MICRONOVA
CENTRE FOR MICRO- AND NANOTECHNOLOGY
TKK – HELSINKI UNIVERSITY OF TECHNOLOGY

COMPOUND SEMICONDUCTORS FOR HARD X-RAY ASTRONOMY

NANOTECHNOLOGY GROUP

OPTOELECTRONICS LABORATORY

At present, semiconductor detectors already play a key role in the field of X- and γ-ray detection. Such detectors have many inherent benefits over traditional detection techniques, which include for example gas ionization detectors, scintillation detectors and x-ray films. The most important properties include the high detection efficiency and the spectroscopic capabilities of semiconductor detectors. In spectroscopic operation mode one can measure the energy of the absorbed X-ray quantum by calculating the number of electron-hole pairs generated by the X-ray quantum.
Silicon based detectors are well mature and have a wide range of applications today. However, silicon is not an ideal material for many detection applications. This is due to the relative low density of silicon, which means that absorption efficiency is low for high energy X-rays.
We study and develop detectors, which have a superior performance over silicon detectors for specific applications. Under development are spectroscopic and imaging X-ray detector matrices made of different semiconductor materials (Ge/GaAs, GaAs, InAs). The materials in this study have various advantageous properties: heavy atoms give a strong X-ray absorption, low-bandgap semiconductors (InAs, Ge) possess a potential for a high energy resolution, and germanium is available with a very high quality.

RECENT RESULTS AND FUTURE WORK:

Three main results have been achieved:

1. Study of the epitaxial growth of gallium arsenide, resulting spectroscopic GaAs detectors with a state-of-the-art energy resolution.
2. A novel processing method that enables finely segmented imaging germanium/gallium arsenide detector has been developed.
3. Alpha particle response measured for an indium arsenide detector.

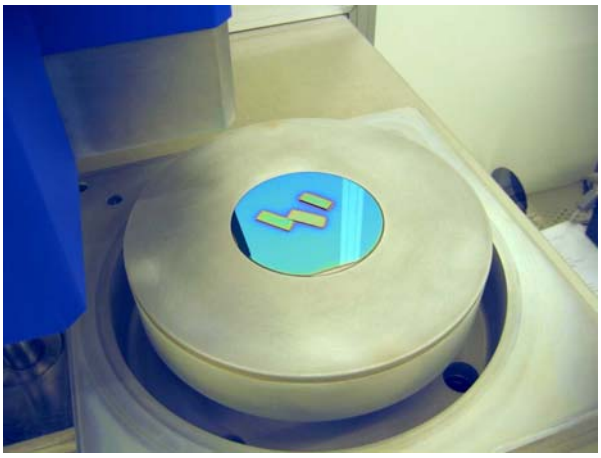
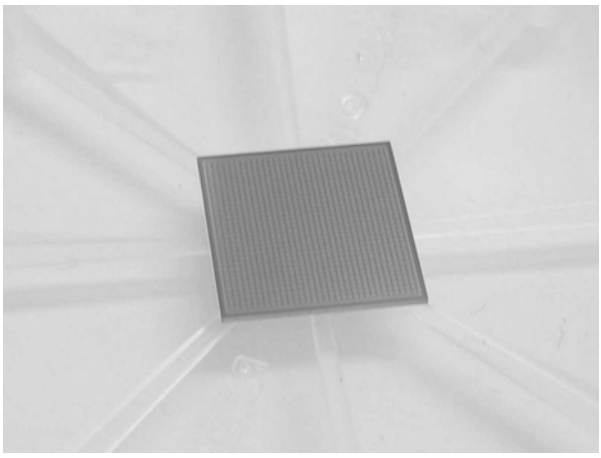


Figure 1: a) A processing step in the cleanroom of Micronova during the manufacture of an InAs radiation detector set.



b) First in the World. A finely segmented imaging detector based on Ge/GaAs technology and with an active volume of germanium.

Funding:

European Space Agency
Helsinki Graduate School of Electrical and Communications Engineering
Graduate School in Electronics, Telecommunication and Automation GETA

Industrial Partners:

Oxford Instruments Analytical Oy

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Recent Publications:

1. A. Säynätjoki, P. Kostamo, J. Sormunen, J. Riikonen, A. Lankinen, H. Lipsanen, H. Andersson, K. Banzuzi, S. Nenonen, H.Sipilä, S.Vaijärvi and D. Lumb: InAs pixel matrix detectors fabricated by diffusion of Zn utilising metal-organic vapour phase epitaxy, Accepted for publication in Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment

2. P. Kostamo, A. Säynätjoki, L. Knuuttila, H. Lipsanen, H. Andersson and K. Banzuzi: Ge/GaAs heterostructure matrix detector, Accepted for publication in Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment

3. A. Lankinen, L. Knuuttila, P. Kostamo, A. Säynätjoki, T. Tuomi, H. Lipsanen, H. Sipilä and S. Vaijärvi: Characterisation of material defects in epitaxial GaAs on high-quality Ge, Accepted for publication in Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment