DF 6 Dielektrische und ferroelektrische dünne Schichten und Nanostrukturen II

Zeit: Montag 14:00–16:20 Raum: TU TC6

DF 6.1 Mo 14:00 TU TC6

Impact of the thermal annealing on $Pb(Zr_{0.3}Ti_{0.7})O_3$ thin film capacitors — •Jiang-Li Cao[1], A. Solbach[1], T. Weirich[2], J. Mayer[2], U. Böttger[3], P.J. Schorn[3], P. Gerber[3], R. Waser[3], and U. Klemradt[1] — [1]II. B Physikalisches Institut, RWTH Aachen — [2]Gemeinschaftslabor fuer Elektronenmikroskopie, RWTH Aachen — [3]Institut fuer Werkstoffe der Elektrotechnik 2, RWTH Aachen

The understanding of the physics of low dimensional ferroelectrics and the related engineering is of crucial importance for the full commercialization of ferroelectric random access memories and is enlightening for other ferroelectric thin film applications. In the present study, the effects of different annealing treatment on the $Pt/Pb(Zr_{0.3}Ti_{0.7})O_3$(PZT)/Pt/Ti oxide/$SiO_2$/Si capacitors with PZT prepared by chemical solution deposition were investigated by using atomic force microscopy and x-ray specular and diffuse reflectivity. A density decrease of the Pt bottom and top electrodes upon annealing was observed from fitting the specular reflectivity and further confirmed by diffuse reflectivity. Measurements of the electrical properties of the capacitors revealed a 12 percent reduction of the remanent polarization induced by the thermal treatment. Based on the results obtained, the effects of the thermal annealing on the multilayered structure and in turn the electrical properties of the capacitors will be discussed in correlation with the polarization change.

DF 6.2 Mo 14:20 TU TC6

Impact of electrode interfaces on epitaxial $Ba_{0.7}Sr_{0.3}TiO_3$ thin film capacitors — •Regina Dittmann[1], Rafael Plonka[2], Nikolay Pertsev[3], and Rainer Waser[1] — [1]Institut für Festk örperforschung and Center of Nanoelectronic Systems for Information Technology, Forschungszentrum Jülich, 52425 Jülich — [2]Institut f ür Werkstoffe der Elektrotechnik, RWTH Aachen University of Technology, 52056 Aachen — [3]A. F. Ioffe Physico-Technical Institute, Russian Academy of Sciences, 194021 St. Petersburg, Russia

We observed significant influence of the top-electrode material on the permittivity of $Ba_{0.7}Sr_{0.3}TiO_3$ (BST) thin-film capacitors epitaxially grown by pulsed laser deposition. For film thicknesses in the order of 100nm, $SrRuO_3$\BST\$SrRuO_3$ thin-film capacitors exhibit a sharp paraelectric-to-ferroelectric phase transition at 350 K with a maximum permittivity of about 6660 [1]. This value is comparable to that of bulk ceramics and exceeds by several times the highest values reported for BST thin film capacitors. The phase transition temperature of $SrRuO_3$\BST\Pt samples with comparable thickness is 60 K lower and the maximum permittivity is about 3 times lower than those of samples with $SrRuO_3$ top electrode. For $SrRuO_3$\ BST\$SrRuO_3$ samples, the transition temperature shifts to lower temperatures with decreasing film thickness, whereas the samples with Pt top electrodes exhibit an opposite trend. Experimental results are analyzed theoretically in the light of the depolarizing-field and strain effects on the transition temperature and permittivity.

[1] R. Dittmann et al. Appl. Phys. Lett. 83, 5011 (2003)

DF 6.3 Mo 14:40 TU TC6

Size effects in chromium doped $PbTiO_3$ nanopowders — •Emre Erdem[1], Rolf Böttcher[1], Anke Weller[2], H.-Jürgen Gläsel[2], Eberhard Hartmann[2], and Juras Banys[3] — [1]Institute of Experimental Physics II, University of Leipzig, Linnestr. 5, D-04103, Leipzig Germany — [2]Leibniz-Institute of Surface Modification, Permoserstr. 15, D-04318, Leipzig Germany — [3]Radiophysics Department, Faculty of Physics, Vilnius University, LT-10222 Vilnius, Lithuania

Lead titanate ($PbTiO_3$) nanopowders with mean particle sizes down to 10 nm were prepared from a metal-organic precursor through combined polymerisation and pyrolysis (CPP). Further reduction in particle diameter was achieved by soft milling. In delineating the structural changes which occur in correlation with size effects and size driven phase transition in $PbTiO_3$, dielectric (1 GHz - 1 MHz) and multi-frequency (9.5, 34.0 and 94.5 GHz) EPR measurements were carried out on chromium doped micro- and nanopowders. The size-dependent multi-frequency EPR spectra are discussed, the spin Hamiltonian parameters are determined and correlated with structural investigations and dielectric measurements.

DF 6.4 Mo 15:00 TU TC6

Self-assembled $SrZrO_3$ nanostructures epitaxially grown on $SrRuO_3$ — •Regina Dittmann, Enrique Vasco, Silvia Karthäuser, Jiaqing He, Chunlin Jia, and Rainer Waser — Institut für Festkörperforschung and Center of Nanoelectronic Systems for Information Technology, Forschungszentrum Jülich, 52425 Jülich

We investigated the possibility to grow self-assembled nanostructures of Cr-doped $SrZrO_3$ (SZO), which is a promising candidate for resistive switching non-volatile memories, by pulsed laser deposition. AFM-measurements with a conducting tip allow to identify SZO during its first growth stages on basis of the difference between the electrical conductivities of SZO and the $SrRuO_3$ (SRO) template layer. We are able to fabricate strain-induced SZO nanodots on SRO films grown on vicinal $SrTiO_3$ in a step flow growth mode. In a second approach, we used a nanopatterned SRO ripple pattern as template, which is created by self-organization in a step-flow inhibited regime employing surface modified $SrTiO_3$ substrates [1]. In that case, we observe the formation of regular dielectric SZO nanowires separated by deep and narrow boundaries that extend up to the conductive buffer layer. The switching properties of SZO nanodots and nanowires are investigated by AFM with a conducting tip.

[1] E. Vasco et. al, accepted for publication in Advanced Materials

DF 6.5 Mo 15:20 TU TC6

Ti-doping of Pr silicate layers for high-k dielectrics applications — •Grzegorz Lupina[1], Thomas Schroeder[1], Jarek Dabrowski[1], Dieter Schmeisser[2], and Hans-Joachim Muessig[1] — [1]IHP, Im Technologiepark 25, D-15236 Frankfurt (Oder) — [2]BTU Cottbus, PF 101344, D-03013 Cottbus

Near-term downscaling of the metal-oxide-semiconductor field-effect transistors (MOSFETs) requires the replacement of the SiO2 gate oxide with a material having a higher dielectric constant. Recent studies indicate that silicate materials are the most promising candidates; among them are Pr silicates. Applying a combination of x-ray photoelectron spectroscopy (XPS), electrical measurements (C-V), and ab initio calculations, we investigated the effect of thin Ti doping on the structural and electrical properties of the gate stacks composed of a Pr silicate film and a SiO2-based interfacial buffer layer. Metallic Ti was deposited at room temperature after the formation of the Pr silicate dielectric. The resulting layered structures were annealed under ultra-high vacuum (UHV) at various temperatures between 70°C and 880°C. XPS indicates that the evaporated layer preserves its metallic character over the whole range of UHV annealing temperatures. Synchrotron radiation XPS at BESSY II shows that large amounts of Ti atoms incorporated into the Pr silicate remain metallic even after air exposure at room temperature. Annealing in nitrogen ambient at 300°C leads to the oxidation of these atoms so that a mixed Pr:Ti silicate is formed. We show that the so formed dielectrics exhibit an improved equivalent oxide thickness and a reduced density of interface states.

DF 6.6 Mo 15:40 TU TC6

High Performance PrTiO3-x MIM Capacitors for RF Applications — •Christian Wenger, Roland Sorge, Anil Mane, Thomas Schröder, Gunther Lippert, and Hans-Joachim Müssig — IHP Microelectronics, Im Technologiepark 25, 15236 Frankfurt (Oder)

Metal-insulator-metal (MIM) capacitors with amorphous PrTiO3-x high-k dielectric films have been investigated. The MIM capacitors with 5 nm PrTiO3-x show very high capacitance densities of 15 fF/mm2. As well as the capacitance density and the voltage coefficient of capacitance (VCC) decreases with increasing dielectric thickness. Optimized MIM capacitors with 20 nm thickness provide high capacitance density and low VCC values within the thermal budget of back end processes.

DF 6.7 Mo 16:00 TU TC6

Modes in circular photonic crystal cavities and local density of states — •Javad Zarbakhsh[1], Jiri Chaloupka[2], and Kurt Hingerl[1] — [1]Christian Doppler Labor fuer Oberflaechenoptische Methoden, Institut fuer Halbleiter und Festkoerperphysik, Universitaet Linz, A-4040 Linz, Austria — [2]Department of Solid State Physics, Institute of Condensed Matter Physics, Faculty of Science, Masaryk University, Kotlarska 2, CZ-61137 Brno, Czech Republic

The penetration depth of light in the band gap is of the order of lattice constant of a photonic crystal, novel structures such as circular photonic crystals (CPC) confine light. By using the photonic local density of states (LDOS) components in a CPC, the eigenfrequencies of localized cavity modes can be efficiently found. Applying the Bloch-Floquet theorem in such a rotationally symmetric case leads to a decomposition of the Green's tensor. Decomposed LDOS shows sharp resonance peaks which correspond to cavity modes. We demonstrate that our method can be a valuable tool to design circular photonic crystal nanodevices.