3 MV PELLETRON ACCELERATOR AND OTHER RECENT DEVELOPMENTS OF ION BEAM SYSTEMS AT IOP

T. Som and D.P. Mahapatra, IOP, Bhubaneswar, India

Abstract

Institute of Physics has a strong multidisciplinary research program based on 3 MV Pelletron accelerator and other ion beam facilities. A new electron cyclotron resonance ion source based low-to-medium energy ion beam facility will be commissioned soon. In addition to these, IOP has a low energy negative ion-beam facility, focused ion beam facility for creation of nanostructured materials and pattern formation, and ultra low energy ion beam induced surface nanostructuring facility for synthesis of self-organized nanostructures.

PELLETRON ACCELERATOR FACILITY

Since the installation of the 3 MV Pelletron accelerator at Institute of Physics (IOP), Bhubaneswar, ion beam based research activity has been one the major areas of research in experimental physics. Six beam lines were installed in the ion beam laboratory (IBL) for conducting various experiments in condensed matter physics, nuclear physics, and accelerator physics. Out of these, three facilities, viz. ion microprobe facility, ultra-high-vacuum (UHV) surface beam line, and accelerator mass spectrometry (AMS) were first of its kind in the country.

The main focus of our research has been on ion beam modification and analysis of materials. Some of the major physics issues, which are being addressed by us, include The following: Thin film growth related phenomena, ion beam mixing, defects and diffusion in semiconductors, magnetism in thin films, ion beam synthesis and modification of nanostructures, irradiation response of nano-dimensional noble metal islands, and surface nanostructuring by ion beams.

Recently we have installed an NEC-make Ion Beam Analysis Endstation for ion beam analysis of materials. This system is capable of analyzing thin films and bulk materials by using ion beam analysis techniques, viz. Rutherford backscattering spectrometry (RBS)-Channeling and elastic recoil detection analysis (ERDA). Figure 1 shows the photograph of this chamber which houses a 5-axes sample manipulator, load lock, and two surface barrier detectors for RBS and ERDA experiments.

We are also in the process of upgrading our irradiation chamber which will be equipped with a load lock chamber and a 5-axes sample manipulator with low- and high-temperature sample holders. We plan to facilitate the on-line heavy ion induced RBS and ERDA techniques as well so far this chamber is concerned. This will help us in absolute quantification of lighter elements and study defect dynamics. This is a unique system in India.

Figure 1. NEC-make Ion Beam Analysis Endstation.

DEVELOPMENT OF AN ECR ION SOURCE (ECRIS) BASED HIGH CURRENT LOW-TO-MEDIUM ENERGY ION BEAM FACILITY

Besides the MC-SNICS based 3 MV Pelletron accelerator facility we are in the process of developing a new ECRIS based low-to-medium energy ion beam facility at IOP. This facility will be able to provide ion beams at a wide range of energies (a few tens of keV to a few MeV) for experiments in condensed matter physics and nanoscience. The new facility will consist of an all permanent magnet 10 GHz, 250 W, 30 kV electron cyclotron resonance (ECR) ion source (Nanogan3) produced by Pantechnik, France [Figure 2]. The source will be installed on a high voltage platform and provide large currents of multiply charged ion beams. The post extraction system to ECRIS will consist of proper focusing arrangement to put the beam up to the switching magnet and subsequently to the scattering chamber.

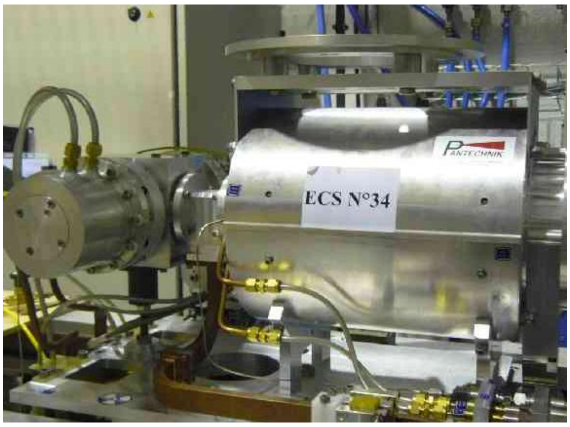

Figure 2. Photograph of the Nanogan3Source

Presently, the ECRIS and its accessories are under fabrication and are expected to be delivered in a month's time from now. Once operational, this facility will be used for high-fluence ion implantation for synthesis of buried nanostructures and self-organized surface nanostructures, ion beam mixing, and recrystallization studies. This facility will also help us to bridge the gap, in terms of ion energy, between the existing 3 MV Pelletron accelerator facility and low energy negative ion beam facility which is described below.

LOW ENERGY NEGATIVE ION BEAM FACILITY

A low energy negative ion beam facility has been developed using a single cathode, negative sputter ion source, which became available after augmentation of the the AMS technique based on the 3 MV Pelletron accelerator facility. A new ion source deck was fabricated to run at a floating potential of 66 kV. It is [Figure 3] being used regularly for low energy implantations of various simple monomer and cluster ions.

Figure 3. Low energy negative ion source and beam line.

FOCUSED ION BEAM FACILITY

We have commissioned a focused ion beam (Zeiss-make) facility at IOP for synthesis of nanostructured materials and nanoscale pattern formation in bulk and thin films. This unit has a liquid metal ion source and can generate intense nm size beam of Ga ions up to 30 keV energy. Figure 4 shows a photograph of this facility which was recently commissioned.

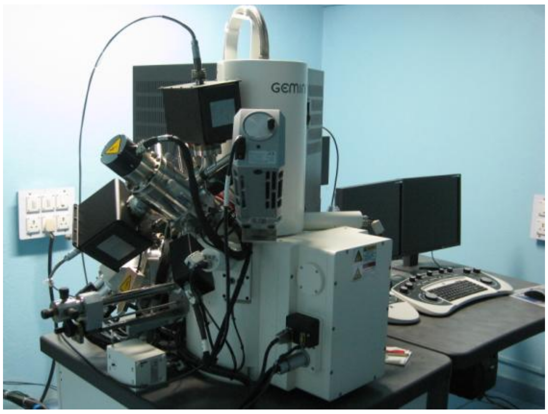

Figure 4. IOP focused ion beam facility

ULTRA LOW ENERGY ECR PLASMA ION SOURCE BEAM FACILITY

Recently we have facilitated an ultra low energy (50 eV – 2 keV) plasma ion source (Tectra make) based unit for creating ion beam induced self-organized nanostructures at the surface of materials. By easy exchange of the beam optics the source can be used to operate in three different main modes, viz. ion source, atom source, and ion/atom hybrid source. At present the ion source is connected to a UHV processing chamber through a differential pumping system. The chamber is equipped with a 5-axes sample manipulator which offers exposure of the samples to the ion/atom beams at variable temperatures (from 77 – 1300 K). Figure 5 shows a photograph of this facility.

Figure 5. Ultra low energy hybrid ion source based surface nanostructuring facility

Thus, after the commissioning of the ECRIS based low-to-medium energy ion beam facility, IOP will be the hub of ion beam based multidisciplinary research in the south-eastern part of the country where we should be able to deliver ion beams of different spot size (nm-mm), current, and energy.