SYFS 2 Ferroelectric and dielectric memories

Zeit: Samstag 14:45–15:45 Raum: TU HE101

Hauptvortrag SYFS 2.1 Sa 14:45 TU HE101

Nanoscopic control of the polarization in ferroelectric thin films — •J.-M. Triscone[1], P. Paruch[1], T. Tybell[2], N. Stucki[1], M. Dawber[1], and T. Giamarchi[1] — [1]DPMC, University of Geneva, 24 Quai E.-Ansermet, 1211 Geneva 4, Switzerland — [2]NTNU, Trondheim, Norway

Ferroelectric memories take advantage of the non-volatile reversible nature of the ferroelectric polarization. In this work, we combine high quality materials, epitaxial atomically smooth ferroelectric perovskite films, and atomic force microscopy (AFM) to control and modify the ferroelectric domain structure at nanoscale. This approach allows new fundamental studies of ferroelectrics at nanoscale and might be a way to develop ultra-high density non-volatile memories. In ferroelectric $Pb(Zr_{0.2}Ti_{0.8})O_3$ thin films, a metallic AFM tip was used as a local electric field source to study individual nanoscale ferroelectric domains. Control of domain size was achieved by varying the strength and duration of the voltage pulses used to polarize the material, permitting the creation of sub-20nm wide lines and ultra-high density arrays reaching ∼30 Gbit/cm^2. The AFM approach developed also allowed us to investigate switching dynamics in ferroelectric thin films. Our data suggest a two step process of domain growth, in which initial nucleation under the AFM tip is followed by radial domain wall motion, perpendicular to the polarization direction. The electric field dependence of the domain wall velocity demonstrates that this motion is a creep process.

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First-principles theory of interfacial electronic structures and energy barriers in electroceramic thin-film devices — •Christian Elsässer[1], Matous Mrovec[1], Jan-Michael Albina[1], and Bernd Meyer[2] — [1]Fraunhofer-Institut für Werkstoffmechanik IWM, Wöhlerstr. 11, 79108 Freiburg — [2]Lehrstuhl für Theoretische Chemie, Ruhr-Universität, Universitätsstr. 150, 44780 Bochum

Nanostructured thin-film devices on the basis of electroceramic perovskite-type oxides have very promising structural, physical and chemical properties for highly integrated functional components, e.g., in computer technology, like high-density dynamic random access memory (RAM) made of $(Ba,Sr)TiO_3$, or novel non-volatile ferroelectric $Pb(Zr,Ti)O_3$ RAM devices. Critical issues in such systems are the interfacial structure, adhesion and electrical barriers at the contacts of the electroceramic thin films to conducting electrodes (e.g., Pt, $SrRuO_3$), and to insulating substrates (e.g., $SrTiO_3$, $LaAlO_3$).

First-principles electronic-structure calculations, by density functional theory and the mixed-basis pseudopotential method, were carried out to analyse interfacial Schottky barriers and band offsets at planar and coherent perovskite/metal and perovskite/perovskite contacts. Influences of different electrode materials, varying chemical film compositions and interface terminations on the interfacial energy barriers will be discussed.

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Resistive switching in $Ba_{0.7}Sr_{0.3}TiO_3$ thin films — •Rob Oligschlaeger[1], Silvia Karthäuser[2], Regina Dittmann[2], Kristof Szot[2], Rene Meyer[2], and Rainer Waser[1,2] — [1]Institut für Werkstoffe der Elektrotechnik 2, RWTH Aachen University, Germany — [2]CNI, Dept. IFF, Research Center Jülich, Germany

Recently, resistive switching of dielectric perovskite-type thin films has attracted a lot of attention in view of its potential for non-volatile information storage in future generation high speed random access memories [1]. We investigated resistive switching of capacitor-like thin film structures of $Ba_{0.7}Sr_{0.3}TiO_3$ (BST), prepared by pulsed laser deposition. $SrRuO_3$ (SRO) grown on (001) oriented $SrTiO_3$ substrates was used as bottom electrode. Pt top electrodes were deposited by sputtering. Electrical measurements show stable hysteretic behaviour in the current-voltage curve. Positive or negative voltage pulses are employed to switch the resistance of the oxide films between a low- and a high-impedance state. The temperature dependence of the current in both states was determined. Read-write measurements over 10^4 cycles show some fatigue in the resistance states. Utilizing different write voltages for the pulses we achieved stable multilevel switching of the resistance. We will discuss the dopant dependence and the potential physical mechanism of the switching phenomena.

[1] A. Beck, J. G. Bednorz, Ch. Gerber, C. Rossel and D. Widmer, Appl. Phys. Lett. 77, 139 (2000)