

SUMMING-UP OF LASER PHYSICS, LASER TECHNOLOGY, AND INDUSTRIAL AND SCIENTIFIC APPLICATIONS

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Ultra short optical pulses of only a few wavelengths or a few femto seconds duration have proven to be very valuable for the understanding of elementary processes. The technology to generate tuneble short pulses with dye lasers in the colliding pulse configuration has been well developed. The further compression by means of self phase modulation in filters and dispersive cells to synchronize the frequency spectrum results in pulses of only a few wavelengths. The technique was reviewed by Kafka and Ippen. The measurements of the optical lengths are done by auto-correlations in a nonlinear crystal like KDP. A very important scientific application of these femto second pulses have been presented by Ippen. He reported on the electron relaxations in semi-conductors and metals. Using GaAs and heating the electrons with about 0.5 eV relaxation phenomena of the order of 200 fs are observed. In gold electron heating up to 1000 K and the speed of energy transport by the electrons of about 10^8 cm/sec was observed. His measurements were based on an adjustable delay of a second probe pulse that follows the pump pulse.

Although molecular laser systems may have many lasing transitions the linewidths i.e. the continuous tuneability is in general poor compared with dye and solid state systems. However, the range of lasing frequencies is considerable due to optical pumping of many lasing gases. Especially the well developed high power CO₂ systems have shown to be very useful as pumping sources. A review of many optically pumped systems were presented by Gupta. The quantum efficiency can be as high as 28%. Several gases like NH₃ and CF₄ will also oscillate in continuous operation. The attractive features are the selective excitation, the non-destructive active medium and the adaptability. Furthermore, the gain anisotropy by pumping off center allows unidirectional amplification in ring lasers.

To get full profit out of laser science the realization of reliable systems is a basic requirement. As long as laboratory studies are concerned with the prove of principle, the stability reproducibility may be poor. For further development also the engineering aspects with respect to scaling parameters, excitation efficiency, simplicity, optimization, etc. become important. Several aspects of laser construction and their performances have been presented by Witteman. He discussed the stability of a transition selective three mirror configuration, single discharge pulsed systems, and a table top e-beam pumped excimer laser construction.

Large scale laser applications are the compact disk and the optical fiber transmissions. Sophisticated system configurations of optical communication by advanced fiber transmission technology were presented by Kimura. He mentioned several experiments with Ne-He and (distributed feed back) semiconductor lasers. A review of coherent optical transmission and the problems related to optical amplification were reported. The most remarkable result is the recent successful experiment with a 400 Mbit/s transmission over 270 km. However, up till now the state-of-the art of semiconductor lasers, especially frequency stability with respect to current and temperature, is insufficient for applying coherent optical transmission systems. High power lasers, both pulsed and continuous systems, are becoming industrial tools for mechanical processing. The automation of welding, cutting, and drilling in heavy steel parts by means of CO₂ lasers seems to be successful. In particular the surface hardening and processing of tools. A review on this technology was presented by Katulin using a 6 kW Hereus and a 1500 W Spectra Physics CO₂ laser. Very dedicated applications with excimer lasers were discussed by Witt. He reported experiments on commercial systems having one joule pulses and an average output of 100 W. The short wavelengths of the excimer lasers turn out to be very useful for processing and control of industrial applications like pattern generation, micro structure generation and the production of semi conductors.