

Preface

Laser is a scientific breakthrough looking for, and finding, multitudinous uses and of all the high-tech developments in recent times the laser probably fascinates more people than most others. After its inception in 1960, the laser has quickly evolved into an extremely powerful tool that is opening up new applications in scientific, industrial and medical fields. In just one generation laser has moved out of the realm of fantasy and into everyday life.

The power generated from a laser increased rapidly starting from the kW (10^3 W) pulses of a free-running laser in early sixties. Introduction of Q-switching technique few years later increased the power level of a laser to MW (10^6 W) range which was further enhanced to GW (10^9 W) range with the introduction of mode-locking in mid sixties. Recently petawatt (10^{15} W) power output has been reported in a single laser using a chirped pulse amplification technique through a series of laser amplifiers.

The usefulness of the laser reached a climax with a call to scientists from President Regan in March 1983 to develop a system capable of destroying the strategic ballistic missiles in flight—known popularly as Star Wars program. Semiconductor lasers with an annual production of about 77 million units have revolutionised the way information is being stored and communicated over long distances, as exemplified by the compact disc industry and the fiber-optic long-distance communication systems. In the communication wavelength window between 1.3 and 1.55 μm there is a bandwidth of 40 THz in a single fiber, that is, enough information-handling capacity to allow everyone on the planet to have a telephonic conversation simultaneously. In addition, the high bandwidth available makes it possible to use lasers for optical interstellar communication links with high-data-rate communication. Also, power can be transmitted in space by laser to run vehicles used for exploring our nearest neighbors in the solar system. Today high-energy and high-peak-power lasers are being used to drive inertial confinement fusion which requires a small fuel capsule containing isotopes of hydrogen which must be heated to a temperature of about 115 million $^{\circ}\text{C}$ and compressed to a several hundred grams per cubic centimeter. In addition, lasers are being used to weld metals, to reattach a detached retina, to remove tumors, for space-based ballistic missile defense, to fuse tooth structure and to provide a light-show. Nonlinear optics will soon replace electronics in processing.

The Indian Institute of Science has made significant contributions to the basic physics of laser systems and also their applications in various fields. Today, practically all the major departments on the campus have on-going research programs involving lasers. The areas of research pursued include the development of laser systems like CO_2 , He-Ne, Argon ion, Nd:YAG and Ti:sapphire and the application of lasers in chemistry, metal processing, flow diagnostics, holography, nonlinear optics, optical communication and dentistry. The departments involved in laser research are Aerospace Engineering, Instrumentation, Physics, Mechanical Engineering, Electrical Communication Engineering, Inorganic and Physical Chemistry, Metallurgy, Centre for Atmospheric and Oceanic Sciences and Materials Research Laboratory.

As the research work on lasers is widely spread out, the importance of the contributions done by various groups is not apparent to a visitor to the campus. The purpose of this special issue is to provide an overall perspective of the research being carried out on campus in the field of lasers and their applications. Although the papers presented here serve the main goal of the special issue, they do not represent the complete work. Due to certain constraints many active researchers have not been able to contribute to this issue. We hope to bring out another special issue in the near future to cover all the work not reported here.

I hope that this issue will convey the flavour of the exciting research that is being carried out on the campus.

K. P. J. Reddy
Guest Editor