Determination of the strain state in highly mismatched core-shell CdTe/ZnTe nanowiers by quantitative TEM

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The CdTe nanowires were grown by Molecular Beam Epitaxy (MBE) with the gold droplets as an eutectic catalyzer using Vapor- Liquid- Solid (VLS) growth mechanism. Depending on the diameter, nanowires (NWs) were obtained with sphalerite or wurtzite crystal structure of the core [1]. In the same MBE process, (Cd, Zn)Te shells were grown at low temperatures, when gold eutectic catalyzer was solidified. The lattice mismatch between core/shell compounds exceeds 6,2% .
For TEM investigations, NWs were transferred to a mesh with holey carbon film and individually observed after orientation to the zone axis. EDS profiles and maps confirmed the core /shell morphology of NWs. HRTEM and HRSTEM images were analyzed using Geometric Phase Analysis (GPA)[2]. The fully strained and partially relaxed NWs were investigated. Fig. 1 shows the GPA analysis for strained and relaxed NWs.
In the case of strained NW with 40 nm CdTe core and 20 nm thick symmetric shell, we detected only one single partial dislocation at the end of SF. In the case of NW with 80 nm diameter core and asymmetric shell, left 40 nm and right 10 nm, the misfit dislocation network were visible on phase as well as amplitude images. For comparable thickness, core and shell accommodate misfit by elastic deformation of both. In the case of more rigid core, plastic relaxation at occur by creation of misfit dislocation at core /shell interface. This suggests that we don't have classical critical thickness as for epitaxial 2d layers but rather creation of misfit dislocation "on demand". Additional investigation was performed on FIB with perpendicular to objects axis cross-sections of the mechanically transferred on Si substrate NWs.

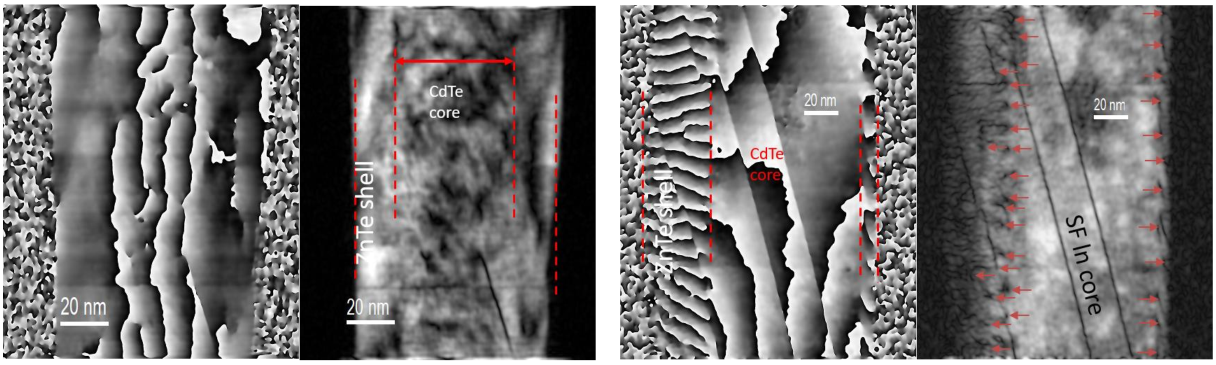

Figure1. GPA Analysis of HR-STEM images. (a) phase and (b) amplitude of 111 beam of strained ZnTe shell on CdTe core, (c) phase and (d) amplitude of 111 beam of relaxed asymmetric ZnTe shell on CdTe core.

References:

[1] A. Kaleta, S. Kret, et al., Acta Physica Polonica, **5**, 131, s. 1399-1405, (2017).
[2] Hÿtch, M. J, Snoeck, E., R. Kilaas, Ultramicroscopy, **74**, s. 131–146 (1998).

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