DF 13: Thin Films and Nanostructures I

Time: Wednesday 14:40–17:00 Location: WIL B321

DF 13.1 Wed 14:40 WIL B321

Effects of microstructure on electric properties in $BiFeO_3$ – $RMnO_3$ thin films — •Claus-Henning Solterbeck, Abdelilah Lahmar, Salah Habouti, and Mohammed Es-Souni — Institute for Materials and Surface Technology, University of Applied Sciences Kiel, Germany

The interplay between structural and electric properties of $BiFeO_3$ (BFO) is not completely understood. For this comparative study, BFO thin films were grown by a sol-gel spin-coating method with incorporation of rare earth manganites ($RMnO_3$). The structure-property correlation is traced by several microscopic methods, but mainly with conductive-tip atomic force microscopy. For our non-epitaxial films, we investigate the effects of co-doping with RE-manganites on the local electric behaviour of the thin films, and we discuss it with respect to pure BFO.

DF 13.2 Wed 15:00 WIL B321

The influence of charged traps on leakage current through thin dielectric films — •Grzegorz Kozlowski, Jaroslaw Dabrowski, Piotr Dudek, Gunther Lippert, Grzegorz Lupina, and Hans-Joachim Müssig — IHP, Im Technologiepark 25, 15236 Frankfurt (Oder), Germany

We consider a problem of tunneling effect through a dielectric film with a certain distribution of charged traps inside. The transmission coefficient is calculated directly from the one dimensional stationary Schrödinger equation. Correction compensating the charge inhomogeneity in the film (charged defect) as well as the effect of image potential on a tunnelling carrier was included in the calculation. Since trap position in film determines the life time of carriers on a resonant state in defect, for traps in the bulk of the material a typical resonant tunneling takes place. On the other hand, as trap is moved towards the electrode (anode), the influence of resonant state on leakage becomes weaker. For defects in vicinity of anode, the effect of lowering the potential barrier due to the presence of charged defect is dominating and we observe the effective shortening of tunneling path. In this case a material can be treated as ideal film with a certain interface roughness. In order to reveal a typical behavior of all investigated mechanisms, additionally a detailed analysis of current in different regimes of applied voltage was performed. The results are compared with experimental data.

DF 13.3 Wed 15:20 WIL B321

Humidity effects on electrical properties and thickness of P(VDF-TrFE) films. — •Gennady Vizdrik, Björn Martin, and Herbert Kliem — Saarland University, Germany

By the Langmuir-Blodgett technique films of P(VDF-TrFE) with 30 and 50 transfers are deposited onto a glass substrate. The films with ellipsometrically determined thicknesses of 56 nm and 75 nm absorb water. Between 10% and 100% relative humidity (r.h.) of the atmosphere the thickness change is less than 2% in accordance with [1]. Using DC measurements at capacitor structures with aluminum electrodes of the area of 1x1 mm square it turns out that water desorption from the saturated state to the dry state takes place in less than 1000 sec. The electrical properties are changed drastically by the absorbed water. In dry samples we find true ferroelectric hysteresis loops, whereas in samples exposed to 100% r.h. a space charge polarization prevails. The remanent polarization is increased by a frequency dependent factor of up to 10. Measurements of the complex permittivity are carried out in the range $0.01\ \mathrm{Hz} < f < 1\ \mathrm{MHz}$. The imaginary part and the real part increase towards low frequencies. This increase is the more pronounced the higher the r.h. of the atmosphere is. A quantitative comparison of the measured DC conductivity with the permittivity confirms that a space charge polarization effect is responsible for the increase of the permittivity at low frequencies.

[1] P. A. Jacobson et al., App. Phys. Lett., 84, 88, 2004

DF 13.4 Wed 15:40 WIL B321

Electrical characterization of ferroelectric tunnel junctions with ferromagnetic electrodes — •Mario Disch[1], Adrian Petraru[1], Michael Hambe[2], Markus Heidelmann[1], Martina Luysberg[1], Falk Amthor[1], Rainer Waser[1], Nagarajan Valanoor[2], and Hermann Kohlstedt[1] — [1]Institut für Festkörperforschung, Forschungszentrum Jülich GmbH, Jülich, Germany — [2]School of Materials Science and Engineering, University of New South Wales, Sydney, Australia

Heterostructures of $SrTiO_3$(substrate)/$SrRuO_3$/$BaTiO_3$/$SrRuO_3$ and $NdGaO_3$(substrate)/$LaSr_{0.67}Mn_{0.33}O_3$/$PbZr_{0.2}Ti_{0.8}O_3$/$LaSr_{0.67}Mn_{0.33}O_3$ were grown by high pressure sputtering and pulsed laser deposition respectively. The $BaTiO_3$ was deposited as wedge-like films. The thickness gradient was determined by transmission electron microscopy and ranged from approximately 1.5 to 3.5 nm. X-ray diffraction indicated epitaxial and fully strained heterostructures. Tunnel junctions and ferroelectric capacitors were fabricated using optical lithography and ion beam etching. The ferroelectric capacitors showed displacement current down to a thickness of about 2 nm of the $BaTiO_3$. Current transport and tunnel magneto resistance were performed down to 10 K and the results will be discussed in the framework of the magneto electric interface effect.

DF 13.5 Wed 16:00 WIL B321

Conductive atomic force microscopy studies of leakage spot evolution in thin $(ZrO_2)_x(Al_2O_3)_{1-x}$-films. — •Dominik Martin[1], Oliver Bierwagen[2], Matthias Grube[1], Lutz Geelhaar[3], and Henning Riechert[3] — [1]namlab Gmbh, D-01187 Dresden — [2]University of California, Santa Barbara 93106 CA, USA — [3]Paul-Drude-Institut für Festkörperelektronik, D-10117 Berlin

In order to achieve at the same time a high dielectric constant and a low leakage current in thin films, an understanding of the charge transport mechanisms is necessary for materials that are inhomogeneous on the nanoscale. Conductive atomic force microscopy (CAFM) measurements on ultrathin $(ZrO_2)_x(Al_2O_3)_{1-x}$-films indicate a strong correlation between leakage spots and crystallites in an otherwise amorphous material. Regular local current-voltage curves were taken at amorphous matrix sites and local current-voltage curves were extracted from multiple images acquired at different biases. The comparison of hysteresis suggests stress induced leakage currents along filamentary leakage paths as well as charge trapping at grain boundaries. The overall local electronic behavior leads to the conclusion that leakage occurs preferably along boundaries between crystallites and the amorphous matrix and that leakage through grain boundaries is comparable to leakage currents through filamentary leakage paths formed by electrical stress.

DF 13.6 Wed 16:20 WIL B321

Study of C_{60} based films formation by NEXAFS — •Daniel Friedrich[1], Marcel Michling[1], Jolanta Klocek[1], Dieter Schmeisser[1], Stas Avdoshenko[2], Dmytro Chumakov[3], and Ehrenfried Zschech[3] — [1]Brandenburgische Technische Universität Cottbus, Angewandte Physik - Sensorik, Konrad-Wachsmann-Allee 17, 03046 Cottbus, Germany — [2]Department of Chemistry, M. V. Lomonosov Moscow State University, 1 Leninskie Gory, 119991 Moscow, Russian Federation — [3]AMD Fab36 LLC & Co. KG, Wilschdorfer Landstraße 101, 01099 Dresden, Germany

The C_{60} fullerenes and some of its -OH, $-CF_3$ and -Cl derivates are candidates for application as ultra-low-k insulators in the semiconductor industry. Future preparation of thin films based on these materials requires the stability of the substituted fullerenes against chemical handling and processing steps. The latter issue was addressed by our NEXAFS studies that were done by synchrotron radiation at the beam line U49/2-PGM2 at BESSY II. Performed were the C K-edge NEXAFS studies in total fluorescence and total electron yield modes. The C_{60} based films were deposited on silicon by spraying from solutions. The influence of the different substitutional groups with C_{60} molecules was studied. The data were compared to the reference spectra of a pure C_{60} film. For $C_{60}(OH)_{24}$, C_{60}-Cl_2 and $C_{60}(CF_3)_{12}$ a variance of the intensity of the π^*-resonance as well as shift to higher energies of 0.5 eV (-OH), 0.6 eV (-F), 0.7 eV (-Cl) were observed. The results confirm the necessary stability of the used C_{60} derivatives and shall be used for optimization of the film deposition chemistry and conditions.

DF 13.7 Wed 16:40 WIL B321

Design of nanostructures with maximal magnetoresistance using genetic algorithms — •daungruthai jarukanont — University of Kassel, Kassel, Germany

Spintronics, or spin electronics, involves the study of active control over spin degrees of freedom in solid-state systems. In the field of molecular-electronics, one attempts to make electronic devices using organic molecules. Traditionally these two areas have lived separate lives. Recently experiments have indicated a possible pathway towards their integration. In molecular-spintronics, the spin-polarized currents are carried through molecules, and these can affect the state of the molecule. We study the system of an organic molecule between two ferromagnetic electrodes. The calculations are based on the non-equilibrium Green's function and the Keldysh formalism for the tight-binding Hamiltonian. We show that organic spin valves can exhibit a bias-dependent magnetoresistance(MR). The magnitude of MR depends on the details of the molecules. These will allow us to suggest an appropriate choice for molecules for molecular-spintronics devices. However since the number of organic molecules that are available is enormous, it is currently very difficult to predict which molecules would be suitable for such devices. We perform a Genetic Algorithm to optimize the magnitude of MR and determine the appropriate molecular choices.