# DS 27: Thin film characterization: structure analysis and composition (post growth analysis XRD, etc..)

Time: Wednesday 16:30–17:30 Location: H 2032

DS 27.1 Wed 16:30 H 2032

**Molecular beam epitaxy of Ge-Sb-Te thin films on Si substrates** — •Alessandro Giussani[1], Perumal Karthick[1], Peter Rodenbach[1], Michael Hanke[1], Wolfgang Braun[1,2], Raffaella Calarco[1], and Henning Riechert[1] — [1]Paul Drude Institut für Festkörpelektronik, Hausvogteiplatz 5-7, 10117 Berlin — [2]CreaTec Fischer Co. GmbH, Industriestr. 9,74391 Erligheim, Germany

Owing to their phase-change properties, Ge-Sb-Te thin films, i.e., Ge2Sb2Te5 (GST), are being intensively studied for new concepts of non-volatile memory. The deposition technique commonly employed is sputtering, leading to poly-crystalline layers. Here it is shown that molecular beam epitaxy allows for the preparation of highly ordered Ge-Sb-Te films even on strongly lattice-mismatched substrates like Si. In situ reflection high-energy diffraction and quadrupole mass spectrometry are utilized to monitor the growth process in real time. Ex situ x-ray diffraction, atomic force microscopy and secondary electron microscopy, and x-ray fluorescence are used to investigate the structural properties, the surface morphology, and the stoichiometry of the grown films, respectively. As main result, single crystalline GST layers can be achieved on Si(111) substrates with epitaxial relationships GST[111]//Si[111] and GST<-110>//Si<1-10> in the growth direction and in-plane, respectively. The growth on Si(001) instead produces (111)-oriented films with weak texture. GST thin films with a high structural order are expected to exhibit superior electrical/switching properties to the poly-crystalline layers deposited by sputtering.

DS 27.2 Wed 16:45 H 2032

**Structural properties of MBE-grown $Bi_2Se_xTe_{3-x}$ layers** — •Steffen Schreyeck[1], Christian Kehl[1], Nadezda V. Tarakina[1], Tanja Borzenko[1], Claus Schumacher[1], Grzegorz Karczewski[2], Jean Geurts[1], Karl Brunner[1], and Laurens W. Molenkamp[1] — [1]Universität Würzburg, Experimentelle Physik III, Würzburg, Germany — [2]Institute of Physics, Polish Academy of Sciences, Warsaw, Poland

$Bi_2Se_xTe_{3-x}$ ($V_2VI_3$) alloy layers, a material system with topological insulator (TI) properties, were grown by molecular beam epitaxy on H-passivated Si(111) at $T_S$=300°$C$. We varied the Se-flux at constant Bi- and Te-flux to obtain $Bi_2Se_xTe_{3-x}$ samples with $x$ ranging from 0 to 3 (flux ratio $\frac{VI}{V}$ from 24 to 65). The crystal forms quintuple layers (QLs) VI(2)-V-VI(1)-V-VI(2), with Van-der-Waals bonds between the QLs. The streaky RHEED patterns, TEM and high-resolution X-ray diffraction (HRXRD) show good crystal quality for all compositions. The Se content $x$ was determined by HRXRD assuming validity of Vegard's law. A comparison of flux ratios yield a highly preferred incorporation of Se rather than Te. Lattice dynamics was analysed by Raman spectroscopy from the even-symmetry optical phonon modes $E_g(2)$, $A_{1g}(1)$ and $A_{1g}(2)$. The mode frequencies are essentially determined by the atomic masses in the VI(2) positions and by the V-VI bonding forces. The essentially constant mode frequencies for Se-content $x$ between 0 and 1 strongly indicate a preferential incorporation of Se in the VI(1) position, which is not involved in the vibrational motion, i.e. the realisation of an ordered $Bi_2SeTe_2$ phase (Te-Bi-Se-Bi-Te).

DS 27.3 Wed 17:00 H 2032

**X-ray Resonant Reflectivity study of Transition Metal Oxides** — •Sebastian Macke[1], Jorge Hamann-Borrero[2], Abdullah Radi[3], Ronny Sutarto[4], George Christiani[1], Gennady Logvenov[1], George Sawatzky[3], Bernhard Keimer[5], and Vladimir Hinkov[1] — [1]Max-Planck-UBC Centre for Quantum Materials, Vancouver, Canada — [2]Leibniz Institute for Solid State and Materials Research Dresden, Dresden — [3]University of British Columbia, Vancouver, Canada — [4]Canadian Light Source, Saskatoon, Canada — [5]Max Planck Institute for Solid State Research, Stuttgart

X-ray resonant reflectometry (XRR) is the ideal tool to study the depth resolved and element-specific electronic structure of multilayer films. Besides of the structural parameters of the thin film like thickness and roughness one is sensitive to the optical constants which includes effects like magnetic profiles, element density profiles, electronic reconstruction [1] and strain effects. By changing angle, energy and polarization of the incoming beam reflectivity maps can be measured leading in principle to an accurate picture of the depth resolved electronic states of thin films. Due to the complex physics of reflectometry this measurement method needs sophisticated tools to analyze the results quantitatively. In this work the issues arising with this method are addressed and discussed. It can be shown by fitting a simple system of a one layer system of PrNiO3 grown on an LSAT substrate that one can obtain from the maps the optical constants of the layers and the element specific density profiles.

[1] E. Benckiser et. al., Nature Materials 10, 189 (2011)

DS 27.4 Wed 17:15 H 2032

**Growth of lead-free piezoelectric thin films of 0.92 ($Bi_{0.5}Na_{0.5}TiO_3$)-0.8 $BaTiO_3$ (BNT-BT) by pulsed laser deposition** — •Mehrdad Baghaie Yazdi, Christian Bausch, Torsten Granzow, Wook Jo, and Lambert Alff — Technische Universität Darmstadt, Darmstadt, Deutschland

Pulsed laser deposition (PLD) is one of the most versatile methods for growing complex oxide thin films. We have investigated the growth of the lead free piezoceramic BNT-BT (0.92 ($Bi_{0.5}Na_{0.5}TiO_3$)-0.8 $BaTiO_3$). By adjusting the growth conditions, it was possible to grow a multitude of different phases out of a single phase BNT-8BT polycrystalline target. All epitaxial films were grown on (100) $SrTiO_3$ substrates, then reproduced on conducting STO:5%Nb to be used as bottom electrode. These thin films were studied by various X-ray diffraction methods and electrical properties were determined using a custom thin film measurement set-up.