Newsletter

CENTRE FOR ADVANCED TECHNOLOGY

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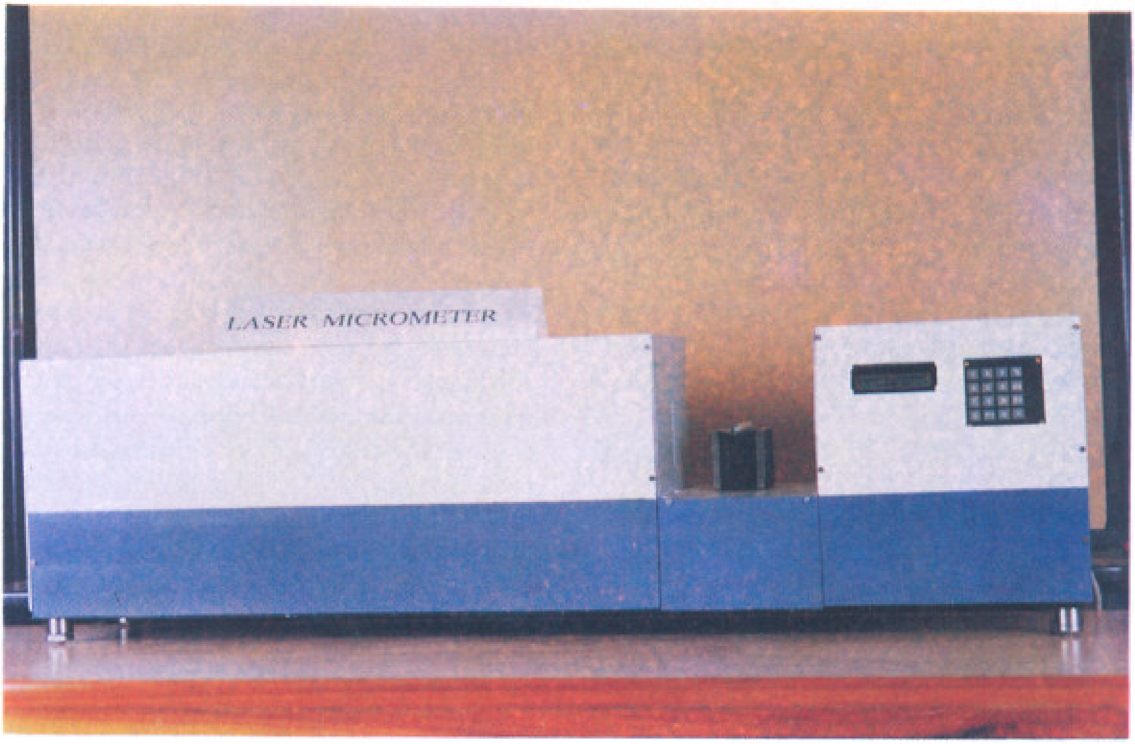

RESEARCH AND DEVELOPMENT

LASER PROGRAMME

Laser micrometer

A laser micrometer (shown above) has been developed at CAT. This instruments allows rapid and distortion-free in-process measurements. This eliminates human errors and also offers continuous data acquisition using a computer. It can be used for both real time dimension monitoring as well as sample inspection of items such as wires, tubings, fibres etc.

The main subsystems in this unit are: a low power Helium-Neon laser, an optical scanner, micro-controller and associated electronics. The He-Ne laser beam scans across the measurement area. When an object is placed in the path of scanning beam, it obstructs the beam. This obstruction is sensed by a photo-detector. The resulting signal is processed alongwith the scan timings to compute the size of object and same is displayed on the LCD panel of the instrument.

With some modifications, this instrument can also be used for measurement of ovality of objects; simultaneous measurements of multiple objects; measurements of minute movements of edges, objects and gap settings between objects such as rollers etc.

Development of transmission grating spectrographs

a) XUV spectrograph

A transmission grating XUV spectrograph has been set up as a diagnostic system for measurements of XUV emission spectrum of laser produced plasmas in the range of 5 Å - 150 Å. The spectrograph is based on diffraction from a free-standing transmission grating (consisting of gold microstructures) in a normal incidence geometry. The grating is mounted in a long tubular housing connected to the plasma chamber. Two different types of gratings are used: Rectangular grating of period $d = 0.2\,\mu m$ and aperture of $150\,\mu m \times 3000\,\mu m$, and Pinhole mounted grating of period $d = 0.5\,\mu m$ and $50\,\mu m$ aperture. The spectrum is recorded either using an XUV soft x-ray sensitive film or a micro-channel plate (MCP) detector. To optimize spectral resolution and the radiation intensity in the detector plane, XUV spectra from carbon, aluminium and copper plasmas have been recorded for different separations between the source and the grating (L), and between the grating and the detector (D). For instance, for $d = 0.2\,\mu m$ grating with a separation of $L = 700$ mm and $D = 330$ mm, the plate factor and the spectral resolution in the first order are 6 Å/mm and ~2 Å respectively.

Fig.1 shows the emission spectrum of an Aluminium plasma produced at a focused intensity of 3×10^{12} W/cm^2 by 15 J, 20 ns Nd:glass laser pulses using the rectangular grating ($d = 0.2\,\mu m$) and XUV sensitive UFSh-4 film. The spectrum clearly shows the central zeroth order and various prominent spectral lines in the first and higher orders symmetrically on either side. 2-D spectral imaging of the plasma is accomplished by using the pinhole transmission grating. Fig.2 shows such a spatially resolved spectrum for Aluminium plasma. Cone shaped images, emanating from different points in the direction of dispersion, correspond to the x-ray emission regions of plasma for various spectral lines. Next, an MCP detector in combination with a CCD camera-frame grabber system has also been used to facilitate on-line recording and processing of the spectrum. Optimization of this detection system is underway.

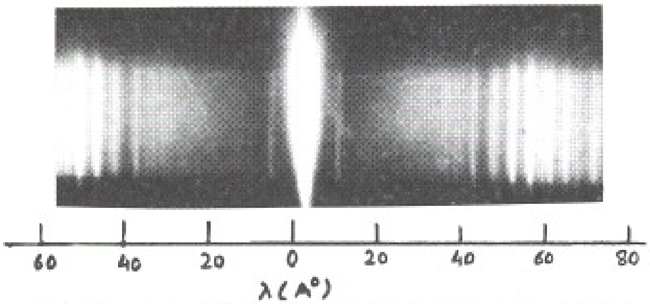

Fig. 1 XUV emission spectra of laser produced Aluminium plasma.

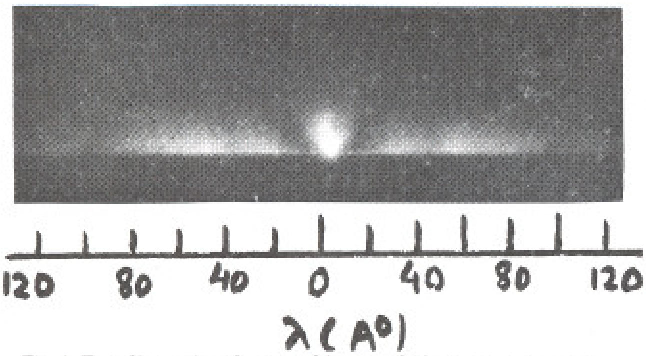

Fig. 2 Two dimensional spectral image of Aluminium plasma using pinhole transmission grating spectrograph.

Laser Micrometer Specifications

Measuring range	1.5 mm - 40 mm
Resolution	1 micron *
Accuracy	± 2 micron *
Repeatability	± 1 micron *
Display	16x2 Char Alphanumeric display
Display update selection:	1 per 2 sec, 2000 readings avg 1 per 5 sec, 5000 readings avg 1 per 12 sec, 10000 readings avg
Communication	RS-232 (9600 BAUD)
Dimensions	1000(L) x 180(W) x 180(H) mm

* The accuracy quoted is at 10000 readings averaged and at 20°C.

b) X - ray spectrograph

An x-ray transmission grating spectrograph has been developed to record and study the x-ray spectrum emitted from laser produced plasmas. It has a free standing gold bar (~1000 lines/mm) as a grating. A phosphor screen deposited on a fibre optic plate is used as an x-ray detector. The intensity on phosphor screen is intensified using a gated image intensifier tube. This spectrograph is designed to provide inverse linear dispersion of $d\lambda/dy \sim 16$ Å/mm with spectrum resolution $\Delta\lambda \sim 6$ Å which was found to be in good agreement with the experimental measurements. All the electronic circuits for driving the image intensifier tube were also developed in CAT. The spectrometer was tested by recording the x-ray spectrum emitted from copper and gold plasma produced by irradiating a picosecond Nd:YAG laser (35 ps and 75 mJ). Fig. 3 shows the image and intensity profile of the x-ray spectrum from Cu plasma, recorded using a CCD camera and processed using the