SEMINARIUM
Instytutu Technologii Elektronowej

Studies on Semiconductor Lasers and Detectors

T. K. Sharma

Semiconductor Laser Section, Raja Ramanna Centre for Advanced Technology, Indore-452103 (M.P), India
(Email: tarun@cat.ernet.in)

During this talk, I should be presenting our results on the development of quantum well (QW) lasers operating in the wavelength range of 670 to 1200 nm. To cover this broad wavelength range, we synthesized strained QW laser structures based on various conventional III-V compound semiconductors. The complete laser structures are grown by metal organic vapour phase epitaxy (MOVPE) technique and devices are fabricated through standard procedure using photolithography. The MOVPE grown QW structures are characterized using optical, electrical and x-ray probes and these results will also be presented. It is of great interest to explore the domain of mid-IR lasers operating at about 4 m wavelength. Here, I should present a new spectroscopic technique (FTIR-SPS[1]) to investigate the complex Antimony based laser structures grown by Molecular Beam Epitaxy technique. Finally, the device characteristics of some of the indigenous laser diodes will be presented. Recently, we also carried out some initial studies on AlGaAs/GaAs based quantum well infrared photodetectors (QWIP) and p-i-n GaAs photodiodes. These results will also be presented.

[1]T. K. Sharma et. al “Room temperature observation of the energy levels of mid-infrared QW lasers by FTIR-SPS, Appl. Phys. Express, **1**, 062001 (2008)

Brief Biography of Dr. T. K. Sharma

Dr. Tarun Kumar Sharma received M.Sc. Physics (Electronics) degree from Meerut University, Meerut (UP) in 1993. He joined 38th batch of the Training School, Bhabha Atomic Research Centre (BARC), Mumbai in 1994. After completion of the training, he was posted in Semiconductor Laser Section of C.A.T., Indore (now known as RRCAT) in Aug. 1995 as Scientific Officer/C. Later, he was deputed to Tata Institute of Fundamental Research (TIFR), Mumbai in April 1997 to work on metal organic vapour phase epitaxy (MOVPE) growth. At TIFR, He worked on the development of Al-free strained quantum well laser diodes operating at 980 nm under the guidance of Prof. B. M. Arora. This was the first time when such novel devices were developed in India. He was promoted to SO/D in 1998. He returned to RRCAT in Jan'1999. At RRCAT, he has been mainly responsible for setting up a laboratory for semiconductor research & optoelectronic device fabrication. He played a key role in the setting up of MOVPE (AIX200) laboratory for the growth of semiconductor heterostructures and the device processing laboratory for laser diodes. He has also developed a spectroscopy laboratory for the characterization of semiconductor bulk and quantum structures. Under his leadership, significant progress has been achieved on the development of high power laser diodes at RRCAT where more than 6 Watts of power have been demonstrated for laser diodes over a broad wavelength range varying from 670-1000nm. He played a key role in successful completion of two successive five year departmental projects costing more than INR 150 Million. Earlier, he had worked at FBH, Berlin with Dr. M. Weyers on the development of high power highly strained InGaAs quantum well laser diodes operating at 1.2 m in year 2001 and on the MOVPE growth of InGaAsP/GaAs epitaxial layers near the miscibility gap in 2002. It was an impressive achievement related to 1.2 m lasers when high power lasers were demonstrated with a very low threshold. He was promoted to SO/E in 2002 and to SO/F in 2007 due to the progress achieved under his leadership. In 2007, he spent 3 months as visiting researcher at Physics Department, University of Surrey, UK under UK India Education and research initiative (UKIERI) scheme of British Council. He received PhD degree from Devi Ahilya Vishwavidhalaya, Indore, India in 2003. The PhD thesis work was carried out at TIFR, Mumbai; RRCAT, Indore; and at FBH, Berlin. He has published/presented eighty two papers in international Journals/Conferences and given several invited/oral presentations at international/national conferences/workshops. He has supervised 6 B. Tech students, 4 M. Tech students and is assisting in the supervision of 3 PhD students. His current research interests include the growth of nanostructures by different routes, development of advanced laser diodes and detectors and in depth characterization of quantum structures especially through spectroscopic techniques. He has been working on the MOVPE growth of InAs, InP quantum dots and subnano quantum wells on GaAs substrate. He has extensively worked on the MOVPE growth of GaAs, InP and GaP epilayers on silicon substrates. He has also been working on the investigation of PLD grown ZnO/MgZnO MQWs and MOVPE grown heavily doped p-type (Mg) GaN epitaxial layers through spectroscopic techniques.

Dr. Sharma is a recipient of University Merit Certificate of Meerut University, Meerut for holding First Rank in M.Sc. (Physics) for year 1993. He is a winner of Homi Bhabha Award for standing first in 38th batch of BARC training school. He is also a recipient of ILA Best Thesis award for the year 2002.

Ten Recent Publications:

1) **T. K. Sharma**, N. Fox and T. J. C. Hosea, G. R. Nash, S. D. Coomber, L. Buckle, M. T. Emeny and T. Ashley, "Room temperature observation of the energy levels of mid-infrared Quantum Well lasers by FTIR-SPS, Appl. Phys. Express (2008), in press

2) **T. K. Sharma**, V. K. Dixit, Tapas Ganguli, S. D. Singh, S. Porwal, R. Kumar, P. Tiwari and A. K. Nath, "Optimization of GaP epitaxial layer grown by MOVPE on GaP (111)B Substrates", Semicond. Science and Technol (2008). In press

3) P. Misra, **T. K. Sharma** and L. M. Kukreja, "Temperature Dependent Photoluminescence Processes in ZnO Thin Films Grown on Sapphire by Pulsed Laser Deposition", Current Applied Physics, (2008), in press. Available online.

4) Pankaj Misra, **T. K. Sharma** and L. M. Kukreja, "Temperature Dependent Photoluminescence from Ultra-thin ZnO Quantum Wells Grown on (0001) Sapphire using Buffer Assisted Pulsed Laser Deposition", Supperlattices and Microstructures, 42,212 (2007).

5) V. A. Kheraj, C. J. Panchal, P. K. Patel, B. M. Arora and **T. K. Sharma**, "Optimization of Facet Coating for Highly Strained InGaAs Quantum Well Lasers operating at 1200 nm", Optics & Laser Technology 39,1395 (2007).

6) S. Pal, A. Ingale, V. K. Dixit, **T. K. Sharma**, S. Porwal, P. Tiwari and A. K. Nath, "A comparative study on nanotextured high density Mg-doped and undoped GaN", J. Appl. Physics 101, 044311 (2007).

7) **T. K. Sharma**, S. D. Singh, S. Porwal and A. K. Nath, "Spectroscopic characterization of InGaAs/GaAs Quantum wells with low and high built-in strain", J. Crystal Growth, 298, 527 (2007).

8) Pankaj Misra, **T. K. Sharma**, Sanjay Porwal and L. M. Kukreja, "Room Temperature Photoluminescence from ZnO Quantum Wells Grown on(0001) Sapphire using Buffer Assisted Pulsed Laser Deposition", Appl. Phys. Letters, 89, 161912 (2006).

9) V. K. Dixit, Tapas Ganguli, **T. K. Sharma**, Ravi Kumar, S. Porwal, Vijay Shukla, Alka Ingale, Pragya Tiwari and A. K. Nath, "Studies on MOVPE growth of GaP epitaxial layer on Si(001) substrate and effects of annealing", J. Crystal Growth, 293, 5 (2006).

10) S. D. Singh, S. Porwal, **T. K. Sharma** and K. C. Rustagi "Temperature dependence of the lowest excitonic transition for an InAs ultra thin quantum well", J. Appl. Phys 99, 063517 (2006).