ESRF	**Experiment title:** Exploiting the bending of GaAs nanowires due to optical excitation using Laser pump and X-ray probe measurement	**Experiment number**: HC-4893
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Report:

We investigated the transient structural response in ensemble of $Al_x\ In_{1-x}As$/GaAs core shell NWs, grown on Si (111) substrate, when irradiated with femtosecond laser pulses via x-ray pump probe experiment at ID09 beamline. The structural variation is introduced via a pulsed laser heating and the transient response is registered via x-ray diffraction by fulfilling the Bragg's condition of GaAs (111) reflection. Femtosecond laser irradiation of solids excites photoelectrons from the valence into the conduction band and triggers a cascade of fundamental dynamical processes that occur on picosecond to nanosecond time scales like excitation and thermal equilibration of phonons. The laser light makes an impact on the lattice properties of the NWs, seen as an expansion of the lattice parameter due to the absorbed energy of the laser pulse. The propagation of temperature gradient along the NW axis is probed by angular evolution of the GaAs NW 111 Bragg peak as function of with delay time between pump and probe pulse. Preliminary data treatment of straight NWs shows a relaxation of thermal strain, on time range of 3μs, accompanied by fast damped mechanical oscillations of the NWs, see Fig 1: (a.).

Comprehensive measurements on straight NWs are crucial for the correct estimation of flexoelectric effect in bent NWs given the fact that the thermal expansion of the lattice induced by electronic heating may also affect the bending and the time necessary to transfer the electronic energy to the phonon system thus must be decoupled accordingly. Unfortunately, experiment on arrays of bent NWs at ID09 beamline of ESRF was not successful due to multiple equipment limitations including experimental uncertainties. However, for the first time we identified a change in the Bragg peak position in $\boldsymbol{Q_z}$ and $\boldsymbol{Q_y}$ directions over the first 200 ns followed by a plateau of ~10s of ns which is a hint for change in bending radius upon photoexcitation. We approximated the shift in the bending radius of the NW by considering the two-dimensional Bragg peak shifts and by relating them to theory of elasticity, see Fig 1: (b). By considering it as two-dimensional problem, we observe 1° linear elastic deformation and recovery of the bending angle during first 300 ns.

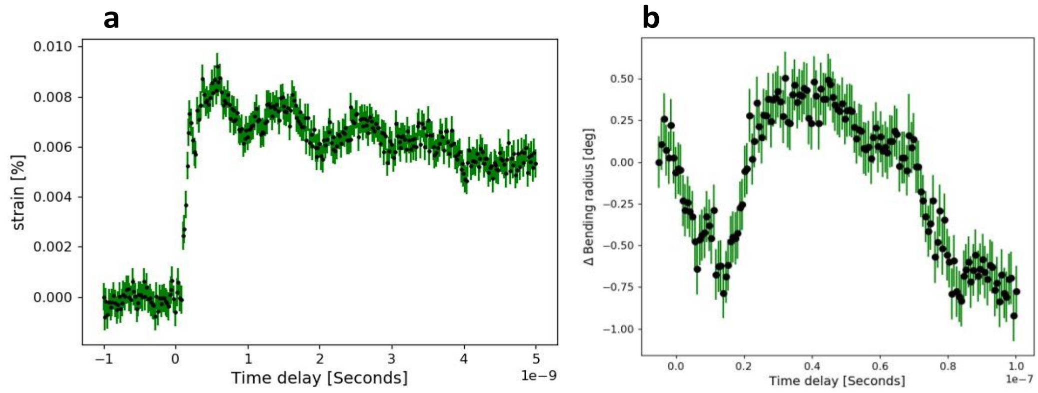

Figure 1: (a) *Ultrafast thermoelastic damping of a straight NW as function of time delay* ***(b)*** *Variation in bending angle of bent NW ensemble.*

This bent NW ensemble was excited with a laser whose spot size was unintentionally twice smaller (realize after the experiment) than the Xray spot size thus we averaged over excited and unexcited parts of the sample, resulting in a large experimental uncertainty, which can be overcome by tuning the spot size of the laser spot. Nonautomated goniometer head together with smaller spot size render significant alignment issues. Such time resolved experiments are extremely alignment sensitive and the lack of the alignment restricted us to obtained spatial overlap between laser and x-ray beam. The sample holder consisted of a disk attached to a pin, which was non-axisymmetric, and it further limit the access to precise sample alignment, center of rotation and translation on the sample.

Approximately we lost one shift of the beamtime due to the beam loss. Besides that, there were minor, however recursive time and labor-intensive issues in the laser set up and x-rays such as beam drifts and table height adjustments.

The experimental data indicate that the diameter of the NWs indeed plays a crucial role in the thermal transport properties on the NWs. On the other hand, presence of a gradient in bandgap energy in bent NW modifies the dynamics of excited charge carriers and will significantly change the mechanical and thermal response compared to straight NW. Unfortunately, systematic investigation of bent NWs could not be realized during this experimental period due to technical issues. Therefore, investigations of bent NWs were not successful, and we did concentrate on straight NWs. Investigation of bent NWs requires further beamtime.