locking, nonlinear devices and problems of optical damage to laser active elements and resonators.

There is no question that W. Koechner's book will be useful for Soviet specialists, particularly for those engaged practically in the field of laser technology, who need both an increase in depth and systemization of physical knowledge. Highly qualified specialists will also find in it much that is useful, for example, they will objectively appreciate the great progress in all aspects of solid-state laser technology and, probably, will note physical and technological possibilities for its further development and improvement.

Translated by G. M. Volkoff