Thin film deposition set-up.

radiation, growth of ultra thin films and characterization of their roughness is an important requirement. Ultra thin gold films (100 Å) have been deposited on good quality float glass and on polished quartz substrate. These films were deposited under ultra high vacuum condition using a turbo molecular and sputter ion pump based physical vapor deposition system, made in CAT. The deposition rate was maintained at 0.2 Å/sec. The in situ thickness and deposition rate were monitored using a quartz microbalance. This system is to be used for the development of multilayer reflectors for soft x-ray synchrotron optics.

The gold films were characterized using x-ray reflectivity measurements at 8.047 keV. With these measurements an estimate of root mean square (rms) surface roughness and the thickness of the films was obtained to an accuracy of a few Å. The data shows that the rms roughness of the gold film deposited on float glass is about 6 Å which agrees well with the results in other laboratories abroad on this type of float glass, while the film deposited on quartz polished in CAT optical workshop showed an rms roughness of about 15 Å. The thickness of the thin film was monitored with Å level accuracy with the help of Kiessing fringe oscillation observed in the x-ray reflectivity measurements. The thickness measurement using these oscillations are in good agreement with the in situ measurements done using quartz microbalance.

Gas flow proportional counter detector system for synchrotron radiation beamline

Gas flow proportional counters are soft x-ray detectors used in synchrotron radiation based experimental stations. This type of detector system has been developed and is to be used on the soft x-ray reflectometer station being set up on the metrology beamline of Indus-1. The detector has a 25 micron diameter tungsten wire as anode and uses P-10 (90% Ar + 10% CH_4) gas as the detection media. It has a thin aluminized mylar window. The energy resolution of the detector is 17% at 5.9 keV and can be operated upto 6000 counts/sec without significant deterioration in resolution. The high count rate performance is limited due to the preamplifier (BARC P-117) and the spectroscopy amplifier (ECIL 572 B). Efforts are underway to make the detector compatible to high vacuum and to increase the count rate performance.

Sine-bar mechanism for selection of wavelength in Indus-1 beam line

Synchrotron radiation from Indus-1 will have a broad wavelength range. For selecting a particular wavelength required for an experiment a monochromator is used in which, by tilting the gratings, a suitable wavelength is selected.

As an example, in the radiometry beam line, the wavelength range is 40 to 1000 Å for which 3 gratings of different groove densities are used. These cover the wavelength ranges of 40 - 120 Å, 120 - 360 Å, and 360 - 1000 Å. Selection of wavelength is required in steps of 0.1 Å, 0.3 Å and 0.9 Å in the three ranges respectively. With the given groove densities, this requires angular displacement of gratings in steps of 0.0033 degree. For giving this fine movement a novel sine bar mechanism was designed and developed. The mechanism consists of a bar having two cylindrical surfaces at its ends. The bar is suspended at one cylinder and other cylindrical end is given linear motion through a linear feedthrough. The bar is connected to grating holder such that the reflecting surface of the grating passes through the axis of rotation of the bar. The linear displacement of the free end of the bar is directly proportional to the sine of its angular displacement, and thus to the wavelength diffracted by the grating. A linear motion of 10 μm provides wavelength changes in the three ranges.

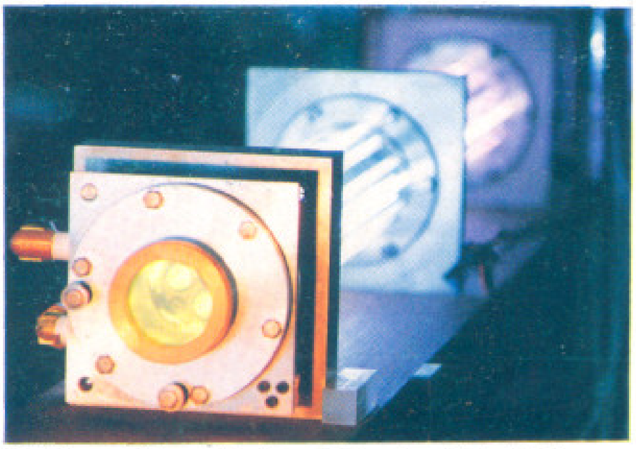
The mechanism has been tested using an autocollimeter and an accuracy of 1 arcsec in 10 arcsec angular displacement has been observed.

LASER PROGRAMME

Surface melting of stainless steel using Multibeam CO_2 Laser

The high power multibeam CO_2 laser developed at CAT was successfully used for surface melting of AISI304 SS. This work was undertaken for IGCAR, Kalpakkam. The multibeam CO_2 laser is a slow flow type laser with six equispaced beams on a circle. Each beam has a diameter of 9mm.

For surface melting, the sample pieces were mounted on a motorised translation stage and the six laser beams were focussed on the samples using a zinc selenide lens. Focal spot of 1mm diameter was used. A jet of argon gas



Multibeam CO_2 laser. Photograph shows the electrical discharge.

was provided on the sample to avoid oxidation of the melted zone. Laser power of 300 to 350 watts was used in this experiment.

The exposed samples were studied at IGCAR and it was found that surface melting was achieved, the melted zone being of the order of 900 μm wide and 150 μm deep. Surface melting of stainless steel improves the wear resistance of moving parts.

Pacemaker-welding laser machine

CAT has developed a PC controlled laser welding machine for welding of titanium shell of heart pacemaker assembly and a feed-through on it.

Heart pacemakers consist of an odd shaped titanium shell (0.4 mm thick) containing an electronic pulse generator circuit. Conventional welding techniques cannot be used for welding the pacemaker as it leads to heating of the job and the electronic circuit gets damaged. A pulsed laser, on the other hand, deposits a precise amount of energy on a small area in a short duration, causing only localised heating of the job.

The pacemaker welding laser machine consists of four sub systems, namely Nd:YAG pulse laser, its power supply, welding rig and a control system.

A pulsed Nd:YAG laser is used which delivers 5 Joules of energy in 8 msec long pulses at a rate of one pulse per two seconds. The flooded laser pumping cavity encompasses a Nd:YAG rod and two krypton filled flash lamps in a closely coupled, gold plated double elliptical chamber. The laser resonator consists of two dielectric coated mirrors, one having maximum reflectivity and other 70% reflectivity (at 1.06 micron). The chamber is cooled by a 500 W refrigeration capacity chiller unit. The cooling circuit incorporates a particle filter of 5 micron grade and deionizing cartridge.

The power supply consists of an ignition source, a simmer current source and main current pulse source for two flashlamps. The ignition source generates 20 KV, 5 μsec pulse for igniting flashlamps and simmer current source keeps the flashlamps in simmer mode by supplying 200 mA current. The main current pulse source is realized by a buck converter operating at 20 KHz and generates 120 A, 8 msec current pulses at the rate of one pulse in two seconds for each flash lamp.

A welding rig consisting of four degrees of freedom has been provided. It comprises of three mutually perpendicular translation stages having linear accuracy of movement within 10 μm and mutual perpendicularity within 30 μm over the entire length of travel, which is 50mm. These translation stages use crossed roller linear bearings and ball screws driven by stepper motor and timing belt pulley driver. The three prisms mounted on these stages move the laser beam in such a way so as to keep the beam focus exactly at the seam of the pacemaker assembly; which is rotating about its axis. The pacemaker to be welded is held in a fixture mounted on vertical shaft in a vacuum chamber, and the shaft is rotated by a stepper motor through 1:10 reduction gear pair. The backlash between the shaft and the fixture is avoided by a spiral spring. The welding of the pacemaker assembly is done in Argon and Helium atmosphere created in the vacuum chamber, previously evacuated to 50 mbar, using Nd:YAG laser. The welding is monitored by CCD camera, mounted on translation stage, which moves along with the focusing lens. The laser enters the vacuum chamber through an AR coated window.

PC based system controller for pacemaker laser welding system consist of stepper motor controller (SMC), analog input card and digital I/O add-on card. The SMC controls four stepper motors required for four degrees of freedom, the analog card checks laser energy, the I/O card enables the PC to control the system. The PC issues the position command to the motor controller, according to the required position, and at the same time it also checks for fault conditions. Software facilitates two modes of operations, namely semiautomatic and manual mode. In semiautomatic mode, all the position commands are generated by the PC according to the profile stored in the memory. This adjusts focussing of the laser spot and positions the job in the vacuum chamber. Before firing a laser shot it checks the temperature of the cavity and coolant flow. If the parameters are within the set limits, the laser fires else alarm is sounded. In manual mode all the above operation involved in welding are done manually.

Besides controlling the position, PC gives online display of the system status. It displays the laser energy, the current position of the job, graphically as well as by co-or-

Cover: *Laser based pacemaker welding machine with computer controls.*