HL 4 New materials

Time: Monday 10:15–12:15 Room: BEY 154

HL 4.1 Mon 10:15 BEY 154

Influence of the stoichiometry on the crystal structure of phase change materials — •Julia Steiner, Henning Dieker, Christoph Steimer, and Matthias Wuttig — I. Institute of Physics (IA), RWTH Aachen University, 52056 Aachen, Germany

Phase change materials are characterized by a remarkable property combination. On the one hand they show a pronounced difference in their optical and electronic properties between the amorphous and the crystalline phase. On the other hand the transition between these two phases proceeds very fast. Because of this property combination phase change materials are of both great physical and technological interest. They are already used in optical data storage applications and are investigated as non-volatile electronic memories as well.

Nevertheless the correlation between stoichiometry, crystal structure and physical properties is not yet fully understood. To investigate the correlation between stoichiometry and crystal structure of phase change materials diffraction methods have been employed to identify the structure of different phase change alloys. This comparative analysis allows us to determine systematic trends in the structure of phase change media with changing stoichiometry.

HL 4.2 Mon 10:30 BEY 154

Kinetics of crystal nucleation in undercooled droplets of phase change alloys — •Dominic Lencer[1], Johannes Kalb[1], Frans Spaepen[2], and Matthias Wuttig[1] — [1]I. Insitute of Physics (IA), RWTH Aachen University, 52056 Aachen, Germany — [2]Division of Engineering and Applied Sciences, 29 Oxford Street, Cambridge MA 02138, USA

The demand for fast, reliable and inexpensive data storage and memory devices has led to the development of devices employing the difference in the physical properties of so-called phase change materials between the crystalline and the amorphous state to store information by switching between these two states.

While this technique is already widely used in optical devices such as CD-RW and DVD±RW, current research heads for competitive electrical memories called PCRAM (phase change random access memory).

The main challenge to turn PCRAMs into a viable alternative for FLASH chips or even DRAMs is related to an improvement in the understanding of the switching process and the crystallization kinetics.

To obtain such insight droplets of four tellurium-based phase change alloys ($Ag_1In_1Te_2$, $Ag_1Sb_1Te_2$, $Ge_1Bi_2Te_4$, $Ge_1Sb_2Te_4$) fluxed in B_2O_3 glass were prepared by annealing and subsequently undercooled below their liquidus temperature using a differential thermal analyzer (DTA).

The results of these measurements enabled us to estimate limits for both the crystal-melt interfacial energy and the steady-state crystal nucleation rate using the nucleation theory.

HL 4.3 Mon 10:45 BEY 154

Nucleation characteristics of silicon nanowires as a function of the metal catalyst — •Anna Fontcuberta i Morral[1,2], Billel Kalache[2], and Pere Roca i Cabarrocas[2] — [1]Walter Schottky Institut- TU Muenchen, Am Coulomwall, 3, 85748 Garching — [2]LPICM, Ecole Polytechnique, 91128 Palaiseau Cedex, France

A theoretical model of the Vapor-Liquid-Solid growth mechanism pertaining to the nucleation of silicon nanowires is presented. The model is based on the diffusion of the silicon through the solid catalyst and predicts an incubation time for the onset of nanowire growth. To validate the model, the incubation times of silicon nanowires obtained by Chemical Vapor Deposition and employing both gold and copper as a catalyst have been measured for the first time The experimentally observed incubation times are in excellent agreement with the presented model and diffusion characteristics of silicon through solid Au and Cu. The results can be applied to any other metal/semiconductor system for the synthesis of nanowires and provide a route to measure the phase space for the nanowire-synthesis.

HL 4.4 Mon 11:00 BEY 154

Band Offset Measurements of Quinternary (AlGaIn)(AsSb) — •Alexander Bachmann, Oliver Dier, Christian Lauer, Ralf Meyer, and Markus-Christian Amann — Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching

Current MIR antimonide-based type-I diode lasers reach a wavelength of up to 3.3 μm. These heterojunction devices use GaInAsSb with maximum 55% of In as quantum-well material and AlGaAsSb with 20% to 30% of Al as barrier material. To enlarge the wavelength further, the active material has to be adjusted. InAsSb has the smallest band gap in the (AlGaIn)(AsSb) system (0.283 eV according to 4.38 μm), but it has type-II alignment if used with AlGaAsSb as barrier material. Therefore, AlInAsSb or the quinternary AlGaInAsSb may be used yielding a type-I arrangement. As it is not possible to grow AlInAsSb with higher Al or In concentrations due to the formation of clusters and a large miscibility gap, Ga-dominated AlGaInAsSb has been used. Because of one more degree of freedom, it is possible to adjust the valence band offset (VBO) and the conduction band offset (CBO) almost independently within a certain range. For a diode laser a sufficiently large VBO for better hole-confinement and moderately large CBO for a homogeneous injection of the electrons in every quantum well are needed. However, band offset calculations from literature yield very different results, depending on the set of material parameters used. In this talk, we therefore present measured band-offsets (by C-V profiling) on MBE-grown quinternary samples of various material combinations to determine the optimal band alignments for type-I lasers.

HL 4.5 Mon 11:15 BEY 154

Parametric Amplification of Magnetoinductive Waves in Bi-periodic Metamaterial Arrays — •Oleksiy Sydoruk[1], Oleksandr Zhuromskyy[1], Ekaterina Shamonina[1], and Laszlo Solymar[2] — [1]Department of Physics, University of Osnabrück,Osnabrück, Germany — [2]Department of Electrical and Electronic Engineering,Imperial College, London, United Kingdom

One of the promising fields of applications of Magnetoinductive Waves [1,2] is in Magnetic Resonance Imaging, where they can provide an elegant and effective solution for signal guiding [3] and detection [4]. Since the human body is a significant source of noise an improvement in the signal-to-noise ratio is always desirable. Amplification of the signal at an early stage in the receiving system (which in the case of a magnetoinductive receiver is a set of magnetically coupled resonators) will allow both noise reduction and compensation for ohmic losses.

Parametric amplification is an obvious candidate for investigations. It was suggested [5] that bi-periodic arrays of metamaterial elements can provide an environment where exact phase matching conditions for parametric amplification may be fulfilled. Here we present a theory of parametric amplification in bi-periodic metamaterial arrays with the required nonlinearity realized by varactor insertions.

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[3] E. Shamonina and L. Solymar, J. Phys. D **37**, 362-367 (2004).
[4] L. Solymar, et. al, *submitted to J. Appl. Phys.*
[5] O. Sydoruk, et. al, Appl. Phys. Lett. **87**, 072501-1-3 (2005).

HL 4.6 Mon 11:30 BEY 154

Near Field Phenomena in Metamaterials — •Frank Hesmer[1], Olexander Zhuromskyy[1], Ekaterina Shamonina[1], and Laszlo Solymar[2] — [1]Department of Physics, University of Osnabrueck, Germany — [2]EEE Department, Imperial College London, United Kingdom

Metamaterials are a new class of electromagnetic materials, which are man-maid structures composed of small resonant elements. The electromagnetic response of metamaterials can differ from that of natural materials, because properties of each individual element can be varied in a wide range. In particular the electromagnetic fields can be manipulated on the scales much smaller than the wavelength.

Applications of metamaterials include subwavelength imaging due to evanescent fields and magnetic flux guiding based on magnetoinductive (MI) waves with potential applications in Magnetic Resonance Imaging.

We apply a number of numerical and analytical tools to study the near field phenomena in a large variety of metamaterial elements (capacitively loaded loops, split ring resonators and swiss rolls). We plot distributions of the magnetic field and also streamlines and magnitudes of the Poynting vector for visualising the near field phenomena in magnetic metamaterials.

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HL 4.7 Mon 11:45 BEY 154

Ellipsometry and Microreflection on Cylindrite — •Chris Sturm[1], Rüdiger Schmidt-Grund[1], Ronny Kaden[2], Bernd Rheinländer[1], Klaus Bente[2], and Marius Grundmann[1] — [1]Universität Leipzig, Fakultät für Physik und Geowissenschaften, Institut für Experimentelle Physik II, Linnéstr. 5, 04103 Leipzig — [2]Universität Leipzig, Fakultät für Chemie und Mineralogie, Institut für Mineralogie, Kristallographie und Materialwissenschaft, Scharnhorststraße 20, 04275 Leipzig

Cylindrite, $FeSn_4Pb_3Sn_2S_{14}$, is a sulfosalt mineral which naturally occurs as lamellae and cylinders. Thus, it is a promising material for micro- and nanostructures. Up to now the optical dielectric function is not known.
By CVT (chemical vapour transport) with iodine as transport agent the cylindrite crystals where synthesized as platelets as well as cylinders.
The samples were studied by ellipsometry in the spectral range from 0.75 eV to 3.5 eV and by microreflection technique in the spectral range from 1.8 eV to 3.2 eV. Using a layer structure model the dielectric function of Cylindrite was obtained. This dielectric function was found to be similar to those of a semiconductor. From the reflectivity spectra in the absorption range it can be concluded that the chemical composition of the cylindric and lamellar samples is different.

HL 4.8 Mon 12:00 BEY 154

Ferromagnetism and magnetic anisotropy in Co-implanted TiO_2 — •N. Akdogan[1], B. Rameev[2,3], L. Dorosinsky[4], H. Sozeri[4], R. Khaibullin[3], B. Aktas [2], L. Tagirov[3,5], A. Nefedov[1], A. Westphalen[1], and H. Zabel[1] — [1]Institute of Experimental Physics IV, Ruhr-University Bochum, D-44780 Bochum, Germany — [2]Gebze Institute of Technology, 41400 Gebze-Kocaeli, Turkey — [3]Kazan Physical-Technical Institute of RAS, 420029 Kazan, Russia — [4]TUBITAK-UME, PK 54, 41470 Gebze-Kocaeli, Turkey — [5]Kazan State University, 420008 Kazan, Russia

Oxide based diluted magnetic semiconductors have recently attracted considerable attention because of reports of room temperature ferromagnetism in several systems and their projected potential for spintronic devices. However, subsequent reports have raised concerns about the initially suggested intrinsic nature of ferromagnetism in these materials.

Magnetic anisotropy of cobalt implanted single-crystalline rutile has been studied by means of MOKE and SQUID techniques. We observed for the first time strong angular dependence of the remanent magnetization and coercive field in the plane of the implanted surface: twofold anisotropy for the (100)- and fourfold anisotropy for the (001)-substrate samples. Possible origins of ferromagnetism and anisotropies in single-crystalline TiO_2 samples after Co-ion implantation are discussed.

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