Innovative Ion-beam methods for frontier cross
disciplinary research and development
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Abstract

MeV ion beams have a long history in the service of science and technology. Modern mobile technology, computers, the Internet of Things, and even front-line science such as quantum computers, innovative treatment of heart disease, all rely on this technology. Their innovative heritage provides a potent basis for new cross-disciplinary innovations, where ion beams offer great and unique potential for making cutting-edge developments. This makes ion beam-based materials science uniquely well placed to play a pivotal part in developing many aspects of society by contributing to solution of many industrial and societal problems.

In the first part of the presentation the basic interactions of energetic ions with materials will be over-viewed in order to set the scene for subsequent discussion. Following a brief introduction to Particle Induced X-ray Emission (PIXE) and Rutherford Backscattering Spectrometry (RBS) some new analytical methods will be introduced. Then recent developments in Time-of-Flight Energy Elastic Recoil Detection Analysis (ToF–E ERDA) that allow profiling of nanometre multilayer films will be introduced. We will then turn to developments in MeV ion beam microscopy including direct Scanning Transmission Ion Microscopy (direct-STIM) and proton induced fluorescence (PIF) for biological studies.

The next part of the presentation will discuss modification of materials and in particular use of MeV ion beams for introducing ionisation dose and atomic displacement damage. This can be used for space electronics defect testing, MeV ion beam lithography and it is application in microfluidics for biomedical analysis, food science and environmental studies.

The final part of the talk will briefly outline new innovative research directions that could be followed-up at LAC. These include: (i) Use of functionalised metal oxide nanoparticles for sub-cellular level imaging to overcome the drawbacks of the cytotoxic fluorescent stains used in PIF. (ii) ToF-E ERDA for functional surface (catalysis, decorative, optical etc.) (ii) Micromechanical engineered microfluidics for analytical organic chemistry of flood and environmental samples e.g. prawn. (iii) Radiation testing for the space environment (iv) Innovative radiation digitisers.
Harry J. Whitlow was born in London, and he was educated in the UK. His academic studies started at The University of Bath with BSc honours degree in physics with physical electronics and he did his Doctor of Philosophy work at Sussex University on Low energy ion implantation of silicon under the supervision of Professor Sir Michael Thompson. Subsequently he moved to Aarhus in Denmark and Helsinki in Finland as a postdoc working on sputtering and ion beam mixing before taking up a position as 1:e research engineer at the Royal Institute of Technology (KTH) in Stockholm where he instigated and developed the Time of Flight ERDA technique. In 1987 he became docent (Reader) in solid state electronics. In 1990 Harry J. Whitlow moved to Lund where he worked on developing the ToF-ERDA technique as a tool for nanoscience and technology and developed a front-line detector system (CHICSi) using advanced Si technology for fundamental intermediate energy nuclear physics research. In 1999 the University of Bath awarded him a Doctor of Science degree and in 2000 he was promoted to professor of experimental nuclear physics: ion physics at Lund University. Since then his interest has been directed towards MeV ion beam lithography. In August 2004 Harry Whitlow moved to Finland to become professor of experimental materials physics in Jyväskylä where he has been working on MeV ion beam lithography for biomedical research. In April 2012 he moved to become Head of Ionlab-Arc at The institute for Applied Microtechnology in the School of Engineering, University of Applied Sciences in La Chaux-de-Fonds, Switzerland. He also holds the position of Adjut Professor in the Chemistry Department of Kasetsart University, Thailand.

His publications span a wide range of topics including archaeological processes on flint tools, violin acoustics, Time of Flight ERDA, sputtering, fundamental nuclear physics, molecular dynamics and molecular orbital calculations, MeV ion beam lithography and fundamental ion-mater interaction data, imaging with ion beams and lithography for microfluidic applications. He has personally supervised 10 PhD’s.