



Indian Institute of Technology Gandhinagar

Institute Lecture Series

Biomedical applications of Lasers

Dr P. K. Gupta

Distinguished Scientist

Raja Ramanna Centre for Advanced Technology,
Department of Atomic Energy,
Indore

Venue: Institute Auditorium (1st floor)

Date: 8 April 2011

Time: 5:30 – 6:30 pm

Abstract:

Lasers have truly been one of the greatest inventions of the 20th century and are finding applications in all walks of human endeavor. I will discuss the use of lasers in an area that concerns us all, the quality of human health care. Lasers are playing an important role in the pursuit of two major objectives of quality health care, to detect the disease at a very early stage before it becomes difficult to manage and secondly to treat it with high selectivity that is with no or minimal adverse effect on the normal tissue. Both the issues will be addressed using illustrations from the work being carried out in these areas at RRCAT, Indore. First I shall describe the use of optical techniques like optical coherence tomography (OCT) for minimally invasive, in-situ biomedical imaging with resolution down to a few micrometers. Some representative applications of OCT like imaging of microstructures of eye; non-invasive monitoring of the healing of wounds and ethanol-induced developmental abnormalities in Zebrafish embryos will be briefly discussed. Next I shall discuss the advantages of the use of optical spectroscopic techniques for the diagnosis of cancer and describe the results of our recent study carried out at Tata Memorial Hospital, Mumbai for in vivo diagnosis of cancer of oral cavity. The use of light for the treatment of cancer with minimal damage to the normal tissue and for photodynamic inactivation of antibiotic resistant bacteria will be discussed next. Finally, I shall discuss the use of light to trap single cells or intracellular objects and for transportation, orientation or rotation of these using only light induced forces. The use of these techniques for spectroscopic studies on single cells or measurement of the visco-elastic parameters of single red blood cells and the role these can play in biomedical diagnosis will also be briefly touched upon.

About the speaker

Dr P. K. Gupta, a Distinguished Scientist at Raja Ramanna Centre for Advanced Technology, presently Heads its Laser Biomedical Applications and Instrumentation Division (LBAID) and the Laser Materials Development and Devices Division (LMDDD).

Dr Gupta joined the Laser Division, BARC in 1974 after graduating from BARC training school. At BARC, Dr. Gupta worked on the generation of coherent radiation in the mid-

infrared region. This involved R&D on nonlinear optical frequency conversion techniques, CO₂ lasers, CO₂ laser pumped NH₃ laser and 16 μ m CF₄ laser. He moved to RRCAT in 1990 where he worked on CO₂ laser pumped FIR laser and started an activity in the area of biomedical applications of lasers, the area of his current research interest. Major contributions of his group in the area of biomedical applications of lasers include (i) unraveling the factors responsible for the observed differences in fluorescence from normal, benign and malignant tissue; (ii) use of optical spectroscopy for in-vivo diagnosis of cancer of oral cavity using systems developed in-house; (iii) development of novel laser micromanipulation techniques for optical transport and rotation/orientation of intracellular objects; (iv) use of optical tweezers for applications like, malaria diagnosis, transfection, guidance of neuronal growth cones, optical binding of nanoparticles, Raman spectroscopy of single trapped cell, etc; (v) development of optical coherence tomography set ups and their use for novel biomedical imaging applications; (vii) unraveling the intriguing effect of light on biological systems.

As Head, LBAID & LMDDD, Dr Gupta is also supervising the R&D programs at RRCAT on the growth of high optical quality single crystals; synthesis of ferroelectric, relaxor materials and transparent ceramics; development of Pt loaded carbon aerogel based catalyst for H/D exchange, and development of various laser-based Instruments to meet in-house requirements of the Department.

Dr Gupta has also worked at Heriot Watt University, U.K as commonwealth research scholar during November 1979 to November 1981 and as Research Associate during April 1988 - April 1989.

Dr Gupta has over 400 research publications that include over 225 publications in journals and edited volumes. Dr. Gupta is a Fellow of the Indian Academy of Sciences, National Academy of Sciences and has received several awards; the N S Satyamurthy memorial award of Indian Physics Association for the year 1988 for his contributions on mid-infrared coherent sources, the 1998 Homi Bhabha Science and Technology Award, for his contributions in the area of biomedical applications of lasers and the annual award of Society for Cancer Research and Communication for the year 2006.