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In-situ X-ray diffraction during molecular beam epitaxy growth of III-V semiconductor nanowire structures

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III-V semiconductor nanowires allow for a dislocation free integration of III-V semiconductors on Si substrates, which is highly interesting for optoelectronic applications. Ga-assisted GaAs nanowires exhibit a polytypism, which results in different segments of zincblende (ZB), its rotational twin (ZBT) and wurtzite (WZ) structure along the axial direction of nanowires.

To better understand the growth processes, we monitor the shape and crystal structure of free-standing GaAs nanowires by in-situ X-ray diffraction (XRD), during fabrication and further processing by molecular beam epitaxy (MBE) growth on (111) plane Si substrates. We are using a portable MBE to do XRD studies at the in-house synchrotron at KIT and also at the large-scale synchrotrons PETRA III and ESRF. Employing X-ray focusing optics and patterned substrates, we are able to tune the number of nanowires we are probing from large ensembles down to a single nanowire.

During experiments at P09 at PETRA III, we monitored the structural and radial evolution of the nanowires by repeatedly recording 3D reciprocal space maps around symmetric (111) and asymmetric Bragg reflections, comprising the (311) ZB, (220) ZBT and (10.3) WZ reflection [1] with a temporal resolution of 1-10min. By simultaneously performing reflective high-energy electron diffraction (RHEED) we gain additional sensitivity during the nucleation stage and to small changes during the growth process.

[1] Schroth et al. *Nano Lett.* **18**, 101 (2018)

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