Newsletter

CENTRE FOR ADVANCED TECHNOLOGY

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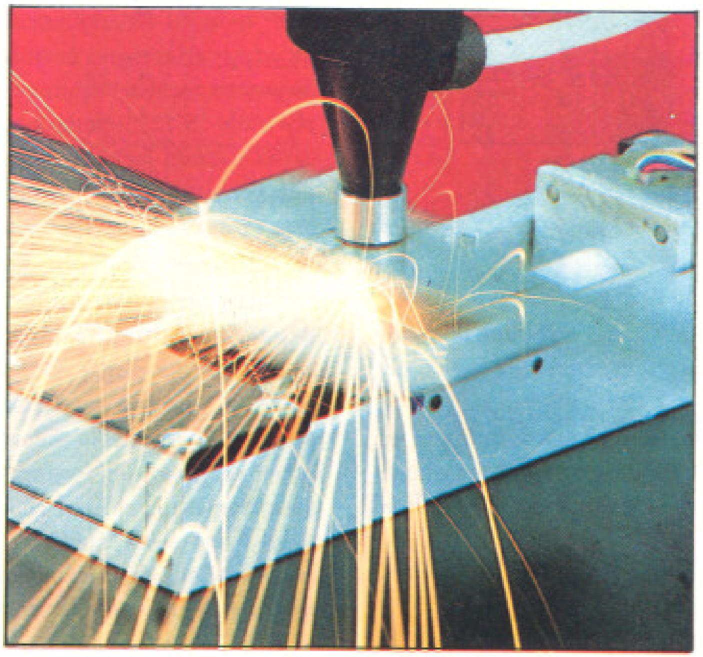


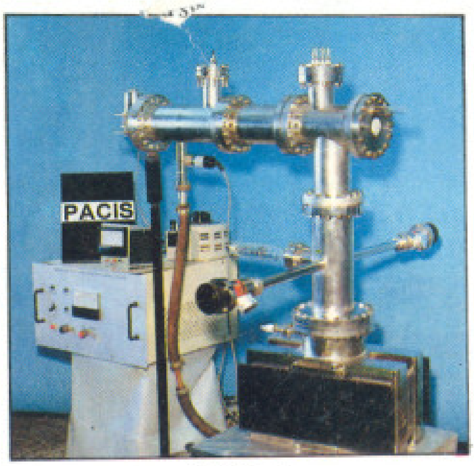
RESEARCH AND DEVELOPMENT

ACCELERATOR PROGRAMME

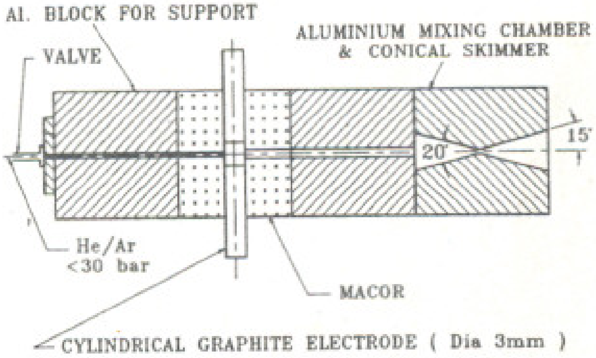
PACIS : a novel cluster source

Cluster Physics is gaining importance in both basic physics and technological application such as microelectronics. One of the very effective methods to produce clusters is by arc discharge. This principle is used in a cluster ion source called "pulsed arc cluster ion source" (PACIS). The advantages of PACIS over other methods for cluster production like laser vaporisation source are higher intensity with clusters having mass upto 4000 amu, and higher repetition rate per pulse. A cluster ion source is developed at CAT in collaboration with Institute of Physics, Bhubaneshwar to study photoelectron spectroscopy of clusters, ionised cluster beam deposition and the subsequent characterisation of films using x-ray standing waves, Rutherford back scattering and channeling.

The design of PACIS is shown schematically in Fig.1 and the laboratory model is shown in the photograph. It consists of an insulator block made of MACOR fixed between two aluminium blocks. Two cylindrical electrodes (3 mm dia) are radially inserted in MACOR for producing the discharge within a gap of 1 to 2mm. A solenoid pulsed valve supplies pure or mixed seeding gas (He, Ar, ..) through 1.5 mm diameter, 50 mm long channel. The discharge is fired inside the carrier gas pulse, the resulting plasma being flushed through a 2mm dia, 50 mm long channel into the



PACIS setup.



Schematic of PACIS

subsequent "mixing chamber". This has a volume of about 300 mm^3 and serves as thermalization zone while effectively mixing the hot helium/plasma part with colder portions of the carrier gas. The resulting mixture is again compressed to 1.5 mm dia. followed by a 35 mm long 15° total angle cone skimmer. This source has been used for producing carbon and rhodium clusters.

Metal - carbon multilayers

As a part of the development of multilayers as soft x-ray optical elements, metal carbon multilayers are being studied. Platinum-carbon multilayer mirrors with a bilayer spacing of 50 Å were fabricated in an ultrahigh vacuum electron beam evaporator. The thermal stability of these multilayers under vacuum annealing has been studied using x-ray reflectivity and x-ray diffraction. It has been observed that upto 450 $^\circ$C, the bilayer spacing increases monotonically accompanied by a gradual increase in the crystallite size and grain texture. At 500 $^\circ$C, multilayer reflection vanishes and platinum crystallites grow abruptly. There is a strong texture of platinum in [220] planes.

Surface analysis equipment commissioned

A spark emission spectrometer model JY56E from M/s Jobin Yvon has been installed during May 1995. This spectrometer is different from the conventional vacuum emission spectrometer in that the optics is in dry nitrogen thereby protecting it from contamination. This machine has been programmed to detect 10 elements viz. P, S, C, Si, Ni, Cr, Mo, Mn, Zr and Fe in a steel sample. Low atomic weight elements like C, S, P, Si can be detected to a level of 0.001%. Using standard stainless steel samples, the equipment has been calibrated and composition of any stainless steel sample can be detected in less than 5 minutes.

LASER PROGRAMME

Development and characterization of Optical and X-Ray Streak Cameras

Measurement of optical and x-ray intensities with a time resolution of few picosecond has become an essential part of a variety of studies e.g. laser-plasma interaction, laser induced fluorescence, non-linear optics etc. High speed streak cameras have emerged as the most important diagnostic tool for this purpose. Three streak cameras : one uv visible (S-20), one visible-near IR (S-1) and one x-ray streak camera have been set up at CAT in collaboration with General Physics Institute (GPI), Moscow, and their performance has been characterized.

The cameras consist of appropriate streak tubes followed by image intensifier tubes, supplied by GPI. Fast streak circuitry based on avalanche transistors, synchronization circuit, various HV biasing power supplies, MCP gated power supply, delay line etc. were made using indigenously available components.(See CAT Newsletter Jan. - June 1993). The output image was recorded either on a film camera kept in direct contact with the MCP screen or by using a CCD camera through an optical imaging system. All the cameras have provision of operating in five different streak speeds.

The operation of the streak cameras has been tested by using 20 psec and/or 100 psec laser pulses from picosecond Nd:glass laser chain. Whereas a part of laser beam was used to illuminate the entrance slit of the S-1 camera, the x-ray streak camera viewed an on-line x-ray emission source produced by intense laser pulses.

Measurements of streak speed and dynamic range have been performed by two methods : 1) by introducing an optical delay in the beam path corresponding to the lower half of the input slit, 2) by using a series of temporarily separated laser pulses of successively decreasing intensity by passing the incident laser beam through an etalon. Two streaks appear due to introduction of an optical delay of 67 psec (4cm long BK-7 glass slab) in the beam path for one half of the slit. The streak images are analyzed using 'Promise' software developed at CAT. A streak speed of 20mm/350 psec is determined from the physical separation