Electron diffraction with scanning nanobeam as a tool to study strain in hetero-nanowires

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In the last two decades, there has been a clear tendency to increase the interest to semiconductor nanowires (NWs). One of the motivations is related to high surface to volume ratio characteristic for these structures. As effect, NW sidewalls can be used actively, which may greatly increase the efficiency of nanoelectronic devices. However, the use of hetero-NWs based on different compounds is necessary in most cases. The strain fields that occurs in such a structures with high lattice mismatch leads to the elastic lattice distortions as well as bending and twisting of NWs. Understanding the mechanism of relaxation process is crucial in the development, controlling and improving the properties of devices based on single or several NWs [1].

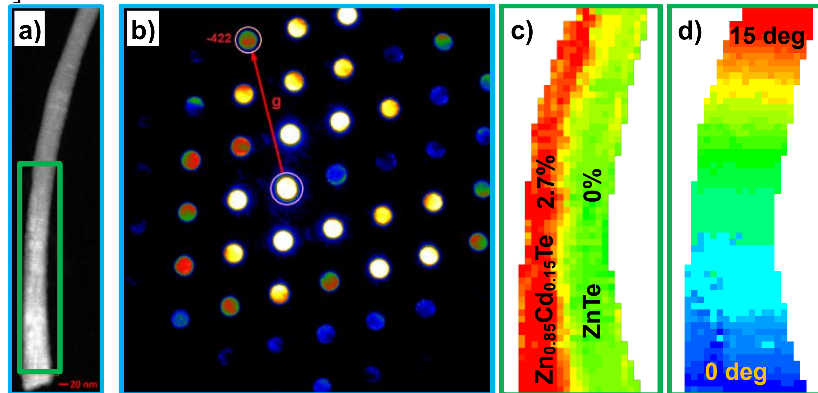

Fig.1 a) STEM image of bi-crystal ZnTe/CdZnTe NW in [011] zone axis; rectangle represent under investigated area. b) one of NBD patterns acquired at 1 mrad semi-convergence angle with labeled reflex using for strain mapping; c) color coded strain distribution and d) – in-plane lattice rotation maps.

The electron microscopy is one of the well designated methods for such investigating with sub-nanometer resolution. At the same time, Scanning Electron Diffraction (SED) compared to High-Resolution Transmission Electron Microscopy (HR-TEM) and High-Resolution Scanning Transmission Electron Microscopy (HR-STEM) allows to obtain information from a large area up to several micrometers even faraway from zone axis orientation. We acquire the series of nanobeam electron diffraction (NBD) patterns for each position of the nanobeam. The obtained patterns are analyzed using our own developed software-DM script [2]. The routine procedure determine the position of reflex compared to direct beam. The analysis relative reflex shift allow to plot 2D map of bending and lattice distortions in NW. The more advance version of such approach takes advantage of the comparison of calculated NBD with experimental ones which allow to determine not only in plane lattice deformation and twist α, but also tilts β and γ. In additionally, taking into account data obtained in different zone axis is open the opportunity to plot model of 3D distortion of crystal lattice in NW.

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[1] P. Wojnar, M. Zielinski, E. Janik et al., *Appl. Phys. Lett.* **104**, 163111 (2014)
[2] Digital Micrograph^{TM} software by Gatan Inc., http://www.gatan.com/products/tem-analysis/gatan-microscopy-suite-software