Radiation Imaging Group – University of Surrey
Paul Sellin – December 2001

The Radiation Imaging Group, part of the Department of Physics at the University of Surrey, has strong research interests in detector physics particularly with regard to semiconductor radiation detectors. We concentrate on fundamental studies of the solid state properties of new wide band-gap semiconductor detector materials. We have extensive electrical, optical and radiation-based characterisation facilities to investigate charge transport, defects and trapping, radiation hardness, and metal-semiconductor contacts. Experimental measurements are complimented by semiconductor device and detector modeling software.

The group consists of 3 academic staff, Dr Paul Sellin, Dr Ed Morton and Dr Walter Gilboy

In addition, the group currently includes 6 postdoctoral Research Associates and 8 postgraduate PhD students

Research Interests

Development of new semiconductor materials for pixel radiation detectors.

We are currently working on a range of semiconductor material systems, both for 'end-user' detector applications and also as 'blue skies' research. These applications are mainly in the areas of astronomical and medical imaging. A summary of current projects includes:

- Cadmium Zinc Telluride (CdZnTe) pixel detectors developed in collaboration with the University of Leicester for astronomical X-ray imaging. Funded by PPARC, this project is using flip-chip bonding and ASICs supplied by Rockwell Scientific Inc.
- CdTe for nuclear medicine imaging, as part of the EU 'Nucam' Framework 5 project. Our role is concentrating on the material characterisation of high purity CdTe grown by Eurorad, Grenoble.
- Fundamental studies of charge transport, trapping, and radiation hardness of other compound semiconductor materials, namely epitaxial Gallium Arsenide and bulk Indium Phosphide, supported by EPSRC.
- Characterisation of charge transport in CVD diamond with applications for alpha particle and UV radiation hard detectors. Ion beam analysis using Surrey's nuclear microprobe is used extensively to image charge transport in this material, supported by an EPSRC Instrument Development grant.
- Development of large-volume segmented germanium detectors as Compton cameras for gamma ray spectroscopy. These devices have applications in nuclear medicine imaging and nuclear structure physics, and is supported by two EPSRC JREI grants

Ion beam and implantation techniques

The University of Surrey hosts the EPSRC-funded national ion beam centre, and consequently we have access to excellent accelerator facilities.

- a new 2 MV tandem accelerator is currently being installed, combined with a scanning nuclear microprobe. This facility allows micron resolution imaging of detector response using 4 MeV protons or 6 MeV helium ions.
- ion implantation for device fabrication or contact studies, using a range of ions from 5 keV up to 2 MV.
- detector damage studies can also be carried out using either the microbeam or implantation facilities
- RBS and PIXE material characterisation
- ^{60}Co irradiation at ~6 kGy/day

Laboratory Facilities

Detector characterisation

- Optical semiconductor characterisation (PL, Raman, spectral photoconductivity) and transient spectroscopy (DLTS and PICTS)
- Electrical semiconductor measurements: picoammeter, CV, manual probe station, and temperature controlled cryostat (down to –60C)
- Detector mapping systems using microfocus lasers, IR microscopy, and collimated radioisotopes
- Radioisotope characterisation of detectors, Over 130 radioisotope sources, including ^{90}Sr MIPS trigger, alpha particle, X-ray and gamma ray, and 18GBq Am:Be neutron sources.
- ^{60}Co irradiator (1.9 TBq), giving approximately 6 kGy per day

Detector fabrication

- Fabrication of simple test structures and single-element detectors is carried out in our own clean room, containing a thermal evaporator, mask aligner and photolithography facilities.
- Detector mask design is carried out with GDS-based CAD software

Detector simulation

- The group has extensive experience with the MCNP and EGS4 detector Monte Carlo codes. There is limited experience within the group of Geant.
- Semiconductor device simulation is carried using the Silvaco commercial 3D modelling software.