Couillaud locking scheme to lock the SLM IR laser to an external resonator.

(Contributed by: TPS Nathan; nathan@cat.ernet.in)

L.14 Hand operated laser manipulator for cutting of coolant channel of feeder coupling bolts in PHWR

Hand operated laser manipulator has been used for cutting operation at Madras Atomic Power Station. One of the major activities during the shut down for preventive maintenance is the replacement of coolant channels. Grayloc coupling based mechanical seal joints are fitted on two ends of the coolant channel and D_2O (inlet and outlet) feeders. For replacing the coolant channels all the joints are to be opened by some mechanical means e.g., powered torque wrench. Due to excessive corrosion and jamming of the bolts, it is expected that it will not be possible to open some of the joints. So, it is needed to cut these bolts. These joints are made up of two of high tensile M16 bolts (fig. L.14.1).

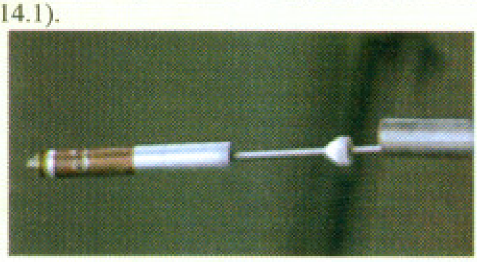


Fig. L.14.1

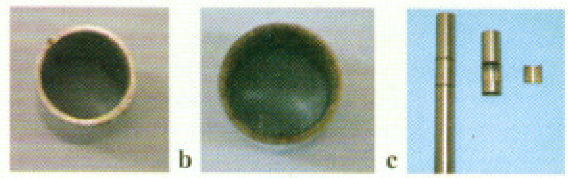
Industrial Nd:YAG Laser with 250W maximum average power delivered through optical fiber beam is connected to the cutting head mounted on the manipulator. An improvement in cut quality is possible with either pure inert gas or inert-oxygen mixture as assist gas.

(Contributed by: TPS Nathan; nathan@cat.ernet.in)

L.15 Laser cutting tool for steam generator tubes in PHWR

In pressurized heavy water reactor based nuclear power plants, mushroom type steam generators (SG), made up of non-magnetic INCONEL-800 material, and are being used. The SG is a sheet and tube type heat exchanger. The SG tubes with inner diameter 14mm and outer diameter 16mm are mounted in the tube sheet in diamond pattern with tube-to-tube distance 22mm. The tubes are U-shaped and running up to 7-8meter height. Leakages in the SG tubes have been identified at various power plants in the country. To identify the reason of thinning of the tubes and leakage, it is necessary to get the sample of the tube from the location of leakage and investigate the reason behind leakage from SG tubes, e.g. material problem, local indentation problem, erosion problem etc., by further metallurgical examination. Laser based cutting mechanisms are being developed to take out the lower portion of the tube or cut a small window from inside and take it out from inside of the tube.

An industrial Nd: YAG laser having 250W average output power with fiber optic beam delivery and manipulator has been designed and developed, which will go inside the tube up-to a desired height and will be moved by motorized rotary mechanism mounted on the bottom of tube sheet A miniature cutting head with outer diameter 13.6mm and 85mm over all length has been developed, so that it can be inserted through 14mm ID SG tube as shown in fig. L.16.1 above. Fig.L.15.1 shows cut quality with oxygen and argon as assist gases.



a b c

Fig. L.15.1

Many cutting trials for both, circumferential and window cutting were carried out. The debris produced in both the cases had just surface adhesion and apparently no adverse effect on the adjacent tubes.

(Contributed by: TPS Nathan; nathan@cat.ernet.in)

L.16 Silicon nano particles with blue – UV photoluminescence

The Si nanostructures have attracted significant attention in the past several years for the photoluminescence studies in the red – green region. Recently oxygen containing silicon fine structures have extended the emission in blue region, which has wider optoelectronic applications. A new technique of generating silicon nano-particles using an ultra dispersive powder (UDP) has been setup. With the thermal evaporation in controlled and varied atmospheres, silicon particles as fine as ~ 60nm were produced with enhanced PL in Blue-UV region.

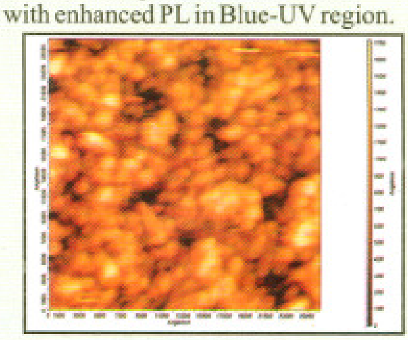


Fig. L.16.1 AFM of Si/SiO_x crystallites

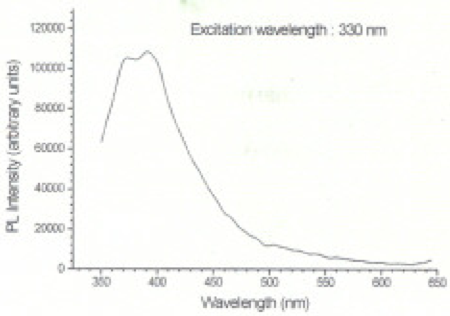


Fig. L.16.2 PL Spectra from the nano-crystalline Silicon film

The samples were characterized by AFM. The surface morphology clearly indicates uniform, closely packed Si/SiO_x crystallites (fig.L.16.1). The photoluminescence (PL) spectrum of the samples was obtained using 330nm excitation wavelength, which clearly showed strong luminescence around 375 – 400nm (fig.L.16.2).

(Contributed by: R. K. Khardekar and D. K. Kohli; khardekr@cat.ernet.in)

L.17 MOVPE system for epitaxy growth of III-V semiconductor heterostructure

The Metal-Organic Vapor Phase Epitaxy (MOVPE) system (AIX200) has been commissioned for epitaxial growth of III-V semiconductor heterostructures (fig. L.17.1). The precursors available on this machine are arsine, phosphine, trimethyl gallium, trimethyl aluminum and trimethyl indium allowing growth of a large variety of semiconductor structures with Al, Ga, In from group 3 and As and P from group 5. The available dopants precursors are silane, hydrogen selenide and dimethyl zinc. In view of the hazardous properties of the precursors installed on the machine, an effluent handling system (wet scrubber) has been commissioned and tested for its satisfactory performance. Apart from He leak testing and efficient disposal of waste gases, other built in safety systems are installed in the machine. In order to grow the laser diode structure, we need to optimize several growth parameters of MOVPE grown epitaxial layers.

The system has been tested by growing thick undoped GaAs layers. We achieved the background doping for undoped GaAs lesser than 10^{15}cm-3 and the mobility at 77K was about 65,000cm^2/V-Sec. A super lattice structure consisted of AlAs/GaAs materials have been grown for measurement of the thickness uniformity of grown layers (fig.L.17.2). The standard deviation value for a 2-inch substrate was about 2% excluding a 5mm outer ring. A quantum well (QW) structure consisting of a 100Å GaAs QW with AlGaAs barrier was also grown. This QW sample was characterized by photoluminescence (PL) measurement. The full width at half maximum of 10K PL spectrum was about 8meV. Figure L.17.3 shows a 10K PL spectrum of a multi quantum well (MQW) sample. This sample consists of four GaAs QWs of varying thickness, which are sandwiched between AlGaAs barriers. The quantization effect mainly the shift of PL wavelength with QW size is clearly visible. We have grown InGaP epitaxial layers on GaAs substrates and we observed red luminescence at room temperature. The red luminescence from $Al_{0.32}Ga_{0.68}As$ layers grown on GaAs substrate was observed. Some samples of GaAs and AlGaAs have been grown for the n type doping studies.

Fig. L.17.1 A photograph of MOVPE system

Fig. L.17.2 Samples of AlAs/GaAs layers

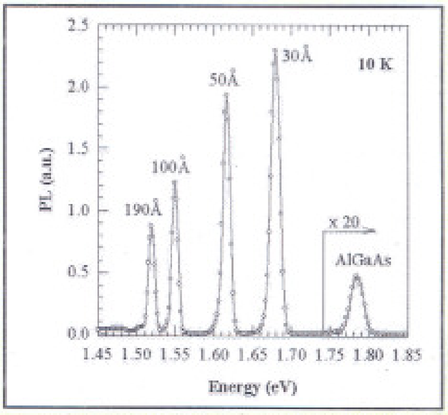


Fig. L.17.3 10K PL spectrum of a MQW sample

(Contributed by: TK Sharma; tarun@cat.ernet.in)