Structural characterization of Si-nanowires using a 200 kV LaB_6 TEM

S. Selve, D. Berger

TU Berlin, Zentraleinrichtung Elektronenmikroskopie (ZELMI), 10623 Berlin, Germany

soeren.selve@tu-berlin.de

Keywords: nanowire, dislocation, Si oxide layer, growing direction

The Central Facility for Electron Microscopy (ZELMI), a service facility for various analytical methods at the TU Berlin, cooperates with many customers from Departments of Chemistry, Physics, Materials Sciences and Medical Department of the TU Berlin, other Berlin Universities, research institutes and industrial companies. In summer 2008, the FEI Tecnai $G^2$20 S-Twin TEM was delivered to ZELMI in particular for structural investigations within the cluster of excellence UniCat.

Although the TEM has a conventional LaB_6-source, it offers a very good information limit measured to 0.2 nm in the strong direction whereas it is specified to 0.24 nm. For investigations of Si-nanowires (courtesy of S. Khachadorian, Inst. Solid State Physics, TU Berlin) this lateral resolution enables the determination of the thickness of their amorphous layer as well as the growing direction.

Fig. 1 shows an image of two Si-nanowires. One can clearly observe the crystalline areas in the inner part of the nanowire. In HRTEM, dislocations and stacking faults have also been imaged. Their existence in the wire affects the electrical properties. The diffraction pattern (fig. 2) of the wires shows their crystallinity as well as the distortions of the lattice planes.

The diffraction reflections are identified with the aid of a standard data base. For the shown dark field image (fig. 3), a [111]-reflection was chosen. Mainly only the inner part of the wire satisfies this Bragg-condition. By small shifts of the objective aperture, lattice planes, which are only slightly tilted, also fulfil the Bragg-condition. Consequently, the core of the wire has a [111]-orientation, while the outer parts deviates. With increasing distance from the core, the orientation of the lattice planes further changes, hence the lattice planes are bended.

By this, the thickness of the amorphous covering layers is determined to 3...5 nm, which is in the range of common Si oxide layers. Using diffraction patterns and HRTEM images, the lattice plane distances are identified as [111] lattice planes. Therefore the growing direction of the nanowires is along [111].

Next steps are further tuning of the growing parameters to improve the quality of the nanowires and to minimize crystal defects in order to achieve optimal electrical properties of the wires.

W. Grogger, F. Hofer, P. Pölt (Eds.): MC2009, Vol. 3: Materials Science,
DOI: 10.3217/978-3-85125-062-6-418 , © Verlag der TU Graz 2009

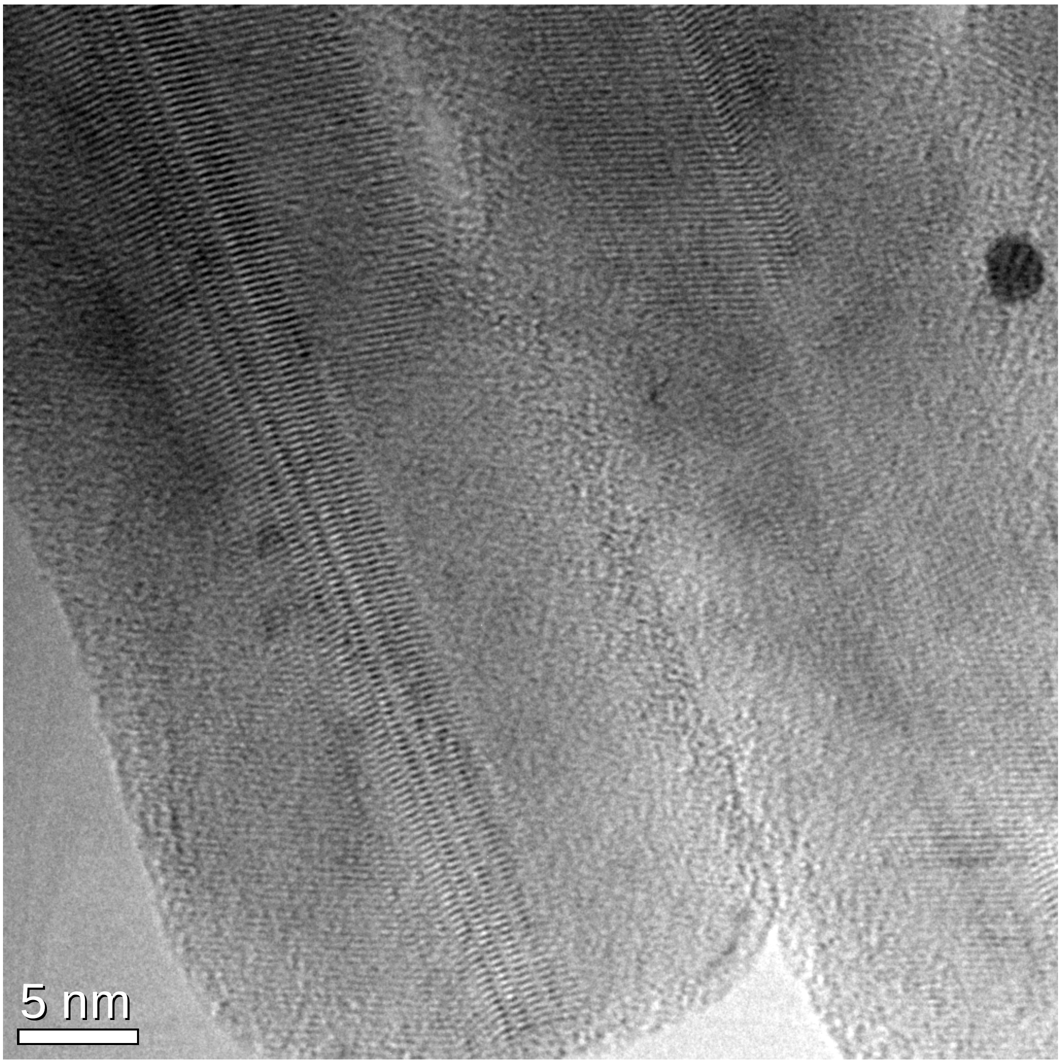

Figure 1. Si nanowires, HRTEM

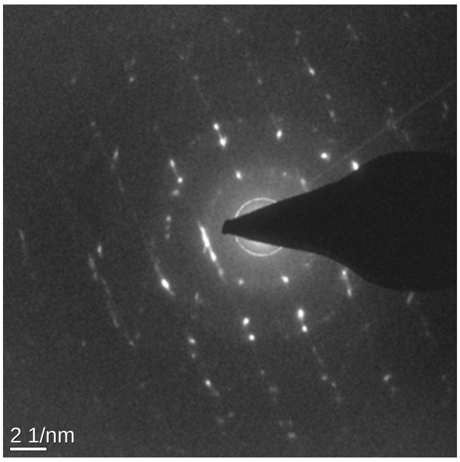

Figure 2. diffraction pattern of Si nanowires

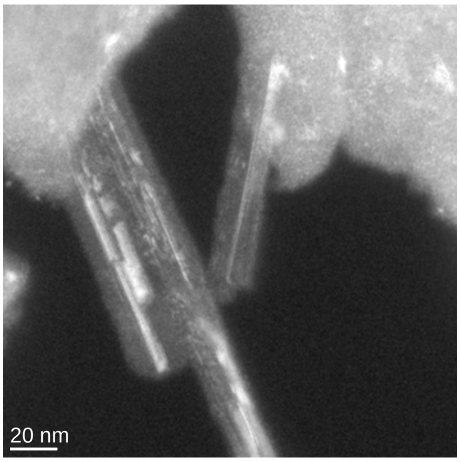

Figure 3. Si nanowires, DF

Acknowledgements: Many thanks to the DFG Cluster of Excellence “UniCat” for the financial support of the TEM.

W. Grogger, F. Hofer, P. Pölt (Eds.): MC2009, Vol. 3: Materials Science,
DOI: 10.3217/978-3-85125-062-6-418 , © Verlag der TU Graz 2009