ESRF	**Experiment title: Mapping the 3D strain in a single InAs/GaSb nanowire by means of 3D x-ray ptychography**	**Experiment number**: HC-2612
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Report: The aim of this experiment was to apply the ptychography at Bragg condition on single isolated nanowires in order to reconstruct the 3D strain distribution using a coherent beam with size of 150x250nm² (FWHM) and an x-ray energy of 9keV. Test measurements did show that InAs/GaSb nanowires planned to use for this study were not suitible for this task. Therefore we applied the ptychography on core-shell-shell $GaAs/In_{0.1}GaAs_{0.9}/GaAs$ nanowires grown by MBE onto 111 oriented Si substrate. This has two reasons: 1) for the first time we applied the 3D ptychography on core-shell-shell nanowires and 2) we additionally explored the appearance of the 3-fold symmetry in this kind of nanowires which was reported in [1]. The 3D ptychography at GaAs 111 was tested by collecting 3D reciprocal space maps at different positions parallel and perpendicular to the nanowire growth axis. The preliminary result of the 3D reconstrcution (integrated along the Y axis) is shown in Fig.1. Currently the ptychography reconstruction is not finished. The scripts from [2] provide3D reconstrcution using simulated probe function Fig. 1). A possible explanation might be that not sufficient overlaping positions were used in ptychography scan.

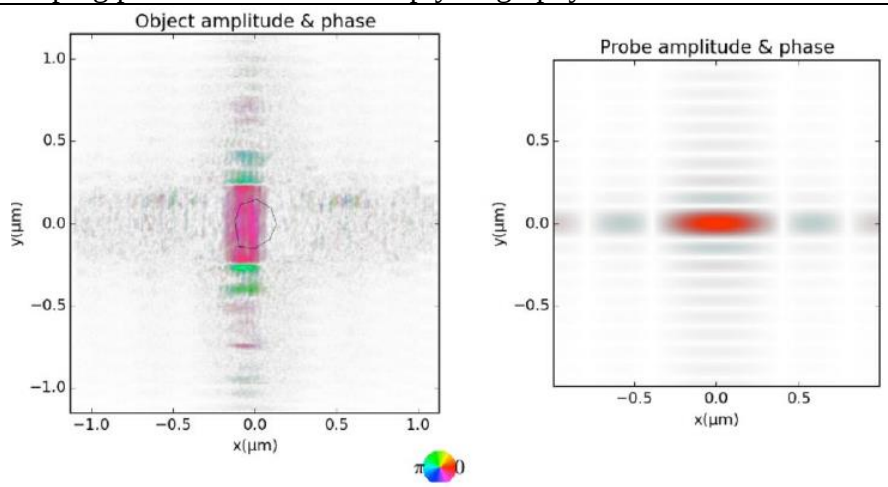

Fig. 1 (left) 3D Ptychography reconstruction of the $GaAs/In_{10}GaAs_{90}/GaAs$ nanowire, integrated along the y axis, measured at GaAs 111 reflection. (rigth) siumlated probe used in 3D Ptychography reconstruction.

After collecting the data for 3D ptychography we combined the ptychography approach with Coherent Diffraction Imaging (CDI). We realized this in 2 experiments at the very same nanowire. First, we colleceted a set of 3D CDI measurements at different positions along the nanowires growth axis as shown in the Fig. 2

(a). The CDI data show that the upper part of the nanowire is homogenious whereas the bottom part not, seen as distortion of the 3D RSM. Second, the angle of incident was fixed at the 111 GaAs Bragg position and 2D ptychography data were collected at 1800 positions. It appears that in 2D ptychography reconstruction (see Fig. 2 (b) and (c)) the phase is very homogenous at the middle part. This is a good agreement with the 3D CDI results. The phase retrieval studies from 3D CDI are on the way.

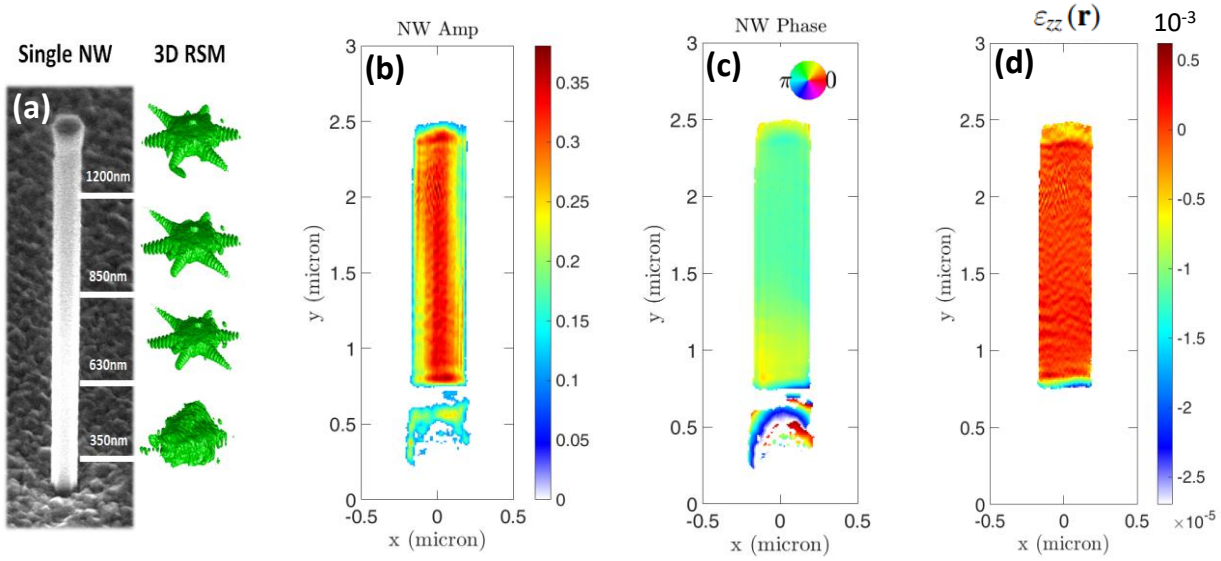

Fig. 2 (a) The SEM image of the core-shell-shell nanowrie. White lines are indicating approximately the positions where the 3D resiprocal space maps were recorded. (b) Reconstrcuted amplitude and (c) phase in real space from 2D ptychography measurement. (d) Displacement field along the 111 dircetion calculated from phase pattern (c).

The combination of 2D ptychography and CDI was probed also at another nanowire in order to study the kind of similarity of nanowires grown near to each other. In Fig. 3 we present the real space amplitude and phase of the 2D ptychography reconstruction (see Fig. 3 (a) and (b)). In contrast to the first nanowire we see a clear difference in the phase pattern of nanowire 2. The data analysis are still on the way. However, we discovered an interesting feature in the collected RSMs taken at different positions 1 and 2 along the nanowire growth axis (see Fig. 3 (c)). In Fig.3 (d) we see a 3-fold rotational symmetry of the nanowire with is at position 2 by 180 degree rotated (which means at lower Z values along the growth direction) with respect to the symmetry seen at position 1 (near the top part of the nanowire).

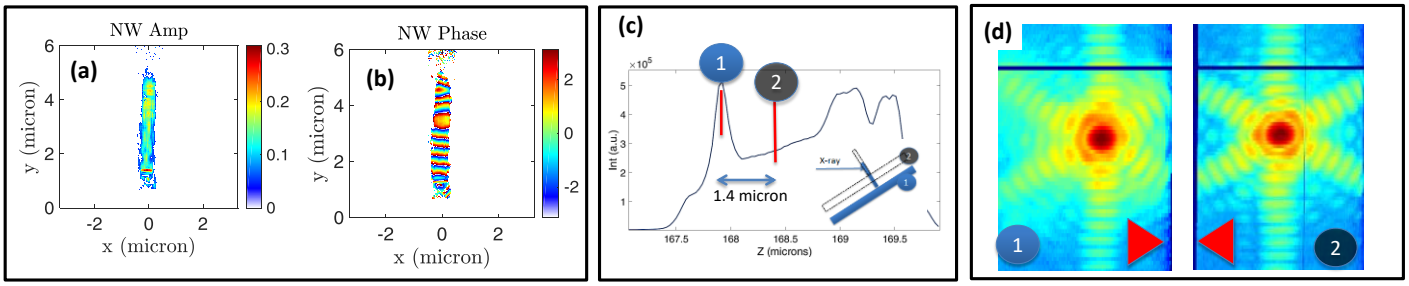

Fig. 3 (a) Reconstrcuted amplitude and (b) phase in real space from 2D ptychography measurement. (c) Integrated intensity as a function of 'z' higth along the nanowire. Positions 1 and 2 correspond to the positions where the 3D RSM was measured by CDI. (d) 2D slices from the 3D RSM measured at postions 1 and 2.

References

1. A. Davtyan et al., **J. Appl. Cryst.** (2017). **50.**
2. O. Mandula eta al**., J. Appl. Cryst.** (2016)**. 49, 1842–1848**