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

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, Professorsgatan 1, Friday September 9th 2016, at 10:15.

Faculty opponent
Anton Plech, Karlsruhe Institute of Technology, Germany

Organization LUND UNIVERSITY Department of Physics Atomic Physics Box 118, SE-221 00 Lund, Sweden	Document name DOCTORAL THESIS Date of issue 2016-08-15
Author(s) Anna Persson	Sponsoring organization

Title and subtitle

Time-resolved x-ray diffraction of nanostructured samples

Abstract

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.

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.

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.

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.

Key words

X-ray diffraction, phonons, optoacoustic transducer, electron diffusion

Classification system and/or index terms (if any)

Supplementary bibliographical information -		Language English
ISSN and key title 0281-2762, Lund Reports on Atomic Physics, LRAP 526 (2016)		ISBN 978-91-7623-914-8 (print) ISBN 978-91-7623-915-5 (pdf)
Recipient's notes	Number of pages 109	Price
	Security classification	

Signature ________________________ Date __________