ESRF	**Experiment title: Relation between electrical and structural properties of individual GaAs/InGaAs/GaAs core-shell quantum well nanowires**	**Experiment number**: hc2276
Beamline:	**Date of experiment**: from: 6.07.2016 to: 09.07.2016 from: 16.07.2016 to: 19.07.2016	**Date of report**: 23.08.2016
Shifts:	**Local contact(s)**: Peter Boesecke, Tobias Schulli	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

A. Davtyan[1*], D.Bahrami[1*], Ali Al-Hassan[1*], D. Kriegner[2*] and U. Pietsch[1]

1:Faculty of Science and Engineering, University of Siegen, 57068 Siegen, Germany

2: Department of Condensed Matter Physics, Charles University in Prague, Ke Karlovu 5, 121 16 Prague 2, Czech Republic

Report: We aimed to find a correlation between crystallographic structure and electrical properties of single core-shell-shell NWs. Particularly we were interested in studying the structure of quantum well in GaAs/$In_{15}GaAs_{85}$/GaAs(fig. 1) nanowires grown by MBE onto silicon(111) substrate. Characterization of the wires have been performed in by measuring the symmetric (111) and (333) reflections using CXDI. In addition we recorded speckle rods along the (331) and (224) asymmetric truncation rods for wires which are bended (fig. 3). Wavefront of the coherent wave was characterized by measuring ptygography of a Siemens star at ID01 in forward direction. The reconstructed object, a part of the Siemens star, and the reconstructed probe functions are shown in fig. 1.

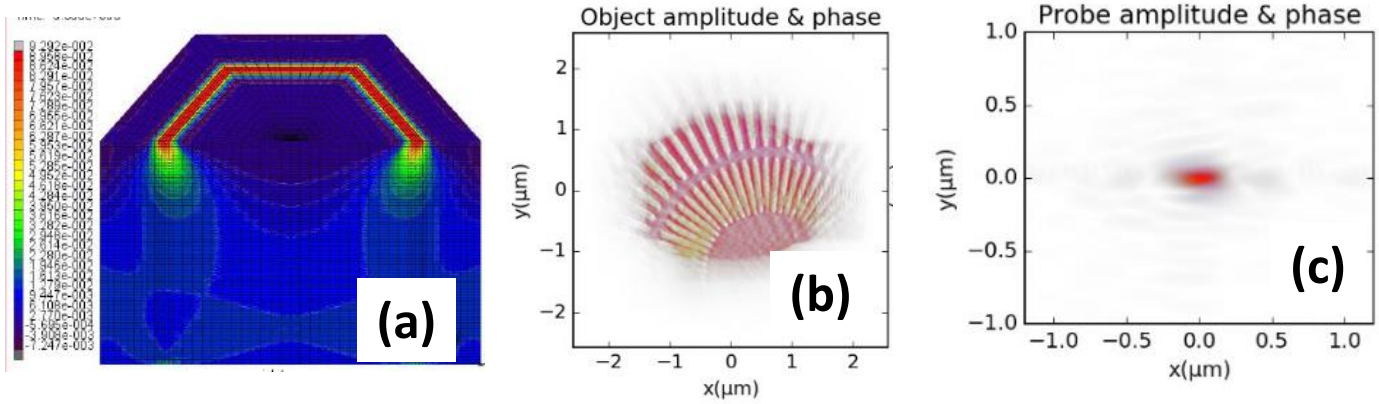

Fig. 1 (a) The FEM model of the GaAs/$In_{15}GaAs_{85}$/GaAs nanowires. (b) and (c) are showing the preliminary reconstructed complex object and probe functions from ptychography experiments in forward direction.

After wave front analysis we record the reciprocal space maps from different wires using the coherent beam with size of 150x250nm² (FWHM) and x-ray energy of 9keV. For the first time we mesured diffraction from asymmetric reflections as 422TZB and 331ZB from several wires. Analysis of x-ray measurements as well as the I-V characterization are in progress. Here we show only two examples out of all where we conclude that the wires are bent due inhomogeneous shell layer thickness at different side planes viisble at the peak positions of the (331) ZB, (10-15) WZ and (422) TZB reflections (fig. 2 (a) and (b)). We also see that

different wires have different TZB content, for example, in fig. 2 (a) the (422) reflection has relatively less intensity in comparison with the case shown fig. 2(b).

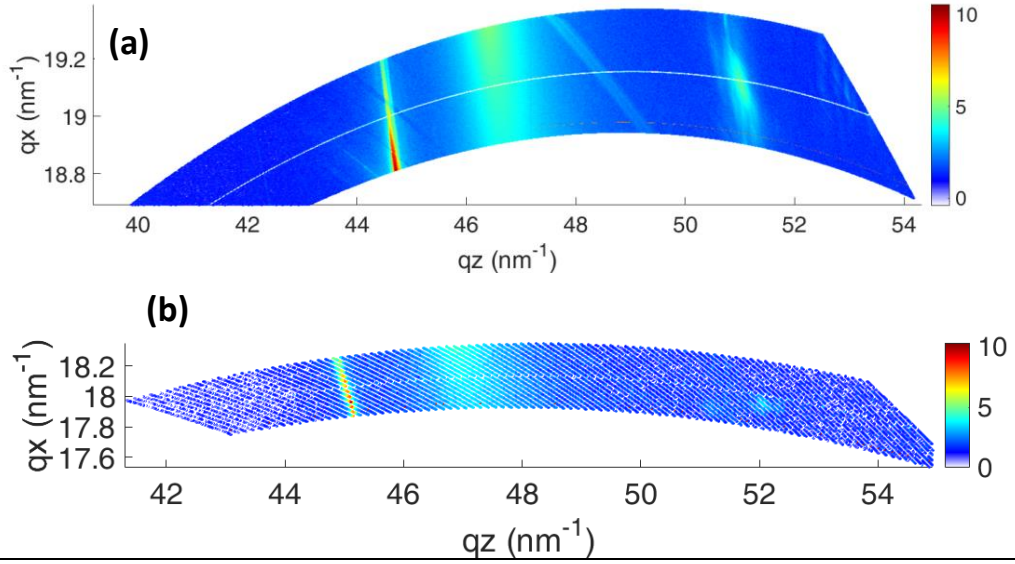

Fig. 2 (a) and (b) Bended wires having WZ and TZB segments.

The segments of several GaAs/$In_{15}GaAs_{85}$/GaAs nanowires wires with 140/10/30nm thicknesses were measured also at the vicinity of (111) Bragg reflection. In figure 2 we present an example of experimentally measured (111) Bragg reflection from the wire which was used for electrical characterization prior to CXDI measurements. We have surprisingly discovered that the thikness fringes from the nanowire side facets are showing long range oscillations (fig. 3 (a) red dashed line). In order to understand whether this behavior is characteristic for the wires that were used to measure the electrical properties (similar to [1]) only we also measured (111) Bragg reflection of several wires which were not affected by a nano-manipulator tip during the electrical measurements (data comparison is currently under the evaluation). First attempt of the phase retrieval analysis (currently under way) are shown in fig. 3 (b) and (c) where we present the reconstructed amplitude and phase patterns.

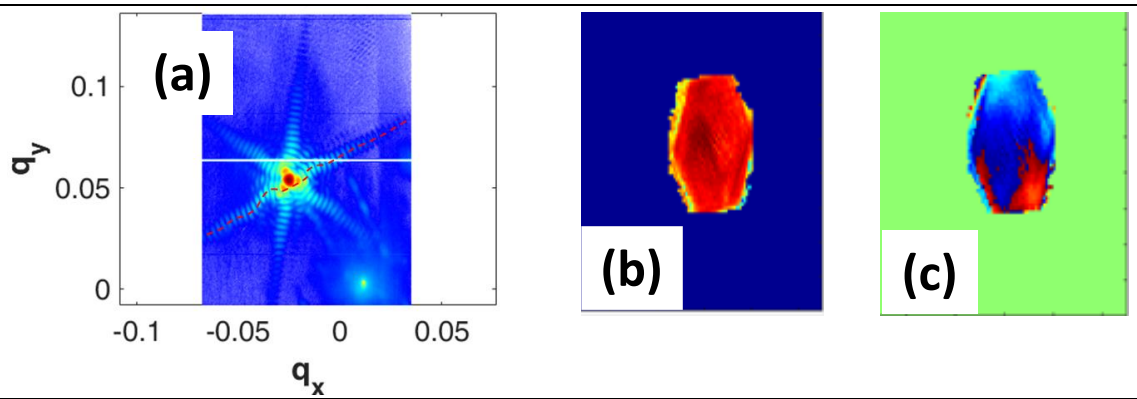

Fig. 3 (a) Reciprocal space map near the (111) Bragg reflection from single nanowire. (b) and (c) are preliminary reconstruction for the amplitude and phase of the cross section of the wire in 2 dimensions using the amplitue from (a).

References

1. Bussone G. et al., Nano Letters 2015, **15**, 981–989