MS40-O2 White beam Laue diffraction of polycrystalline materials using 3D energy dispersive detector (pnCCD)

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Energy-dispersive CCD detectors, as the charged-coupled pnCCD, operating in the single photon counting mode (SPC) using white or pink beam spectra allows for simultaneous position and energy dispersive detection of scattered photons. This approach is well suited for Laue-type diffraction experiments because it provides structure data from a fixed sample position without sample rotation. In this presentation we report on pnCCD application using hard x-rays ($30 < E < 140$keV) where bare silicon detectors are typically less sensitive. This deficit is partially compensated by coupling the silicon chip with a scintillator crystal converting the not directly counted photons into electrons and fluorescence photons of low energy. Due to the flat curvature of Ewald sphere at high photon energies a large number of Bragg reflections become accessible at same time. Each of the measured Laue spots can be indexed based on the knowledge on Bragg angles and diffraction energies. In case of polycrystalline materials and considering the respective crystal system we are able to assign each of the Laue spots to one or another of the illuminated grains. Grain defects can be classified via evaluation of streaking Laue spots as function of photon energy. These unique capabilities allows for the measurement of lattice parameter variations caused by local strains.

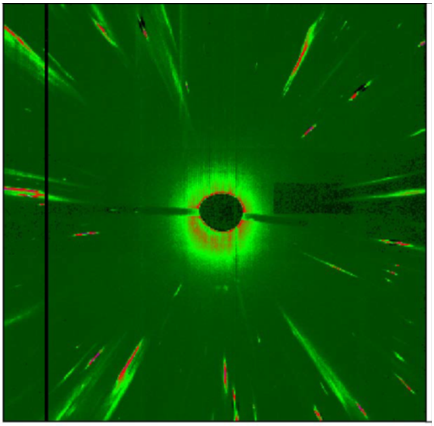

Figure 1. Laue pattern of a polycrystalline Ni sample measured in spectral range between 30 und 140 keV, Streaking is changing as function of tensile load

Keywords: white beam Laue diffraction, 3D energy-dispersive detector, polycrystalline material

MS40-O3 High-resolution XRD investigation of SiGe/Si heterostructures for novel X-ray detectors

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Imaging sensors directly coupled to complex readout units form an area of immense technological interest. One example concerns devices for X-ray imaging and inspection, ranging from medical diagnostics and cancer therapy to non-destructive testing of all kinds of goods (quality assurance, security). However, the development of semiconductor X-ray detectors monolithically integrated on a CMOS platform encounters lots of difficulties associated with crystal defects, layer cracks and wafer bowing. A new approach towards detector fabrication that involves epitaxial growth of thick three-dimensional Ge and SiGe crystal arrays on patterned Si(001) substrates has allowed to solve these problems [1].

We will present a high-resolution XRD study of such SiGe crystals heteroepitaxially grown on pillar-patterned Si(001) substrates. The Ge content in the heterostructures is gradually increased through the pillar height from 0.05 at. % at the interface with the substrate to ~80 at. % at the surface. We will show analysis of the reciprocal space maps (RSMs) measured around the symmetrical (004) and asymmetrical (115) Bragg reflections in order to investigate the strain gradient in the grown SiGe crystals. The results of the calculations of the in-plane and out-of-plane strain as well as the Ge content in the top layer of SiGe will be presented.

[1] C.V. Falub, H. von Känel, F. Isa, R. Bergamaschini, A. Marzegalli, D. Chrastina, G. Isella, E. Müller, P. Niedermann, L. Miglio, Science, **335**, 1330 (2012).

Keywords: X-ray detectors, monolitic integration, SiGe crystals, high-resolution XRD