DS 28: Layer Properties: Electrical, Optical, and Mechanical Properties

Time: Thursday 9:30–13:00 Location: H8

DS 28.1 Thu 9:30 H8

Crystallization Kinetics of Phase-Change Materials in the High-Speed Regime — •Julia Benke[1], Egidio Carria[1], Martin Salinga[1,2], and Matthias Wuttig[1,2] — [1]I. Physikalisches Institut (IA) — [2]JARA-FIT, RWTH Aachen

Phase-change materials (PCM) are dominating the field of rewritable optical data storage. The pronounced optical contrast between their amorphous and crystalline phase is used to code the digital information in rewritable CDs, DVDs and Blue-Ray discs. Nevertheless these devices do not tap the full potential of PCM. The fast transition between the two phases can compete with writing speed in DDR-RAM and, atdditionally, this technology provides the great advantage of non-volatility.

In recent years, many efforts have been spent to unravel the origin of the ultra-fast phase transition. Especially, the limiting process of crystallization has attracted much interest. PCMs can be divided into two classes, nucleation-dominated materials like Ge2Sb2Te5 and growth-dominated materials such as Ag-In-doped Sb2Te. The interplay of nucleation and growth during the crystallization process is of great interest for the reliability of down-scaled PC-memory cells. With our new Phase-change Optical Tester, we have investigated the crystallization kinetics of GeTe and Ag-In-doped Sb2Te under isothermal conditions over a large temperature range up into the high-speed regime. Starting from these measurements, we have inferred several properties of the melt-quenched amorphous phase building a general correlation with the switching mechanism in PCMs.

DS 28.2 Thu 9:45 H8

(Magneto)-optical investigations of $NiFe_2O_4$ and $CoFe_2O_4$ epitaxial thin films — •Cameliu Himcinschi[1], Ionela Vrejoiu[2,4], Georgeta Salvan[3], Michael Fronk[3], Andreas Talkenberger[1], Dietrich Zahn[3], and Jens Kortus[1] — [1]TU Bergakademie Freiberg, Institute of Theoretical Physics, D-09596 Freiberg — [2]Max Planck Institute of Microstructure Physics, Weinberg 2, D-06120 Halle — [3]TU Chemnitz, Semiconductor Physics, D-09107 Chemnitz — [4]Max Planck Institute for Solid State Research, D-70569 Stuttgart

Nickel and cobalt ferrite epitaxial films were deposited on Nb doped $SrTiO_3$ by pulsed laser deposition. X-Ray diffraction and atomic force microscopy showed that the films have a good crystalline quality and smooth surfaces. A larger number of phonons was observed in the polarization dependent Raman spectra of the ferrite films than expected for the cubic spinel structures. This is explained by short range ordering of the Ni^{2+}(or Co^{2+}) and Fe^{3+} cations at the octahedral sites inducing a lowering of the symmetry. The dielectric functions for nickel and cobalt ferrites are determined from ellipsometry in the 0.73-5eV photon energy range. The absorption edge was analyzed using a bandgap model and the energies for the indirect and direct optical transitions were calculated. Magneto-optical Kerr effect spectroscopy in combination with spectroscopic ellipsometry allowed the off-diagonal elements of the dielectric tensor to be determined in the energy range from 1.7 eV to 5eV.

DS 28.3 Thu 10:00 H8

Superconductivity in the turbostratically disordered misfit layered compounds $[(PbSe)_{1.10}]_m(NbSe_2)_n$ — •Corinna Grosse[1], Zachary Jones[2], Olivio Chiatti[1], Matti Alemayehu[2], David C. Johnson[2], and Saskia F. Fischer[1] — [1]Novel Materials, Humboldt-Universität zu Berlin, 10099 Berlin, Germany — [2]Department of Chemistry, University of Oregon, Eugene, OR 97401-3753, USA

The turbostratically disordered $[(PbSe)_{1.10}]_m(NbSe_2)_n$ misfit layered compounds, so called *ferecrystals*, are novel materials composed of alternatingly stacked superconductors and normal conductors. They allow us to study the effects of turbostratic disorder, layer thickness and stacking sequence on the electrical properties. Oosawa *et al.* [1] have observed superconductivity in $[(PbSe)_{1.10}]_m(NbSe_2)_n$ misfit layered compounds without turbostratically disordered structure. We carried out temperature-dependent in-plane resistivity measurements down to 300 mK on $[(PbSe)_{1.10}]_m(NbSe_2)_n$ ferecrystals as well as angle-dependent magnetotransport measurements and compare the results to the measurements in [1]. We observed resistive transitions to the superconducting state with critical temperatures below those reported in [1]. Critical currents were measured as a function of temperature for samples with different (m,n) values. Angle-dependent magnetoresistance measurements below T_c show that the in-plane resistance is anisotropic with regard to the direction of the external magnetic field.

[1] Y. Oosawa *et al.* Jpn. J. Appl. Phys. Vol. 31 (1992), L1096-L1099.

DS 28.4 Thu 10:15 H8

CVD-Like Growth Mechanism and 3D Nucleation in ZnO-TFTs Deposited by Pulsed Spray Pyrolysis — •Marlis Ortel and Veit Wagner — Research Center for Functional Materials and Nanomolecular Science, Jacobs University Bremen, Campus Ring 1, 28759 Bremen, Germany

Zinc oxide is a promising material for large area electronics due to high mobility and large area compatible deposition techniques. Proper film formation is crucial to obtain high quality layers. We investigate the growth and nucleation of zinc oxide thin films deposited by pulsed spray pyrolysis from aqueous zinc-precursor solution is investigated. The Leidenfrost effect was found to be a crucial mechanism during film growth since the Leidenfrost point has to be exceeded to form high quality layers. Furthermore, it is concluded that 3D nucleation of ZnO nano-crystals takes place out of the gaseous phase by a CVD-like process on ITO as well as on SiO2 substrates. Surface crystal orientation and roughness of the zinc oxide layer are found to be substrate dependent. These findings were utilized to optimize the deposition of the active layer in a zinc oxide thin film transistor (TFT) and investigate its semiconducting properties as degree of quality of the functional layer. Under optimized conditions the mobility was found to exceed 12cm2V-1s-1, the on-set was at 1V and the on-off current ratio was found to be higher than 108.

DS 28.5 Thu 10:30 H8

Modellierung des spektralen Reflexionsgrades verschiedener ITO Schichten nur mit Hilfe des Drude Modells — •Nadine Wolf, Daniel Gerstenlauer und Jochen Manara — Bayerisches Zentrum für Angewandte Energieforschung e.V., Würzburg

Um die Korrelation zwischen den elektrischen und den infrarotoptischen Eigenschaften von verschiedenen Zinn dotierten Indiumoxid (engl. tin doped indiumoxide, ITO) Schichten im infraroten Spektralbereich zu untersuchen, wurde der spektrale Reflexionsgrad vermessen und im nahen infraroten Spektralbereich analysiert. ITO stellt dabei das ideale Material dar um zu überprüfen, ob der gemessene Reflexionsgrad im NIR Bereich ausschließlich mit Hilfe des Drude Modells beschrieben werden kann, da die optischen und elektrischen Eigenschaften von ITO in erster Linie anhand der Freien-Elektronen-Theorie beschrieben werden können.

Die gemessenen spektralen Reflexionsgrade verschieden prozessierter ITO Schichten wurden anhand des Drude Modells gefittet, indem die Hochfrequenz-Dielektrizitätskonstante, die Streuzeit und der Quotient aus der Ladungsträgerdichte und der effektiven Masse der Elektronen über einen Least Square Fit angepasst wurden.

Es wird gezeigt, dass die erhaltenen Fitparameter konsistent sind, d.h. die Ladungsträgerdichte, die Streuzeit und die dielektrische Konstante der verschiedenen ITO Schichten verhalten sich zueinander wie erwartet und stimmen mit den Literaturwerten gut überein. Demzufolge ist es möglich die gemessenen Reflexionsgrade verschieden prozessierter ITO Schicht nur mit Hilfe der Drude Gleichungen zu fitten.

DS 28.6 Thu 10:45 H8

Transition levels of defects in $CuAlO_2$ — •Charles Patterson and Ciaran McNamee — School of Physics, Trinity College Dublin, Dublin 2, Ireland.

$CuAlO_2$ has been investigated as a potential p-type semiconducting oxide for transparent conducting oxide applications. The perfect crystal is a wide gap insulator and its p-type conductivity is believed to arise from V_{Cu} vacancy defects, which are abundant in $CuAlO_2$. We report calculations of defect formation energies and charge transition levels for V_{Cu}, V_O, V_{Al} vacancies, Cu_{Al} and Al_{Cu} substitutions and the Oi_i interstitial. Calculations are performed using a hybrid density functional theory (DFT) method. The electronic structure of each defect and charge state is investigated in detail. The V^-_{Cu}/V^0_{Cu} transition level is lower than that predicted in a previous hybrid DFT calculation and may be in better agreement with results from measurements

of carrier density versus temperature in $CuAlO_2$.

DS 28.7 Thu 11:00 H8

Systematic investigations of low energy ion beam sputtering of Si and Ag — •René Feder, Frank Frost, Horst Neumann, Carsten Bundesmann, and Bernd Rauschenbach — Leibniz-Institut für Oberflächenmodifizierung e.V,, Permoserstr. 15, 04318 Leipzig, Germany

Ion beam sputter deposition (IBD) provides intrinsic features which influence the properties of the growing film, because ion properties and geometrical process conditions generate different energy and spatial distribution of the sputtered and scattered particles.

A vacuum deposition chamber has been set up which allows ion beam sputtering of different targets under variation of geometrical parameters and of ion beam parameters to make a systematic analysis of the correlation between the properties of the ion beam, the properties of the sputtered and scattered particles, and the properties of the deposited films. A set of samples was prepared and characterized with respect to selected film properties, such as thickness and surface topography. The experiments indicate a systematic influence of the deposition parameters on the film properties. Because of this influence, the energy distribution of secondary particles was measured using an energy-selective mass spectrometer. Among others, experiments revealed a high-energetic maximum for backscattered primary ions, which shifts with increasing emission angle to higher energies. Experimental data are compared with Monte Carlo simulations done with the well-known TRIM.SP code.

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Coffee break (15 min)

DS 28.8 Thu 11:30 H8

Attenuation of coherent longitudinal acoustic phonons in free-standing gold-membranes — •Alexandra Frik[1], Mike Hettich[1], Oliver Ristow[1], Martin Grossmann[1], Axel Bruchhausen[2], Martin Schubert[1], and Thomas Dekorsy[1] — [1]Department of Physics and Center of Applied Photonics, University of Konstanz, 78457 Konstanz, Germany — [2]Instituto Balseiro & Centro Atomico Bariloche (CNEA), and CONICET, Argentina

The damping time of coherent longitudinal acoustic phonons in free standing gold membranes is measured by high speed asnchronous optical sampling (ASOPS) [1], a modified femtosecond pump probe spectroscopy method. We investigate the frequency dependence of the fundamental thickness mode lifetime by varying the membrane thickness. In addition, we study the influence of the surface roughness on the mode lifetimes. Temperature dependent measurements allow us to seperate the intrinsic damping mechanisms from surface contributions. The free-standing membranes were produced by thermal evaporating and where subsequently placed on a TEM-grid by a floating technique.

[1] A. Bartels Entwicklung von Femtosekundenlasern mit Repetitionsraten oberhalb 1 GHz und ihre Anwendungen Shaker Verlag Aachen, ISBN: 3-8265-8400-7 (2001)

DS 28.9 Thu 11:45 H8

Generation of a broadband acoustic frequency comb in the 100 GHz-range — •Martin Grossmann[1], Oliver Ristow[1], Mike Hettich[1], Chuan He[1], Reimar Waitz[1], Patricia Scheel[1], Axel Bruchhausen[2], Martin Schubert[1], Vitaly Gusev[3], Elke Scheer[1], and Thomas Dekorsy[1] — [1]Department of Physics, University of Konstanz, D-78467 Germany — [2]Instituto Balseiro & Centro Atómico Bariloche (CNEA), and CONICET, Argentina — [3]Institut des Molécules et Matériaux du Mans, UMR CNRS 6283, Université du Maine,France

Acoustic properties in the GHz frequency range are not very well understood for most semiconductors although intrinsic attenuation and scattering at interfaces of acoustic waves is of great interest for both fundamental and applied science. Additionally adhesion properties of very thin films are both hard to control and to evaluate. A thin Al/Si-membrane which is investigated by asynchronous optical sampling, a pump-probe technique, can be used to gain knowledge of these crucial properties. The cavity-like behavior for acoustic pulses of the membrane is used to generate a frequency comb in the 100 GHz range consisting of 24 eigenmodes. By analyzing the Fourier spectrum of the generated acoustic pulse we can evaluate the adhesion of the two layer system and by analyzing the individual reflected pulses, frequency dependent damping constants can be extracted for frequencies up to 300 GHz. Furthermore a frequency shift of the higher harmonics from the expected values given by the ground mode due to the two-layer system is measured.

DS 28.10 Thu 12:00 H8

Coherent phonon pump-probe spectroscopy on off-stoichiometric Co-doped NiMnGa films — •Martin Schubert[1], Jan Mayer[1], Mike Hettich[1], Hanjo Schäfer[1], Aleksej Laptev[1], Moritz Merklein[1], Chuan He[1], Martin Grossmann[1], Oliver Ristow[1], Yuansu Luo[2], Vitalyi Gusev[3], Jure Demsar[1], Mikhail Fonin[1], Konrad Samwer[1], and Thomas Dekorsy[1] — [1]Department of Physics, University of Konstanz, Germany — [2]Physikalisches Institut, Georg-August-Universität Göttingen, Germany — [3]Université du Maine, Le Mans, France

The shape memory alloy NiMnGa is characterized by a reversible and diffusionless structural transition from a high-temperature austenitic phase to a low-temperature martensitic phase, which can be induced by stress or temperature. We investigated the phase transition of off-stoichiometric NiMnGa thin films with and without Co-doping by asynchronous optical sampling (ASOPS), an ultra-fast optical pump-probe measurement technique. A wide range of different compositions is investigated by both cooling and/or heating the sample depending on the transition temperature. For all samples that were investigated, a distinct softening of the dominant acoustic phonon mode can be observed when the temperature of the sample approaches the phase transition temperature. Structural changes due to heating are not sufficient to explain the shift in frequencies. The softening is therefore linked to a strong electron-phonon interaction similar to that in a charge density wave (CDW) system. CDW haven't been observed in off-stoichiometric films but they have been measured in stoichiometric NiMnGa films.

DS 28.11 Thu 12:15 H8

Optical Properties and Wetting-like Behavior of Gallium Selenide Nanoflakes on Crystalline Carbon — •Raul D. Rodriguez[1], Alexander Villabona[1,2], Susanne Müller[1], Philipp Tonndorf[3], Rudolf Bratschitsch[3], Santos A. Lopez-Rivera[2], and Dietrich RT Zahn[1] — [1]Semiconductor Physics, Chemnitz University of Technology, Chemnitz, Germany — [2]Universidad de Los Andes, Laboratorio de Física Aplicada, Merida, Venezuela. — [3]Dynamics of Nanoscopic and Mesoscopic Structures, Chemnitz University of Technology, Germany

Two-dimensional (2D) materials have become the focus of research in recent years due to the remarkable physical properties observed in structures such as graphene. In this context, other 2D systems like gallium selenide and gallium sulfide have been investigated for a variety of applications from transistors to photodetectors. In this work we report on the study of the optical and the structural properties of high quality GaSe nanoflakes deposited on highly oriented pyrolitic graphite (HOPG). AFM observations show that GaSe layers adopt the morphology of the underlying carbon in a wetting-like behavior. Such strong interaction can be presumably attributed to van der Waals interaction non-screened in this system due to the high hydrophobicity of both substrates. Spatially resolved Raman and photoluminescence spectroscopies reveal a strong anisotropy on the edges and the stripe-like defects of the GaSe nanoflakes. It is found that GaSe regions with highest Raman activity and luminescence are located on crystal borders with a minor contribution from the basal crystal planes.

DS 28.12 Thu 12:30 H8

Strain analysis of CVD graphene — •Gerald V. Troppenz, Marc A. Gluba, Jörg Rappich, and Norbert H. Nickel — Helmholtz-Zentrum für Materialien und Energie GmbH

Biaxial compressive strain is induced in single layer CVD graphene grown on polycrystalline copper foil. It is generated during thermal quenching by the mismatch of thermal expansion coefficients of graphene and Cu. In situ Raman spectroscopy was used to study the phonon softening of graphene's 2D phonon mode during the transfer from Cu to thermal SiO_2. By determining the strain and stress sensitivities of the 2D phonon mode of biaxial compressed CVD graphene on Cu, we quantify the strain relaxation and the residual strain.

DS 28.13 Thu 12:45 H8

Transport properties of graphitized polymers — •Andreas Geworski, Yuri Koval, and Paul Müller — Department of Physics and Interdisciplinary Center for Molecular Materials, Universität Erlangen

We are able to convert a thin surface layer of polyimide into a graphite - like material by low-energy ion bombardment. We have found that the graphitized layer shows conductivities, which increase with the temperature of the polyimide during the ion irradiation process and which can reach more than 103 S/cm. The thickness of the graphitized layers is so low, that the films are rather transparent, which makes them interesting for carbon based optoelectronics. The optical properties were investigated in the wavelength range of 400nm-1100nm and compared to electrical measurements. The transition from insulating to semi metallic behavior already observed in the transport measurements appears in optical characterization, too. Standard interpretations like closing of an optical band gap are discussed.