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Single Nanowire Studies at the GINIX Nanofocus

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Semiconductor nanowires (NWs) are crystalline nanostructures which are intensely researched in areas such as electronics, light-emitting devices, and quantum optics. In particular, nanowire-based solar cells have shown strong development in recent years [1,2]. While the mean crystal parameters can be measured easily for large numbers of NWs, the strain/stress and bending of individual NWs have only by measured at synchrotron radiation facilities.

The small length scales of NWs, with a diameter of around 200 nm and a length of about 2 µm, asks for new kinds of focusing optics. We have used Multilayer Zone Plates (MZPs) that can focus hard x-ray energies down to 2D spot sizes below 10 nm [3,4], and hence are suited to spatially map out the NW crystal lattice or act as local stimulus in X-ray beam induced current (XBIC) experiments [5].

We report on recent imaging experiments and in-operando studies on individual shell-core nanowires, which are paralleled by advances on MZP optics and imaging. Real-time data analysis resolves another bottleneck we faced at recent beamtimes.

[1] J. Wallentin et al: InP Nanowire Array Solar Cells Achieving 13.8% Efficiency by Exceeding the Ray Optics Limit, Science 339 (2013).
[2] M. Borgström et al: Nanowires With Promise for Photovoltaics, IEEE JSTQE 17 (2011).
[3] F. Döring et al: Sub-5 nm hard x-ray point focusing by a combined Kirkpatrick-Baez mirror and multilayer zone plate, Opt. Express 21 (2013).
[4] M. Osterhoff et al: Towards multi-order hard X-ray imaging with multilayer zone plates, J. Appl. Cryst. 46 (2015).
[5] J. Wallentin et al: Hard X-ray Detection Using a Single 100 nm Diameter Nanowire, Nano Letters 14 (2014).

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