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Program Title (English) :In-situ X-ray Characterization of strain evolution during axial and radial growth of InAs/InSb heterostructure nanowires
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1. Summary

We performed in situ molecular beam epitaxy (MBE) growth of InAs/InAsSb nanowires while measuring X-ray diffraction patterns with a 2D pixel detector. The results show dynamic movements of the nanowires during and after the InAsSb deposition. Bending of the nanowires was caused by the lattice mismatch between the InAs core and thin layer of InAsSb residing on one side of the nanowires.

2. Experimental

The InAs substrates, patterned with regular arrays of gold nanoparticles were mounted in the MBE chamber and aligned with the X-ray beam for the Bragg condition for the Wurtzite (WZ) ($10\bar{1}1.5$) peak (indices given in the ZB surface coordinate system). At the same time parts of the Zinc Blende and twinned Zinc Blende (TW) structures, corresponding to the substrate and parasitic substrate growth were measured with the 2D detector.

First, pure WZ InAs nanowires were grown measuring changes in intensity of the WZ peak, which holds information about growth dynamics. Simultaneously we could monitor parasitic substrate growth, occurring in ZB and TW phases.

Next, Sb shutter was opened initiating the InAsSb growth. Development of strain and different phases of InAsSb was monitored my measuring intensities and positions of the corresponding Bragg peaks and crystal truncation rods (CTRs). Additionally, 3D reciprocal space maps (RSM) was acquired at several growth stages.

3. Results and Discussion

Due to very uniform distribution thicknesses and growth rate among the nanowires we were able to see lateral and longitudinal Laue developing during the growth of the pure InAs nanowires. This allowed us extracting precise nanowire dimensions at each time step.

Analysis of the measured diffraction data and complimentary characterization with TEM and SEM showed that most of the InAsSb has grown axially along the InAs nanowire. However, a very thin layer resided on one side of the InAs core and caused bending of entire nanowire due to the lattice mismatch. Moreover, we could see that each opening or closing of the Sb shutter caused oscillating movements of the nanowires.

4. Others

Additional characterization of the nanowires was performed using SEM, High Resolution TEM and 3D reciprocal space mapping.