DS 11: Thin Film Characterisation: Structure Analyse and Composition (XRD, TEM, XPS, SIMS, RBS, ...)

Time: Tuesday 9:30–11:30 Location: H 2013

DS 11.1 Tue 9:30 H 2013

New possibilities in high sensitivity Low Energy Ion Scattering (LEIS) for probing the outermost atomic layer — •Thomas Grehl[1], Ewald Niehuis[1], Rik ter Veen[2], and Hidde Brongersma[2] — [1]ION-TOF GmbH, Heisenbergstr. 15, 48149 Münster, Germany — [2]Calipso BV, Den Dolech 2, 5612 AZ Eindhoven, The Netherlands

With a recently developed high sensitivity Low Energy Ion Scattering (LEIS) instrument, a range of new applications arises for this extremely surface sensitive analytical technique. Known capabilities of LEIS are the selective characterisation and quantification of the atomic composition of the outermost atomic layer, i. e. precisely the atoms that control properties like catalytic performance, adhesion, wetting, corrosion, etc.

New possibilities such as surface imaging, sputter as well as non-destructive (static) profiling and even higher sensitivity for light elements have been added. The energy range of the primary ion source of up to 8 keV allows an improved mass resolution, thus enabling a better separation of the heaviest elements. In addition, a time-of-flight filter dramatically improves the detection limit for light elements. This filter suppresses the signal arising from sputtered ions, while scattered ions reach the detection system unhindered.

In this contribution, we show the utilization of these new capabilities to a range of samples and applications. Furthermore, we will show how LEIS can benefit from the combination with the complementary technique Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS), which adds ppb - ppm sensitivity, lateral resolution of 100 nm and chemical information.

DS 11.2 Tue 9:45 H 2013

Non-destructive probing of the chemical state of buried TiO_x nanolayers — •Beatrix Pollakowski[1], Burkhard Beckhoff[1], Stefan Braun[2], Peter Gawlitza[2], Falk Reinhardt[1], and Gerhard Ulm[1] — [1]Physikalisch-Technische Bundesanstalt, Abbestr. 2-12, 10587 Berlin — [2]Fraunhofer Institut Werkstoff- und Strahltechnik, Winterbergstr. 28, 01277 Dresden

Near edge x-ray absorption fine structure (NEXAFS) in combination with grazing incidence x-ray fluorescence (GIXRF) analysis provides a good approach for a depth-sensitive characterization of buried nanolayers with respect to both elemental composition and speciation. This idea offers the specific advantage of a high tunability of the information depth. The GIXRF regime implicates the occurrence of the x-ray standing waves (XSW) field above, at and below the surface affecting directly influence on the total fluorescence yield (TFY). The XSW field and the resulting mean information depth are dependent on incident angle and photon energy. The variation of the photon energy during a NEXAFS study requires to correct the incident angle to keep the mean information depth constant. The sample system consists of several 30 nm Ti nanolayers oxidized to different extents and being buried below 5 nm C. The results of angular corrected Ti $L_{3,2}$ NEXAFS spectra exhibit an electronic structure presumably comparable to that measured in total electron yield (TEY) and confirm the potential of this method. GIXRF-NEXAFS provides a complementary approach to different non-destructive techniques based on electron detection, which can reach their limits for deeply buried thin layers.

DS 11.3 Tue 10:00 H 2013

100% epi-Ge layers on engineered oxide heterostructures on Si — •Peter Rodenbach[1], Alessandro Giussani[1], Jose Ignacio Pascual[2], Dorin Geiger[3], Hannes Lichte[3], Peter Storck[4], and Thomas Schroeder[1] — [1]IHP Microelectronics, Im Technologiepark 25, 15236 Frankfurt Oder — [2]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin — [3]Technical University Dresden, Zellescher Weg 16, 01062 Dresden — [4]Siltronic AG, Hans-Seidel-Platz 4, 81737 München

Gallium-arsenide is a promising candidate for photo-voltaic systems due to its high efficiency factor, but has been reserved to space applications, owing this fact to the tremendous production costs. By providing an affordable Ge layer as a GaAs substrate, this technology might take a big step towards terrestrial use. Our group chose a 100% Ge on insulator technology approach, by epitaxially grown Ge epilayers on engineered oxide heterostructures on top of the Si(111) material system. In this case a cubic praseodymium-oxide buffer film is utilized. The MBE grown heterostructure has been examined by in-situ RHEED and ex-situ XRR, which both prove the smoothness of the closed (111)-oriented Germanium epi-layer. Furthermore the determination of the structural composition by GIXRD and XRD pole-figures show the single-crystalline and twin-free A-B-A stacking nature of the Si(111)-Pr oxide-Epi-Ge(111) system. In addition the defect behaviour, especially stacking faults, is discussed based on the results obtained by TEM.

DS 11.4 Tue 10:15 H 2013

Lattice engineering of dielectric heterostructures on Si by isomorphic oxide - on - oxide epitaxy — •Andreas Wilke[1], Olaf Seifarth[1], Ioan Costina[1], Rakesh Sohal[1], Peter Zaumseil[1], Jose Ignacio Pascual[2], Peter Storck[3], and Thomas Schroeder[1] — [1]IHP Microelectronics, Im Technologiepark 25, 15236 Frankfurt Oder — [2]Institut für Experimentalphysik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin — [3]Siltronic AG, Hans-Seidel Platz 4, 81737 München

We are examining a new mixed oxide buffer system for the integration of functional semiconductors via heteroepitaxy on the Si (111) material platform, namely the flexible isomorphic oxide - on - oxide epitaxy approach of Y2O3 on cubic Pr2O3 with the ability to tune the buffer lattice constant. Our GI-XRD measurements prove the growth of high quality single crystalline Y2O3 on the cubic Pr2O3 (111) / Si (111) support system. Depth profiling X-ray diffraction shows that the growth mechanism of Y2O3 on cubic Pr2O3 is determined by the formation of a transition layer with variable lattice parameters, either due to strain or due to an interface reaction. In order to elucidate this question, in-situ XPS, UPS and RHEED measurements were applied.

DS 11.5 Tue 10:30 H 2013

ToF-SIMS Analysis of thin $Al_{1-x}Si_xO_y$ layers — •Pawel Michalowski[1], Gert Jaschke[2], Jens Steinhoff[2], and Steffen Teichert[2] — [1]Fraunhofer Center Nanoelektronische Technologien, Dresden — [2]Qimonda, Dresden

Recent interest in manufacturing new generation of memory devices based on high-k materials requires parallel development of proper analytic techniques. This work focuses on Secondary Ion Mass Spectroscopy (SIMS) measurements on atomic layer deposited $Al_{1-x}Si_xO_y$ composite materials in form of thin films in range of 5-20 nm. SIMS is a very sensitive method for contamination monitoring. Based on standards created with Rutherford Backscattering Spectrometry (RBS) SIMS proved to be useful for identification of the composition of unknown samples. Recent measurements are aimed to determine diffusion of silicon from substrate into a sample during the annealing process. This work can also provide useful information which can help to deeply understand what processes occurs in the material during the annealing under different temperature conditions. SIMS is a very promising technique for multi-purpose characterization of different materials and further optimization of measurement conditions and proper interpretation of results will be performed.

DS 11.6 Tue 10:45 H 2013

X-ray Photoelectron diffraction study of thin epitaxial MnO films — •Christian Langheinrich[1], Mathias Nagel[2], Angelika Chassé[1], and Thomas Chassé[2] — [1]Martin-Luther-Universität Halle-Wittenberg, FB Physik, FG Theoretische Physik, 06099 Halle — [2]Eberhard-Karls-Universität Tübingen, Institut für Physikalische und Theoretische Chemie, Auf der Morgenstelle 8, 72076 Tübingen

Transition metal oxides reveal interesting properties due to their high electronic correlation and magnetic phenomena. The MnO/Ag(001) system is an interesting model system due to the high lattice mismatch (9*%). By choosing the optimal preparation method either pseudomorphic or relaxed growth of ultrathin MnO on Ag(001) can be obtained. Recently, evidence for a tetragonal distortion of initial MnO layers epitaxially grown on Ag has been provided from both XPD and XAS experiments but further understanding seems necessary [1, 2].

Here, XPD has been applied to investigate MnO(001) and Ag(001) bulk, as well as ultrathin epitaxial MnO films on Ag(001). Calculations have been performed within a multiple scattering cluster model in order to obtain the lattice parameters. An r-factor analysis indicates that the MnO films exhibits a tetragonal distortion and relaxes step by step to bulk MnO with thicker films. In addition we are able to show the relaxation in dependence on the film thickness.

[1] M. Nagel, I. Biswas, P. Nagel, E. Pellegrin, S. Schuppler, H. Peisert, T. Chassé, Phys. Rev. B 75 (2007) 195426

[2] A. Chassé, Ch. Langheinrich, F. Müller, S. Hüfner, Surf. Sci. (accepted)

DS 11.7 Tue 11:00 H 2013

The interplay of PVD growth parameter and nanostructuring of C:V and C:Co nanocomposites — •Markus Berndt, Gintautas Abrasonis, Matthias Krause, Arndt Mücklich, Andreas Kolitsch, and Wolfhard Möller — Institute of Ion Beam Physics and Materials Research, Forschungszentrum Dresden-Rossendorf,D-01314 Dresden, Germany

The growth regimes of C:V and C:Co nanocomposite thin films (metal content of ≈ 15 and 30 at.%) grown by ion beam co-sputtering in the temperature range of RT-500°C are investigated. X-ray diffraction (XRD), transmission electron microscopy (TEM) and Raman spectroscopy at two excitation wavelengths (532 nm and 785 nm) have been used to characterize the microstructure of carbon and metal coexisting constituents of the nanocomposites. In order to reveal the influence of the transition metal on the encapsulating matrix, pure carbon films were deposited at the same temperatures.

C:Co and C:V nanocomposites exhibit a fine-grained structure at deposition temperatures below 300°C. At higher temperatures C:Co films tend to form nanocolumns, whereas the globular structure is preserved for C:V. X-ray patterns show low degree of crystallinity of the nanoparticles in C:Co and C:V composites.

Raman spectroscopy results show that the presence of metal significantly enhances the formation of aromatic clusters. This enhancement occurs independently on metal nanoparticle size, shape and phase.

DS 11.8 Tue 11:15 H 2013

Herstellung und Charakterisierung von Monolagen von Cobalt-Platin-Nanopartikeln — •Denis Greshnykh, Vesna Aleksandrovic, Igor Randjelovic, Andreas Frömsdorf, Andreas Kornowski, Christian Klinke und Horst Weller — Universität Hamburg, Institut für Physikalische Chemie, Grindelallee 117, 20146 Hamburg

Langmuir-Blodgett-Methode wurde verwendet um ausgedehnte geschlossene Monolagen von Cobalt-Platin-Nanopartikeln herzustellen.

Die Morphologie der erhaltenen Filme wurde mittels Elektronnemikroskopie (SEM) und Kleinwinkel-Röntgen-Streuung (GISAXS) untersucht.

Gleichstrommessungen bei unterschiedlichen Temperaturen zeigten einen thermisch aktivierten Ladungstransport. SEM, GISAXS und elektrische Messungen spiegeln die geringe Größenverteilung und den hohen Ordnungsgrad der Filme über mehrere Millimeter wider.