DS 20: Application of Thin Films

Time: Tuesday 10:15–12:15 Location: GER 38

DS 20.1 Tue 10:15 GER 38

Thin isolators consisting of aluminum oxide and self-assembled monolayers for tunnel diodes — •Andreas Hochmeister[1], Mario Bareiss[1], Ute Zschieschang[2], Hagen Klauk[2], Bernhard Fabel[1], Giuseppe Scarpa[1], and Paolo Lugli[1] — [1]Institute for Nanoelectronics, TU München — [2]Max Planck Institute for Solid State Research, Stuttgart

We present a fabrication method and results of the electrical characterization of metal-oxide-metal (MOM) tunnel diodes. Two different materials (aluminum and gold) were used as metals to produce an asymmetric diode, which can act as a rectifier, e.g. for infrared antenna applications. First an aluminum line was evaporated on a SiO_2/Si substrate through a shadow mask. The dielectric (aluminum oxide) was produced by oxidation using a RIE treatment; the diode was completed by a second evaporation step of gold lines perpendicular to the aluminum line. Gold pads were used for having a better contact during electrical characterization. We could show that by adding a layer of phosphonic acid self-assembled monolayer (SAM) on the isolating aluminum oxide film before the gold evaporation, the effective thickness of the insulator could be tailored. The thickness of the aluminum oxide is approximately 3nm, which could be controlled to 4-6 nm by the additional layer of SAM. Electrical characterization was performed by dc I-V measurements. At high electric fields Fowler-Nordheim tunneling and dielectric breakdown was observed.

DS 20.2 Tue 10:30 GER 38

The influence of the crystallinity of TiO_2 on the resistive switching behavior of memristor devices — •Hannes Mähne[1], Stefan Slesazeck[1], Stefan Jakschik[1], and Thomas Mikolajick[1,2] — [1]NaMLab gGmbH, Dresden, Germany — [2]Institut für Halbleiter und Mikrosystemtechnik, TU Dresden, Germany

Since 1970, Chua postulates the existing of a memristor and HP found the first device in 2008, a lot of research has been done. Several research groups using successfully titanium oxide without detailed understanding of the switching mechanism. The following work fill a gap of information and create a link between the crystalline structure of TiO_2 and its switching parameters. In this work used structure consists of Si substrate with thermally grown SiO_2 and deposited Ti as adhesion layer before Pt was sputtered as an inert bottom electrode. After deposition of TiO_2, by RF sputtering from a TiO_2 target with additional 2 sccm O_2, the material is in an amorphous phase. To get different phases the samples are annealed in a RTP oven at 500°C and 700°C in Ar atmosphere and with O_2. The top electrode material was evaporated aluminum. To create a temperature stable bottom electrode, several bottom layer stacks are tested and results in a thick Pt layer on a preoxidized Ti adhesion layer. Otherwise the bottom electrode becomes damaged. A reason for this behavior is that thin Pt becomes crystalline and holes are created. Next to this, temperatures above 700°C causes cracks in the TiO_2 films. The change in crystallinity results in a change from a oxygen migration like switching in amorphous to a filament like switching behavior in the crystalline samples.

DS 20.3 Tue 10:45 GER 38

Coexistence of filamentary and homogeneous resistive switching in Fe-doped $SrTiO_3$ thin film memristive devices — Ruth Münstermann[1], •Regina Dittmann[1], Tobias Menke[1], Ingo Krug[1], Daesung Park[2], Joachim Mayer[2], and Rainer Waser[1,3] — [1]Peter Grünberg Institut, Research Centre Jülich — [2]Central Faculty for Electron Microscopy, RWTH Aachen — [3]Institut fuer Werkstoffe der Elektrotechnik 2, RWTH Aachen

Resistive switching phenomena which are observed in many transition metal oxides are under consideration for future non-volatile memories (so called memristive devices). We used conductive-tip AFM combined with a delamination technique to remove the top electrode of Fe-doped $SrTiO_3$ memristive devices to gain insights into the active switching interface. We observed that resistive switching in Fe-doped $SrTiO_3$ thin films can be either confined to a single strong filament or distributed over larger areas beneath the electrode, in the ideal case the whole junction area. Both types of switching coexist in one and the same sample and exhibit the opposite switching polarity. Combining our electrical date with PEEM and HRTEM analysis, we discuss the nature of the observed switching phenomena.

DS 20.4 Tue 11:00 GER 38

AlN-based microstructures for biocompatible piezo-generation — •Nicola Heidrich[1,2], Fabian Knöbber[1,2], Vadim Lebedev[1], Ram Ekwal Sah[1], Oliver Ambacher[1,2], and Volker Cimalla[1] — [1]Fraunhofer-Institute for Applied Solid State Physics, Freiburg, Germany — [2]Department of Microsystems Engineering, University of Freiburg, Germany

The aim of this work is to fabricate a biocompatible micro-generator using aluminium nitride (AlN) as piezoelectric material to supply implantable sensors sufficiently with energy, rendering batteries and external power supplies unnecessary. Membranes made from AlN- thin films and silicon nitride (SiN), with diameters of 0.8 to 3 mm were investigated with respect to their material properties, resonant behaviour and power-output in different environments, using internal piezoelectrical and external mechanical excitation of the membranes. The out-of-plane displacement of the surfaces was measured by a laser Doppler vibrometer (LDV) with a precision below 1 pm. It goes to show that tensile stressed membranes almost only generate power at their resonant frequencies well above 50 kHz, while compressive stressed (corrugated) membranes are capable of responding effectively to excitation in the low frequency range, being an appropriate solution for energy harvesting from random body movement. Compared to a single corrugated membrane the peak generated power is increased by almost three orders of magnitude with a 3x4 array of serial and parallel connected membranes.

DS 20.5 Tue 11:15 GER 38

Nanoscaled photoelectron ionisation detector based on lanthanum hexaboride — •Cordula M. Zimmer[1], Jürgen Schubert[2], Ulrich Kunze[1], and Theodor Doll[3] — [1]Werkstoffe u. Nanoelektronik, Ruhr-Universität Bochum, Germany — [2]Institute of Bio- and Nanosystems (IBN-1), Forschungszentrum Jülich, Germany — [3]Institut für Physik, Johannes-Gutenberg Universität Mainz, Germany

In this work the development of a nanoscaled photo ionisation detector is presented, whose functionality is based on the photoelectric effect of lanthanum hexaboride (LaB_6) thin films. Photoemitted electrons will be brought up to energies of 7 to 18 eV within a nano-electrode arrangement, which does not exceed the mean free path of molecules at 10^5 Pa (70 to 110 nm). This enables the ionising and sensing of specific gases such as hydrocarbons, solvents, organic and inorganic substances under ambient conditions without the risk of molecule fragmentation. The yield of photoelectron current emitted under ultraviolet (UV) irradiation was optimised by tuning the work function of the LaB_6 films. The proper choice of the substrate material and/or the deposition of additional interlayers is important to establish a favourable crystal orientation and stoichiometry of the LaB_6 film which lowers its work function.

DS 20.6 Tue 11:30 GER 38

Characterization of ITO films on fluorescent borate glasses — •Franziska Steudel[1], Nico Teuscher[2], Susanne Richter[1], Andreas Heilmann[2], Christan Hagendorf[1], Paul-Tiberiu Miclea[1,3], and Stefan Schweizer[1,4] — [1]Fraunhofer Center for Silicon Photovoltaics, Walter-Hülse-Str. 1, 06120 Halle (Saale) — [2]Fraunhofer Institute for Mechanics of Materials, Walter-Hülse-Str. 1, 06120 Halle (Saale) — [3]Institute of Physics, Martin Luther University of Halle-Wittenberg, Heinrich-Damerow-Str. 4, 06120 Halle (Saale) — [4]Centre for Innovation Competence SiLi-nano®, Martin Luther University of Halle-Wittenberg, Karl-Freiherr-von-Fritsch-Str. 3, 06120 Halle (Saale)

For photovoltaic applications, the cover glass is one of the key products in solar modules. For high efficiency modules, it would be advantageous to use the glass not only as a cover but also as a down-converter. Samarium-doped borate glasses, for instance, convert the incident violet and blue part of the solar spectrum to visible red light which is more efficiently absorbed by the solar cell. The chemical composition of borate glasses consists of boron oxide as a network former and metal oxides as network modifiers. In this work, borate glasses with different network modifiers were prepared and used as substrates for the depo-

sition of a conductive indium tin oxide (ITO) film. The deposition is done by magnetron sputtering at room temperature. To understand the electrical and optical properties of the deposited ITO films the diffusion of the glass components into the films is studied by time of flight secondary ion mass spectrometry (ToF-SIMS).

DS 20.7 Tue 11:45 GER 38

A-periodic multilayer development for attosecond pulses in the 300-500 eV photon energy range — Alexander Guggenmos[1,2], Michael Hofstetter[1,2], Roman Rauhut[1], and •Ulf Kleineberg[1,2] — [1]Fakultät für Physik, Ludwig-Maximilians-Universität München, Garching, Germany — [2]Max-Planck-Institut für Quantenoptik, Garching, Germany

The development of ultrafast X-ray pulses in the sub-femtosecond time regime is a cutting edge technology for studying electron dynamics in atoms, molecules or solid surfaces / nanostructures by means of pump/probe electron spectroscopy. XUV elements as multilayer mirrors and thin metal filters are used to filter and shape attosecond bursts from high harmonic radiation. One near future goal is to extend the current technology to higher photon energies, reaching the water window range around 300 - 500 eV, where the in-vitro investigation of bio-materials on ultra-short time scales becomes possible. Following the ideas of nowadays experimental setups, both the spectral and the temporal resolution can be determined and guided by means of periodic and a-periodic multilayer mirrors, allowing for spectral and temporal soft X-ray pulse shaping. We will present first investigations of periodic and a-periodic multilayer XUV optics in that energy range of 300-400 eV and discuss their applications for filtering single attosecond pulses from High Harmonic radiation. Simulations and optimizations of various binary and ternary multilayer material systems as well as first experimental results achieved by Ion Beam Deposition and insitu-ellispometry of the deposited nanolayers are demonstrated.

DS 20.8 Tue 12:00 GER 38

Ultra fast electrochromic switching of nanoporous tungsten-tantalum oxide films — •Robin Kirchgeorg, Steffen Berger, and Patrik Schmuki — Institute for Surface Science and Corrosion (LKO), Department Material Science and Engineering, Friedrich-Alexander-Universität Erlangen-Nürnberg, Martensstraße 7, 91052 Erlangen, Germany

Self-organized anodic oxide nanostructures have attracted remarkable scientific interest within the last decades. Due to their unique properties, the applicability of these materials were explored in numerous applications, such as in electrochromic devices. The benchmark for electrochromic materials nowadays is WO_3. However, these anodically fabricated WO_3 electrodes still lack cycling stability and performance. Recent results on anodic oxides grown on TiW, TiMo and TiNb alloys indicate a significant enhancement of the stability by the formation of oxide composites, but with the fundamental electrochromic properties being considerably poorer than for pure WO_3. Self-organized nanoporous oxide layers on a W-Ta alloy grown by anodization in a flouride containing electrolyte, show drastically enhanced electrochromic properties combined with high cycling stability. These self-organized, nanostructured, mixed oxide layers show an ultra-fast electrochromic switching behaviour. Up to more than 10 times higher switching frequencies are reached along with a significantly enhanced lifetime and cyclability. The presentation will provide a comparison of anodically selforganized nanostructures of WO_3 and a W-Ta alloy, regarding their electrochromic properties and cycling stability.