Revealing Single Crystal Quality by Insight Diffraction Imaging Technique

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Abstract : X-ray Bragg diffraction imaging (“topography”)entered into practical use when Lang designed an “easy” technical setup to characterise the defects / distortions in the high perfection crystals produced for the microelectronics industry. The use of this technique extended to all kind of high quality crystals, and deposited layers, and a series of publications explained, starting from the dynamical theory of diffraction, the contrast of the images of the defects. A quantitative version of “monochromatic topography” known as“Rocking Curve Imaging” (RCI) was implemented, by using synchrotron light and taking advantage of the dramatic improvement of the 2D-detectors and computerised image processing. The rough data is constituted by a number (~300) of images recorded along the diffraction (“rocking”) curve. If the quality of the crystal is such that a one-to-onerelation between a pixel of the detector and a voxel within the crystal can be established (this approximation is very well fulfilled if the local mosaic spread of the voxel is < 1 mradian), a software we developped provides, from the each rocking curve recorded on each of the pixels of the detector, not only the “voxel” integrated intensity (the only data provided by the previous techniques) but also its “mosaic spread” (FWHM) and peak position. We will show, based on many examples, that this new data, never recorded before, open the field to a highly enhanced characterization of the crystal and deposited layers. These examples include the characterization of dislocations and twins occurring during silicon growth, various growth features in Al203, GaNand CdTe (where the diffraction displays the Borrmannanomalous absorption, which leads to a new type of images), and the characterisation of the defects within deposited layers, or their effect on the substrate. We could also observe (due to the very high sensitivity of the setup installed on BM05, which allows revealing these faint effects) that, when dealing with very perfect crystals, the Kato’s interference fringes predicted by dynamical theory are also associated with very small modifications of the local FWHM and peak position (of the order of the µradian). This rather unexpected (at least for us) result appears to be in keeping with preliminary dynamical theory calculations.

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