

Investigation of charge collection in semiconductor pin photodiode structures

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As an augmentation to previous characterisation with non-collimated light, X- and gamma-rays [1,2], ion beam induced charge (IBIC) imaging has been used to investigate charge transport properties within silicon pin photodiode structures.

Microbeam measurements were done at the ATOMKI nuclear microprobe 5MV Van de Graaff accelerator laboratory with a 2 MeV focussed He beam. High resolution images of pulse height spectra of different regions of the device are obtained at low and high electric field strengths. A mean pulse height algorithm is applied to each pulse height spectrum to generate a two dimensional image after data collection. This type of image directly shows areas of the photodiode structure with different charge collection efficiency values. Whole spectral distributions of different regions are also recorded to investigate surface and buried structures and variance of the charge carrier collection efficiency. Additional measurements with an Am241 alpha source (cca 5.5 MeV) have also been done to reveal fine details of the shape of the spectra and to interpret unclear spectral features obtained with the microbeam irradiation. A comparison of our results with previous EBIC (electron beam induced current) analysis [3] is also given.

The investigated effects contribute to the further understanding of the operation of the Si photodiode in order to use it as a reliable detector.

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- [2] G. Kalinka, T. Papp, Gy. Hegyesi: Spectral artefacts with a Si-pin photodiode x-ray detector: II. The high energy case, Atomki Annual Report 2001 (2002) 63.
- [3] F. Riesz, A. L. Tóth, L. Ryć, W. Słysz, M. Węgrzecki: The EBIC study of boundary effects in the Si pin photodiodes for x-ray detector applications, Nukleonika 44 (1999) 635.