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Nano X-ray diffraction imaging of strain and structure in semiconductors and devices

X-ray diffraction has played an important role in the analysis of strain, texture and epitaxial relation. Traditionally x-ray diffraction is considered as a method with poor spatial resolution yielding only spatial averages as useful results. Very recent developments in the use of highly focused beams produced on the most advanced synchrotron sources show however a great and rapidly developing potential of diffraction imaging techniques. At the ESRF Grenoble, ID01 is the beamline specialized on nanodiffraction imaging using scanning probe- and full-field techniques. With the completion of the first phase of the upgrade of the European Synchrotron Radiation Facility (ESRF), the ID01 beamline has returned successfully to user operation. Offering scanning diffraction microscopy at 100Hz with 100nm focused x-ray beams [1], full field x-ray diffraction microscopy using compound refractive lenses and coherent beams for coherent diffractive imaging applications we can supply a vast spectrum of techniques for high resolution strain imaging. Even if all three methods can be described as strain and structural microscopy in a wider sense, they differ significantly in terms of resolution, speed, experimental boundary conditions and challenges in data treatment. Depending on the sample and the questions to be answered images of strain distribution can be obtained using scanning diffraction techniques. Brought to maturity during the first phase of the ESRF upgrade these techniques allow for strain and texture imaging in thin films with a spatial resolution below 10 nm and strain sensitivity of $\varepsilon=\Delta a/a<10^{-5}$. With the capacity of imaging buried layers and the enormous gain in data recording speed (comparable to other scanning probe methods) this strain imaging technique offer a highly promising method for the characterization of advanced materials and devices. In order to overcome the diffraction limit of the x-ray optics as fundamental resolution limits of the first two techniques, coherent reconstruction can be used at ID01 in order to resolve strain and structure in 3D and with spatial resolution below 10 nm. The talk will give an overview on the state of the art of the nano diffraction imaging techniques readily available at ID01 with examples from recently obtained results ranging from silicon based devices to novel perovskite based Solar cells.