ATF-SNEAP 2006 Laboratory Report

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The Electronic Materials Engineering (EME) Department conducts materials science studies employing ion-irradiation and/or ion-beam analysis. The research is centred on the accelerator facilities, consisting of two ion-implanters (150 kV and 1.7 MV tandem) and a versatile RBS ion-beam analysis machine (a 1.7 MV tandem) together with an array of complementary techniques.

High Energy Implanter

An NEC 1.7MV tandem accelerator (5SDH-4) is used for ion-implantation and ion-beam modification of materials research. This machine uses a SNICS II ion source to produce negative ions. These are mass analysed and accelerated to the terminal potential (maximum 1.7 MV) before passing through a gas stripper to produce a range of positive ions for subsequent acceleration. Selected ions are electrostatically scanned over a defined area on the sample.
Some technical aspects of the implanter are as follows:

- Samples can be heated or cooled during irradiation over a temperature range from 77 to 800K.
- Five CTI-8 cryo pumps maintain the implanter vacuum at around 2 x 10^{-8} torr.
- The SNICS source has an external cathode positioner to optimise the cathode current.
- SF6 is used as the accelerator insulating gas.

HE Maintenance Issues

The predominant maintenance issues relate to cathode shorts or blown ionisers. The extractor and focus areas are stripped for cleaning every 6 months with major accelerator servicing every 12-18 months.

Low Energy Implanter

The EME designed and built 'low' energy ion implanter is intended for experimental implants of the energy range 20-150 kV. It fills a range of implantation energies that are difficult to achieve on the large NEC implanter and is considerably simpler to operate.
This machine also uses an NEC SNICS II ion source, nearly identical to the one used on the high energy machine, to produce negative ions.
The implant holders are interchangeable between both implanters.

RBS

An NEC 1.7MV tandem accelerator (5SDH) using an Alphatross RF gas source is used for routine ion-beam analysis of materials, including Rutherford Backscattering Spectrometry (RBS) and ion channelling.
The radio frequency (RF) ion source produces positive ions from the He gas that is bled into a quartz bottle; an RF oscillator connected to the quartz bottle dissociates the neutral gas. A probe voltage of 6 kV is used to push the ions out of the chamber through the Ta exit canal, making a continuous positive beam that is immediately injected into a rubidium (Rb) charge exchange cell to produce the required negative beam. The Rb gives up electrons and negatively charges the ions that are then accelerated by the source bias voltage (normally 18 kV) towards the accelerator and to the rest of the beamline.

RBS Maintenance Issues

The main technical issues with the RBS system revolve around the RF source and the Rb exchange chamber.
The difficulties with the Rb exchange chamber persist. The main problem is that the Rb migrates out of the ends of the exchange chamber when hot and then condenses on the cooling baffles on either end of the chamber. Surface tension seems to keep the Rb from flowing back to the Rb oven. If too much Rb collects on the baffles the output from the source drops off markedly. The only solution to date has been to strip and clean the source and put in a new charge of Rb.
A PID controller has been used to control the power to the Rb oven.
A new beamline and goniometer system have been built are ready to be put into service and will be controlled using a Labview interface.