L.1 : CW operation of 980 nm semiconductor diode laser

Pulse mode operation of semiconductor diode laser was achieved for the first time at RRCAT by the Solid State Laser Division in 2006. Since then, continuous effort has been given to improve the duty cycle and to operate the lasers in continuous wave mode. To improve the duty cycle and power of laser diode, surface passivation and isolation of device elements play an important role. For this, two processing steps are necessary: first, mesa etching till cladding layer, and second, deposition of a good quality oxide between two diode elements. The oxide layer isolates the devices, reduces the carrier losses and hence improves the injection efficiency of the laser diode. It also passivates the side walls of the individual device.

Following methodology was adapted: First, front ohmic contacts (stripes) were defined using conventional photo-lithography and lift-off technique. The next step was to define mesa structures in between the metal stripes. To achieve a good mesa structure (flat topped elevation with steep walls) and uniform etching through cladding layer, the wet chemical etching process was optimized using citric acid (monohydrate) : H_2O_2 (10:1) solution. Best isolation and uniform etching were obtained for 10 minutes etching. Next, SiO_2 was investigated as a potential dielectric layer to be used for isolation, carrier confinement in lateral direction, and passivation of laser devices. For this purpose, SiO_2 layers with different thickness were deposited under various deposition conditions using the e-beam deposition facility at Laser Systems Engineering Division, RRCAT. The electrical properties of the dielectric layer were characterized by fabricating metal-oxide-semiconductor structures. Finally, SiO_2 layer of about 200 nm thickness, giving largest break-down voltage and lowest leakage current, was used for laser diode processing. After deposition of SiO_2 layer, windows were opened on top of the metal contacts using photolithography and the dielectric was completely removed selectively from the contact region by etching with buffered hydrofluoric acid. Complete removal of SiO_2 was examined using EDX facility at Indus Synchrotrons Utilization Division, RRCAT. Next, the device processing was followed by back-side lapping and polishing (to thin down the devices), n-side ohmic contact deposition, and cleaving into 1-mm long bars.

The processed laser bars were tested by operating them under CW condition. Fig.L.1.1 shows the picture of laser emission seen on IR viewer card which clearly shows an elliptical beam profile as expected for laser diodes. Fig.L.1.2 shows the L-I characteristics of the laser (operating at 980 nm) in CW mode. The maximum average power is about 25 mW per facet. The device was operated in CW mode for ~ 4 hours at low current (< 125 mA), at ~ 10 mW average power. Fig.L.1.3 shows the laser emission spectrum clearly displaying the small FWHM value of the cw laser diode.

Fig.L.1.1: Laser emission seen on IR viewer card .

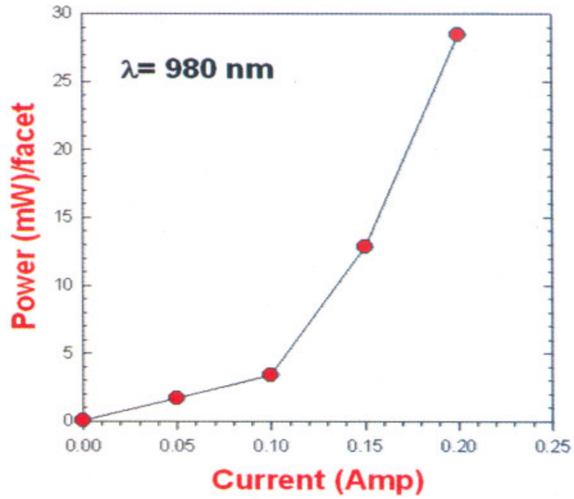

Fig.L.1.2: L-I characteristics of the laser in CW mode.

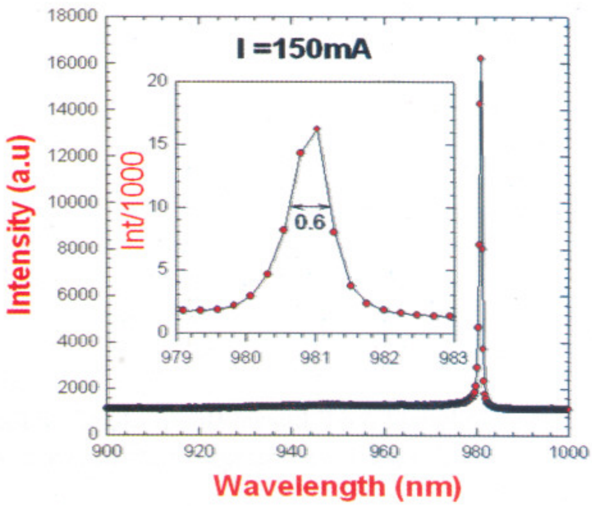

Fig.L.1.3 : The laser emission spectrum.

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