Individual GaAs nanorods imaged by coherent x-ray diffraction

BIERMANNS A.[1], DAVYDOK A.[1], PAETZELT H.[2,3], DIAZ A.[4], GOTTSCHALCH V.[3], METZGER T.H.[4], PIETSCH U.[1]

[1]University of Siegen, Walter-Flex Str. 3, 57072 Siegen, Germany, [2]Leibniz Institute for Surface Modification, 04318 Leipzig, Germany, [3]University of Leipzig, D-04103 Leipzig, Germany, [4]European Synchrotron Radiation Facility, BP 220, F-38043 Grenoble, France
andreas.biermanns@uni-siegen.de

Semiconductor nanorods (NRs) are of particular interest for new semiconductor devices with unique electrical and optical properties and performance[1]. Complementary to electron microscopy techniques, destruction free X-ray diffraction techniques can be used to determine structural and morphological details. We have used the evolving method of coherent diffraction imaging in order to identify structural differences between individual nanorods grown simultaneously in the same environment.
Using scanning x-ray diffraction microscopy with a spot size of 200x600nm^2 we were able to inspect individual GaAs nanorods grown by seed-free MOVPE in a periodic array with 3µm spacing on GaAs[111]B through circular periodic openings in a SiNx mask. In combination with coherent diffraction imaging, we were able to characterize morphological details and the strain state of individual rods grown at different positions in the array. Using two different methods for shape reconstruction, i.e. simple Fourier transformation and phase retrieval, respectively, we find that a nanorod in the centre shows an almost perfect hexagonal symmetry and a size of 590nm x 400nm (H x V), whereas the dimensions of a rod at the edge are reduced by 20% each and the shape appears compressed in one direction. In addition we show that the lattice parameter of nanorods is larger in the vertical, but smaller in the in-plane direction with respect to the substrate and changes up to 20% between the different nanorods. [2]

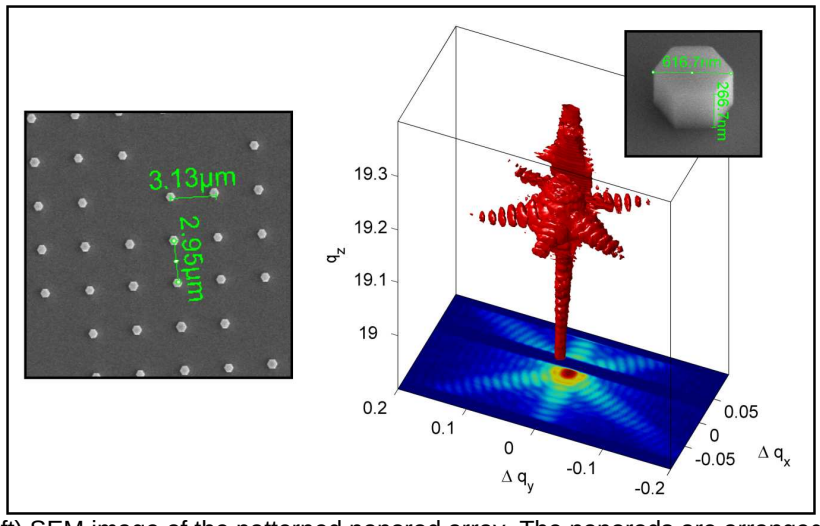

Figure 1: (left) SEM image of the patterned nanorod array. The nanorods are arranged in a square pattern with 3µm spacing. (right) 3dimensional coherent diffraction pattern of an individual nanorod. Size, shape and strain of the individual object (inset) can be derived from the intensity distribution.

References

[1] R. Yan et al., *Nature Photonics* **3**, 569 (2009)
[2] A. Biermanns et al., *J. Synchrotron Rad.* **16**, 796 (2009)