



# LUND UNIVERSITY

## Time-resolved x-ray diffraction of nanostructured samples

Persson, A. I. H.

2016

*Document Version:*  
Other version

[Link to publication](#)

*Citation for published version (APA):*

Persson, A. I. H. (2016). *Time-resolved x-ray diffraction of nanostructured samples*. [Doctoral Thesis (compilation), Department of Physics].

*Total number of authors:*

1

### General rights

Unless other specific re-use rights are stated the following general rights apply:

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: <https://creativecommons.org/licenses/>

### Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117  
221 00 Lund  
+46 46-222 00 00

# Time-resolved x-ray diffraction of nanostructured samples

Anna Persson



**LUND**  
UNIVERSITY

DOCTORAL THESIS

by due permission of the Faculty of Engineering, Lund University, Sweden.  
To be defended at Rydberg lecture hall, Fysicum, Professorgatan 1, Friday  
September 9<sup>th</sup> 2016, at 10:15.

*Faculty opponent*

Anton Plech, Karlsruhe Institute of Technology, Germany

|  |  |  |       |
|--|--|--|-------|
| Organization<br>LUND UNIVERSITY<br>Department of Physics<br>Atomic Physics<br>Box 118, SE-221 00 Lund, Sweden  |  | Document name<br>DOCTORAL THESIS                               |       |
|  |  | Date of issue<br>2016-08-15                                    |       |
| Author(s)<br>Anna Persson  |  | Sponsoring organization  |       |
| Title and subtitle<br>Time-resolved x-ray diffraction of nanostructured samples  |  |  |       |
| Abstract<br><p>The work presented in this thesis is based on time-resolved x-ray diffraction studies of InSb (111) samples. The experiments were carried out using a pump-probe configuration using short laser pulses as the pump and x-rays as the probe. Laser excitation leads to the formation of a strain pulse that propagates through the sample. The strain pulse gives rise to coherent longitudinal, acoustic phonons, which were probed with the x-rays. By detuning the x-ray energy away from the Bragg reflection, phonon modes could be studied as oscillations in the x-ray reflectivity. The experiments were performed at the, now decommissioned, storage ring MAX-II at the MAX IV Laboratory, with long x-ray pulses (~600 ps). Using a streak camera, time resolutions down to 1 ps could be achieved.</p> <p>An optoacoustic transducer was used to modify the acoustic phonon spectrum. A 150 nm nickel film was deposited on the InSb bulk sample, and a strain pulse was generated in the nickel film by laser excitation. The strain pulse is partially transmitted and partially reflected at the interface between the nickel and indium antimonide. This leads to a train of strain pulses in the indium antimonide, and constructive and destructive interference of the diffracted x-rays.</p> <p>Optoacoustic transducers were also used to study electron diffusion in nickel and gold. The metals were deposited on bulk InSb and excited by short laser pulses. The resulting strain pulse was broadened by electron diffusion. This could be studied in the indium antimonide since the oscillations in x-ray reflectivity mainly occurred when the sharp edge between compression and expansion part of the strain pulse had entered the indium antimonide. The time delay between the strain pulse entering the indium antimonide and the expansion part entering the bulk material can be used to study the shape of the strain pulse.</p> <p>Using InSb nanowires, the generation of coherent acoustic phonons was used to study the speed of sound, which is related to the thermal conductivity of the material. It was found that the speed of sound, and hence the thermal conductivity, is lower in InSb nanowires than in bulk InSb.</p> |  |  |       |
| Key words<br>X-ray diffraction, phonons, optoacoustic transducer, electron diffusion   |  |  |       |
| Classification system and/or index terms (if any)  |  |  |       |
| Supplementary bibliographical information<br>-   |  | Language<br>English  |       |
| ISSN and key title<br>0281-2762, Lund Reports on Atomic Physics, LRAP 526 (2016)   |  | ISBN 978-91-7623-914-8 (print)<br>ISBN 978-91-7623-915-5 (pdf) |       |
| Recipient's notes  |  | Number of pages<br>109   | Price |
|  |  | Security classification  |       |

I, the undersigned, being the copyright owner of the abstract of the above-mentioned dissertation, hereby grant to all reference sources permission to publish and disseminate the abstract of the above-mentioned dissertation.

Signature \_\_\_\_\_ Date \_\_\_\_\_