DS 30: Thin Film Characterization: Structure Analysis and Composition (XRD, TEM, XPS, SIMS, RBS,...) II

Time: Thursday 14:45–17:15 Location: H32

DS 30.1 Thu 14:45 H32

CVD and ALD deposited hafnia: an XPS study — •Simone Brizzi, Massimo Tallarida, and Dieter Schmeisser — BTU Cottbus , Konrad-wachsmann allee 17 03046 Cottbus

In this work we report on Hafnium oxide deposited on silicon by means of chemical vapour deposition (CVD) and atomic layer deposition (ALD) using tetrakis-di-methyl-amino-Hf (TDMAHf) and water as precursors. We have studied the behavior of ALD and CVD at intermediate temperatures: ALD was performed outside the ALD window (T>300°C), whereas CVD was performed at low temperatures, approaching the ALD window (T<400°C). In this way we wanted to elucidate about the possibility of taking advantage of the conformality of ALD films and the high growth rate of CVD at the same time. Comparable sets of samples prepared with the two methods were measured by X-ray photoelectron spectroscopy and atomic force microscopy in order to determine differences between them: growth rate, Hf/O ratio, valence band positions and roughness are discussed and compared as a function of deposition temperature and process parameters.

DS 30.2 Thu 15:00 H32

Formation of ultrathin silica/iron-oxide epitaxial layers on Ru(0001) — •xin yu, anibal boscoboinik, bing yang, shamil Shaikhutdinov, and Hajo Freund — Fritz-Haber-Institut der Max-Planck-Gesellschaft,Berlin, Germany

Silica is one of the most abundant materials on our planet and is the key material in many modern technological applications. Thin silica films grown on metal substrates are well-suited model systems for studying structure-property relationships of silica related materials.[1] In particular, silica bilayer film weakly bound to a metal substrate can be grown on Ru(0001). This system has recently been used as a template for the preparation of aluminosilicate films.[2] In continuation of these works, here we studied preparation of Fe-doped silicate films. The experiments were carried out in an UHV chamber (base pressure < 3x10-10 mbar) equipped with LEED, AES, UPS, XPS, IRAS and STM. The film preparation includes sequential vapor deposition of Si and Fe onto an O precovered Ru(0001) substrate at ~100 K followed by high-temperature annealing (ca. 1100 K) in ~10-6 mbar of oxygen. The atomic structure of the resulted films was studied as a function of the Fe/Si ratio. The experimental results, substantiated by DFT calculation (performed by Sauer*s group in HU Berlin), revealed the formation of the epitaxial film consisting of a single layer of silica on top of a single layer of FeOx on Ru(0001). We believe that the prepared hetero-layered films may be interesting objects in nanotechnology. [1] S. Shaikhutdinov, H.-J. Freund, Adv. Mater., 2012. [2] J. A. Boscoboinik, et al., Angew. Chem. Int. Ed., 51 (2012) 6005

DS 30.3 Thu 15:15 H32

Composition and Chemistry of a Pd-Ni-Co thin film alloy studied by HAXPES — •Julius Kühn[1], Andreas Lippitz[1], Mihaela Gorgoi[2], Kai Nörthemann[3], Werner Moritz[3], and Wolfgang Unger[1] — [1]BAM Federal Institute of Materials Research and Testing, Berlin — [2]Helmholtz Zentrum Berlin — [3]HU Berlin

The surface near region is very important for catalytic processes. Compositional changes, e.g. segregation of alloy constituents in states before and after hydrogen sulfide exposure was investigated by non-destructive chemical HAXPES depth profiling. The HAXPES data are completed by results of AES providing data characteristic of the uppermost surface and EDX data characteristic of the bulk of the alloys.

DS 30.4 Thu 15:30 H32

Nickel Induced Crystallization of Carbon During Deposition — •Robert Wenisch, Sibylle Gemming, and Gintautas Abrasonis — Helmholtz-Zentrum Dresden-Rossendorf

A single-step process for the preparation of very thin polycrystalline carbon films on uniform nickel thin films is presented. The process temperature is significantly reduced in comparison to annealing of an amorphous carbon film without the aid of a transition metal. The degree of graphitization and the average grain size of the resulting films are examined by means of Raman-spectroscopy and transmission electron microscopy. The chemical state of the carbon atoms is analyzed by X-ray photoelectron spectroscopy. Additionally, nuclear reaction analysis is employed to confirm the temperature independence of the carbon absorption on the nickel surface. We believe that the process holds a potential for the synthesis of crystalline thin films or single layers of different 2D nanomaterials.

DS 30.5 Thu 15:45 H32

Substrate strains measured by convergent beam electron diffraction in epitaxial Ba(Fe1-xCox)2As2 thin films — •Paul Chekhonin[1], Jan Engelmann[2], Bernhard Holzapfel[2], Bernd Rellinghaus[2], Carl-Georg Oertel[1], and Werner Skrotzki[1] — [1]Institut für Strukturphysik, Technische Universität Dresden — [2]Leibniz-Institut für Festkörper- und Werkstoffforschung Dresden

Epitaxial Ba(Fe1-xCox)2As2 thin films have been produced by pulsed laser deposition on a spinel substrate with an iron buffer layer. Using the convergent beam electron diffraction technique in the transmission electron microscope, it is possible to obtain a Kossel pattern of the substrate. Strain-induced changes of the lattice parameters are derived from the captured Kossel pattern of substrate areas close to the interface with the iron buffer layer. The in-plane lattice parameters increase with respect to bulk spinel, giving evidence, that the strain in the Ba(Fe1-xCox)2As2 thin film is mainly determined by the iron buffer layer, and not by the substrate.

DS 30.6 Thu 16:00 H32

On the similarity of multiple scattering and the Moiré Effect in reciprocal space and how to make use of it in LEED — •Matthias Meissner[1], Falko Sojka[1], Marcel Grosch[1], Thomas Dienel[2], and Torsten Fritz[1] — [1]University of Jena, Institute of Solid State Physics, Max-Wien-Platz 1, 07743 Jena, Germany — [2]Empa, nanotech@surfaces, Überlandstrasse 129, CH-8600 Dübendorf, Switzerland

The effect of multiple scattering of electrons during low-energy electron diffraction (LEED) has been described decades ago. Likewise, the formation of Moiré patterns at the interface of different surface lattices is a well-known and common feature in surface physics. By definition, they are two distinct effects with different origins. However, in reciprocal space both can be treated very similarly, few assumptions provided.
It will be shown that this can be used as a powerful tool to analyze LEED patterns of systems where Moiré effects occur, e.g. Al_2O_3 on $Ni_3Al(111)$ and boron nitride on Pt(111), or in organic-inorganic hetero-epitaxy, e.g. peri-hexabenzocoronene (HBC) on graphite. Additionally, a kinematic approach to calculate spot intensities, even though imperfect to fully account for all influences on intensity, can help to understand LEED patterns, for example in the cases of few layer graphene on SiC(0001) and Al_2O_3 on $Ni_3Al(111)$.

DS 30.7 Thu 16:15 H32

Momentum-resolved Energy Loss Spectroscopy of Ultrathin Oxide Layers — •Kinyanjui Michael[1], Gerd Benner[2], Giuseppe Pavia[2], Nicolas Gauquelin[3], Gianluigi Botton[3], Hans-Ulrich Habermeier[4], Eva Benckiser[4], Bernhard Keimer[4], and Ute Kaiser[1] — [1]University of Ulm, Central Facility of Electron Microscopy, Albert-Einstein Allee 11, 89081, Ulm, Germany — [2]Carl Zeiss NTS GmbH, Oberkochen, Germany — [3]Canadian Centre For Electron Microscopy, McMaster University, 1280 Main Street West, Hamilton, Ontario, L8S 4M1, Canada — [4]Max Planck Institute for Solid State Research, Heisenbergstrasse 1, D-70579 Stuttgart, Germany, N. N.

Momentum-resolved electron-energy loss spectroscopy (MREELS) is a technique suitable for the study of momentum dependence (dispersion) of electronic excitations as well as excitations in anisotropic systems, including hidden interfaces which are hard to study with x-ray scattering. Here we report on the acquisition of MREELS spectra from ultra-thin LaNiO3-LaAlO3 layers grown on LaSrAlO4 substrate using nano-beam electron diffraction (NBED). With NBED we obtained a nearly parallel electron beam with a spot size ~ 1.5 nm which is slightly smaller than the layer thickness of one LaNiO3 /LaAlO3 layer (layer thickness ~ 1.7 nm). We observe features in the EELS spectra which are identified as collective electron excitations arising at the interface.

This observation is supported by associated EELS spectra calculations for super-lattices. From MREELS we were also able to resolve the dispersion of the observed interfacial collective excitations.

DS 30.8 Thu 16:30 H32

Quantitative Analysis of REELS Spectra and Modeling of Optical Properties of Multilayer systems for EUV Radiation Regime — Evelyn Handick[1], •Sina Gusenleitner[1,2], Dirk Hauschild[1,3], Tina Graber[2], Dirk Ehm[2], and Friedrich Reinert[1,3] — [1]Physikalisches Institut, Experimentelle Physik VII, Universität Würzburg, 97074 Würzburg — [2]Carl Zeiss SMT GmbH, 73447 Oberkochen — [3]Karlsruhe Institut für Technologie, Gemeinschaftslabor für Nanoanalytik, 76021 Karlsruhe

Multilayer mirrors (MLM) are widely used in the extreme ultraviolet (EUV) radiation regime for various applications, but their lifetime suffers from degradation through contamination. Diverse capping layers can be used to terminate EUV MLM to protect the underlaying multilayer stack. One very promising caping material is Ru. In order to understand the time dependent influence of contaminations on these Ru capped MLM particular heterosystems were investigated with Reflection Electron Energy Loss Spectroscopy (REELS). Analysis of the REELS spectra lead to determination of the dielectric function and various optical properties in the EUV photon energy regime which are not easily accessible by optical measurements. Furthermore, the influence of different cleaning procedures, such as Ar+ ion sputtering or atomic hydrogen cleaning, on the electronic and optical properties of the systems are monitored. Comparison of these findings with results for Ru single crystal surfaces, show the connection between the model system and the application oriented polycrystalline Ru thin-film on the heterostructure.

DS 30.9 Thu 16:45 H32

EBSD on thin FePtCu films to investigate the influence of copper content and annealing temperature on (001) texture formation and grain size — •Nathanael Jöhrmann, Herbert Schletter, Christoph Brombacher, Manfred Albrecht, and Michael Hietschold — Institut für Physik, Technische Universität Chemnitz, 09107 Chemnitz

FePt shows a very high uniaxial magnetocrystalline anisotropy in its chemical ordered $L1_0$ phase. Therefore thin FePt films are a promising candidate to raise the storage density of magnetic storage devices. For such applications it is necessary to grow films with (001) texture. The addition of copper can improve the texture formation during annealing [1-2]. To further investigate the influence of copper content on the texture formation and grain size, Electron Backscatter Diffraction (EBSD) measurements on 5-nm-thick FePtCu films with variable copper content from 0 at. % up to 21 at. % were performed. The films were prepared by magnetron sputtering of Cu/FePt bilayers at room temperature on thermally oxidized Si(100) substrates, followed by rapid thermal annealing to 600 °C for 30 s. Studies were also carried out for 15-nm-thick FePtCu films, where the annealing temperature has been varied from 500 °C to 700 °C.

Our findings suggest that copper primarily promotes nucleation of $L1_0$ (001) grains, while a higher heating temperature accelerates the crystallite growth.

[1] C. Brombacher et al., J. Appl. Phys. 112, 073912 (2012)
[2] M. Maret et al., Phys. Rev. B 86, 024204 (2012)

DS 30.10 Thu 17:00 H32

Einfache Methode zur Steigerung der Empfindlichkeit in Null-Ellipsometrie — •Marco Muth[1,2], Reiner P. Schmid[1] und Klaus Schnitzlein[2] — [1]BTU Cottbus, Institut für Physik und Chemie, LS Leichtbaukeramik, Konrad-Zuse-Straße 1, 03046 Cottbus — [2]BTU Cottbus, Institut für Verfahrenstechnik, LS Chemische Reaktionstechnik, Burger Chaussee 2, 03044 Cottbus

Die Ellipsometrie stellt eine Messmethode dar, bei der, basierend auf der Änderung des Polarisationszustandes von Licht, Brechungsindizes und Schichtdicken von Schichtsystemen, kontaktlos und schnell bis in den unteren Nanometer-Bereich untersucht werden können. In diesem Beitrag wird gezeigt, wie die geringfügige apparative Modifikation eines Null-Ellipsometers zu einer deutlich gesteigerten Empfindlichkeit der Messmethode führen kann. Beim Nachweis sehr dünner Schichten stößt das übliche Setup an seine Grenzen. Wie unsere Berechnungen und Messungen zeigen, führt eine Neujustierung des Kompensator-Azimuths, von den üblichen 45°, auf einen kleineren Wert, bei ausgewählten Schichtsystemen zu einer deutlichen Steigerung der Empfindlichkeit. Fehler werden minimiert und der Null-Findungs-Prozess optimiert. Somit ist an bestehenden Geräten eine Steigerung der Messgenauigkeit und Präzision möglich. Durch Modellrechnungen wird gezeigt, welche Schichtsysteme und Schichtdicken sich besonders eignen. Demonstriert wird die Leistungsfähigkeit der apparativen Modifikation durch Präsentation von Ergebnissen aus Messungen an den Schichtsystemen Luft/Protein/Wasser und Luft/SiO2/c-Si.