DS 28: Thin film characterization: structure analysis and composition (Spectroscopy)

Time: Wednesday 17:45–19:45 Location: H 2032

DS 28.1 Wed 17:45 H 2032

X-ray absorption and resonant photoelectron spectroscopy of epitaxial Fe-doped SrTiO$_3$ — •Annemarie Köhl[1], Christian Lenser[1], Dariusz Kajewski[2], Jurek Kubacki[2], Chencheng Xu[1], Sebastian Wicklein[1], Jacek Szade[2], and Regina Dittmann[1] — [1]Peter Grünberg Institut 7, Forschungszentrum Jülich GmbH, Germany — [2]A.Chelkowski Institute of Physics, University of Silesia, Katowic, Poland

In recent years resistive switching in transition metal oxides received a lot of research interest due to the proposed application as non-volatile data memory. SrTiO$_3$ serves as a model system for the investigation of resistive switching due to the valency change mechanism. Frequently, slightly Fe doping is used, as it has shown to improve the switching properties. The focus of this study is the effect of Fe-doping of SrTiO$_3$ in thin epitaxial films.

Thin film samples with Fe concentration of 2 at.% and 5 at.% were prepared by pulsed laser deposition at varying substrate temperatures. The surface morphology of the films is studied with AFM. X-ray absorption spectroscopy is performed in total-electron and auger-electron yield offering different probing depths. Significant variations of the Fe-L edge between bulk and interface as well as after annealing are observed and discussed in terms of integration into the lattice and evolution of secondary phases. Resonant photoelectron spectroscopy at the absorption edge of Ti, O and Fe was used to determine the spectral contributions to the valence band. Most noteworthy we find significant spectral weight above the valence band, which can be attributed to Fe-states.

DS 28.2 Wed 18:00 H 2032

Quantitaive and wavelenght dispersive x-ray fluorescence spectrometry of buried nanostructures — •Rainer Unterumsberger, Beatrix Pollakowski, Falk Reinhardt, Matthias Müller, and Burkhard Beckhoff — Physikalisch-Technische Bundesanstalt, Abbestr. 2-12, 10587 Berlin, Germany

Quantitative X-Ray Fluorescence (XRF) spectrometry with synchrotron radiation is a well-established method for thickness determination of thin layers. The combination of Grazing Incidence X-Ray Fluorescence (GIXRF) and XRF spectrometry enables the possibility of near surface quantification of lowest depositions as well as buried nanolayer quantification. In this work quantitative XRF and GIXRF was compared and the advantages and limits of both methods will be presented. The sample systems consist of buried boron-carbon nanolayers varying in thickness and covered with 2.5 nm silicon dioxide. In addition, some of these sample systems were analyzed by X-Ray Emission Spectrometry (XES) employing a wavelength dispersive spectrometer combined with a refocussing optic optimised for a high detection efficiency, which allows for the investigation of buried nanolayers. This method will be used for the investigation of the chemical speciation and the impact of the chemical state on atomic fundamental parameters, which are relevant for the reliabilty of the thickness determination employing XRF.

DS 28.3 Wed 18:15 H 2032

X-Ray induced characterization of ion implantation depth profiles — •Philipp Hönicke and Burkhard Beckhoff — Physikalisch-Technische Bundesanstalt (PTB), Abbestr. 2-12. 10587 Berlin, Germany

An X-ray induced characterization method using Grazing Incidence X-Ray Fluorescence (GIXRF) analysis has been applied to the characterization of various ion implantations into silicon, germanium and gallium arsenide. Multiple implanted species with nominal fluences between 1x10^{14} cm^{-2} and 1x10^{16} cm^{-2} and implantation energies between 0.5 keV and 150 keV have been characterized using this method. The depth profiling with GIXRF analysis is based on the in depth changes of the X-ray Standing Wave (XSW) field intensity. The XSW field arises between the primary and the reflected beam and is dependent on the incident [1]. The implantation depth profile is convolved with this intensity distribution and creates a specific fluorescence curve when a GIXRF measurement is performed. The GIXRF measurements have been carried out at the laboratory of the PTB at BESSY using monochromatized synchrotron radiation of well-known radiant power and spectral purity [2]. The results obtained with this method show good agreement with secondary ion mass spectrometry and medium energy ion scattering [1] as well as grazing exit X-ray fluorescence [3] investigations.

[1] P. Hönicke et al., Anal. Bioanal. Chem. 396(8), 2825-2832 (2010)
[2] B. Beckhoff et al., Anal. Chem. 79, 7873-7882 (2007)
[3] Y. Kayser et al., Spectrochim. Acta B 65, 445-449 (2010)

DS 28.4 Wed 18:30 H 2032

Direct Fourier imaging of distortions in LaAlO$_3$ Films — •Christoph Schlueter[1], Tien-Lin Lee[2], Carmela Aruta[3], and Jörg Zegenhagen[1] — [1]ESRF,Grenoble, France — [2]Diamond Light Source Ltd, Didcot, UK — [3]CNR-SPIN, Naples, Italy

The formation of a quasi-2dimensional electron gas at interface of SrTiO3 (STO) and LaAlO3 (LAO) attracted considerable attention in the recent years. The polar LAO layer was expected to cause the build-up of an electric potential. Distortions in the overlayer are discussed as one possible response of the system. The highly sensitive X-ray standing wave (XSW) imaging technique is well suited to study theses films because of its chemical and spacial resolution.

LAO thin films below (2uc) and above (6uc) the critical thickness for conductivity were studied at the hard X-ray photo electron spectroscopy end station of ID32 at the ESRF. The XSW modulated core level photo electron yield was recorded for the five elements present in film and substrate for seven different Bragg reflections. Subsequent analysis provided for each reflection and element the amplitude and phase of one Fourier coefficient of the elemental atomic distribution function. The three dimensional real space image of the atomic distribution for each of the elements is reconstructed by direct Fourier inversion. The reconstructed 3D images obtained by this model free approach reveal significant atomic displacements.

DS 28.5 Wed 18:45 H 2032

Chemical Depth Profiles of Ternary Pd Alloys by HAXPES and First Spectra Simulations — •Julius Kühn[1,3], Andreas Lippitz[1], Thomas Gross[1], Mihaela Gorgoi[2], Sebastian Linke[3], Werner Moritz[3], and Wolfgang Unger[1] — [1]BAM Federal Institue of Materials Research and Testing, Berlin, Germany — [2]Helmholtz Zentrum Berlin, BESSY II, Berlin, Germany — [3]Department of Physical Chemistry, Humboldt-Universität zu Berlin, Germany

The catalytic activity of Pd is well known. By alloying with other transition metal the resistivity against poisoning due to sulfur can be improved. In our study we investigated the chemical states of a PdNiCo ternary thin film alloy used as the catalytically active layer in a hydrogen sensor by hard X-ray photo electron spectroscopy (HAXPES). The new technique offers the possibility to study the first nanometers of the sample by increasing the excitation energy from 2010 eV to 6000 eV to perform a non-destructive chemical state depth profiling across the surface of the alloy layer down to 18 nm. We studied the influence of hydrogen and hydrogen sulfide exposure and temperature treatments on the chemical composition of the alloy surface. In addition hard XP-spectra of PdNiCo alloys were calculated by the Simulation of Electron Spectra for Surface Analysis (SESSA) software and compared to experimental data. By doing this evidence for segregation phenomena at the ternary alloy surface is derived.

DS 28.6 Wed 19:00 H 2032

Factor Analysis and Advanced Inelastic Background Analysis in XPS: Unraveling time dependent contamination growth on multilayers and thin films — •Sina Gusenleitner[1,2], Tina Graber[2], Dirk Ehm[2], and Friedrich Reinert[1,3] — [1]Physikalisches Institut, Experimentelle Physik VII und W. C. Röntgen Research Center for Complex Material Systems, Universität Würzburg, 97074 Würzburg — [2]Carl Zeiss SMT GmbH, 73447 Oberkochen — [3]Karlsruhe Institut für Technologie, Gemeinschaftslabor für Nanoanalytik, 76021 Karlsruhe

In order to follow and understand time dependent contamination growth on multilayer mirrors for extreme ultraviolet (EUV) lithography applications, particular heterosystems were investigated with various spectroscopic methods like X-ray Photoemission Spectroscopy (XPS) and Reflection Electron Energy Loss Spectroscopy (REELS). Diverse capping layers can be used to terminate EUV multilayer mirrors to protect the underlaying multilayer stack, one very promising is Ru. In XPS problems encounter when analyzing spectra as the signals of Ru and C overlap. Further, Ru is not only present as pure metal, but also in its oxidized state. Disentangling the overlapping XPS spectra is achieved by application of Factor Analysis (FA) yielding not only the spectra of each component but also the according weights. Thus a model for the time dependent contamination growth can be developed. This model was cross checked by advanced inelastic background analysis. Both methods display an eminent way to unravel overlapping datasets and deducing multilayer composition models.

DS 28.7 Wed 19:15 H 2032

Structure determination of monolayer FeO(111) films on Ag(001) — •Daniel Bruns[1], Irena Kiesel[2], Steffen Jentsch[1], Soeren Lindemann[1], Christian Otte[1], Timo Kuschel[1], and Joachim Wollschlaeger[1] — [1]Fachbereich Physik, Universität Osnabrück, Barbarastr. 7, 49069 Osnabrück — [2]Technische Universität Dortmund, Fakultät Physik/DELTA, Maria-Goeppert-Mayer-Str. 2, 44227 Dortmund

Ultra thin iron oxide films were grown on Ag(001) via reactive molecular beam epitaxy (metal deposition in oxygen atmosphere). The first monolayer shows FeO stoichiometry as concluded from x-ray photoemission spectra. Both low energy electron diffraction and scanning tunneling microscopy demonstrate that the FeO layer has quasi-hexagonal symmetry. This points to the growth of FeO(111) although the films is deposited on a surface with square symmetry. The periodicity as well as the height of the undulated FeO(111) film was analyzed by STM and SPA-LEED. The FeO(111) lattice is slightly rotated with respect to the Ag(001) substrate surface. This rotation causes an undulation of the oxide layer in two different directions with different undulation heights.

DS 28.8 Wed 19:30 H 2032

Lattice dynamics and magnetism of metallic Samarium in Sm-type and dhcp structured films — •Olga Bauder[1], Alessandro Barla[2], Ilia Sergueev[3], Rudolf Rüffer[3], and Svetoslav Stankov[1] — [1]KIT, Karlsruhe, Germany — [2]ALBA, Barcelona, Sapin — [3]ESRF, Grenoble, France

The lattice dynamics of metallic samarium was unknown until recently. The high reactivity of Sm along with its large absorption cross section for thermal neutrons prohibited the application of inelastic neutron scattering, the standardly used method for determination of lattice dynamics. We determined the phonon density of states (DOS) of samarium by nuclear inelastic scattering on 149Sm. The experiments were performed at the end-station ID22N of the ESRF in Grenoble in a dedicated ultrahigh vacuum (UHV) system. 500 nm thick epitaxial Sm films exhibiting either the native for this metal Sm-type structure or the characteristic for the light lanthanides dhcp one were grown by molecular beam epitaxy following an elaborated procedure. In order to avoid oxidation and to reduce the multiphonon excitations the samples were investigated under UHV conditions and at 100 K. The magnetic properties of both structures were investigated by nuclear forward scattering in the temperature range 10 K - 300 K. From the phonon DOS a number of thermodynamic properties for this metal were determined. *S.S. acknowledges the support by the Helmholtz Association for establishing a Helmholtz-University Young Investigator Group *Interplay between structure and dynamics in epitaxial rare earth nanostructures* (VH-NG-625).*