

DS 3: Metal Layers and Multilayers

Time: Monday 9:30–11:00

Location: H34

DS 3.1 Mon 9:30 H34

High Kinetic Energy Photoelectron Spectroscopy on Metal Heterostructures — ●MIHAELA GORGOI¹, OLOF KARIS², SVANTE SVENSSON^{1,2}, GUNNAR ÖHRWALL², GABRIELLA ANDERSSON², MORENO MARCELLINI², FRANZ SCHÄFERS¹, WALTER BRAUN¹, and WOLFGANG EBERHARDT¹ — ¹BESSY GmbH, Albert-Einstein-Str. 15, 12489 Berlin, Germany — ²Department of Physics, Uppsala University, PO Box 530 SE 751 21 Uppsala, Sweden

In the present work, results on different Cu/Ni heterostructures studied by high kinetic energy photoelectron spectroscopy are presented. Core level shifts are found as a function of the Cu layer thickness within the multilayer structure as well as a function of the interface type between the copper and nickel. While the thickness of the Ni layer was fixed at 5 ML, the thickness of the Cu layer varied. Three samples are studied for Cu thicknesses of 2 ML, 4 ML and 5 ML. The measured core level shifts are found to confirm theoretical calculations of these systems [1, 2]. We have been able to study the destruction of the layered structures from the core photoelectron chemical shifts. Thus we have developed a new non destructive tool to study the quality of deeply buried interfaces. This study may therefore have considerable technical and commercial applicability.

[1] W. Olovsson, E. Holmström, J. Wills, P. James, I.A. Abrikosov, A.M.N. Niklasson, Phys. Rev. B 72 (2005) 155419; [2] W. Olovsson, E. Holmström, I.A. Abrikosov, A.M.N. Niklasson, M. Gorgoi, O. Karis, S. Svensson, G. Öhrwall, G. Anderson, M. Marcellini, W. Braun, W. Eberhardt, accepted Phys. Rev. Lett.

DS 3.2 Mon 9:45 H34

Reactive Surfaces under Electrochemical Control: Cl/Cu(100) — ●HUBERT ZAJONZ¹, HELMUT DOSCH¹, PETER BROECKMANN², SASCHA HUEMANN², and KLAUS WANDEL² — ¹Max-Planck-Institut für Metallforschung, Heisenbergstr.3, 70569 Stuttgart, and Institut für Theoretische und Angewandte Physik, Universität Stuttgart, Pfaffenwaldring 57, 70569 Stuttgart, Germany — ²Institut für Physikalische und Theoretische Chemie, Universität Bonn, Wegelerstr. 12, 53115 Bonn, Germany

The surface structure of Cu(100) modified by chloride has been studied in an electrochemical environment by means of in-situ surface x-ray scattering with a particular focus on adsorbate and potential dependent surface relaxation effects. An extraordinary large Cu-Cl bond length of 2.63 Å is found for the $c(2 \times 2)$ -Cl phase on the basis of diffraction data analysis at positive potentials close to the on-set of the copper dissolution reaction. This finding points to a largely ionic character of the Cu-Cl interaction on Cu(100) with chloride particles likely retaining their full charge upon adsorption. In combination with the positive surface charging at these high potentials this ionic Cu-Cl bond is discussed as the origin of the observed 2.2% outward relaxation between the first two copper layers. These results indicate that the bond between the first and the second copper layer is significantly weakened which seems to be the crucial prerequisite for the high surface mobility of copper-chloride species under electrochemical annealing conditions at these high potentials.

DS 3.3 Mon 10:00 H34

Evolution of the Quantum Well States in Ag layers on Au(111) — FRANK FORSTER¹, EUGEN GERGERT¹, ●ANDREAS NUBER¹, AZZEDINE BENDOUNAN¹, LI HUANG^{2,3}, XINGAO GONG², and ZHENYU ZHANG³ — ¹Universität Würzburg, Experimentelle Physik II, Am Hubland, 97074 Würzburg — ²Surface Physics Laboratory and Department of Physics, Fudan University, Shanghai 200433, P.R. China — ³Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831, USA

Electronic quantum well states (QWS) confined in ultrathin films are of great scientific interest. Outside the substrate energy gap the confinement is suppressed. They can couple with substrate states and form quantum well resonances (QWR). We present systematic studies on epitaxial layer-by-layer growing Ag films up to 45 ML on Au(111) using angular resolved photoelectron spectroscopy (ARUPS) ($\Delta E = 3 \text{ meV}$, $\Delta \Theta = 0.3^\circ$).

Our data in combination with density functional theory show the transition from QWR to QWS. We investigated the localization of the states in terms of their center-of-charge, peak position and line-

shape. In contrast to comparable systems like Ag/W(110) QWS in Ag/Au(111) are formed not before a thickness of $\approx 8 \text{ ML}$. The center-of-charge and the peak position are localized within the Ag overlayer and Au energy gap, respectively, at the same film thickness and hence can be used as criteria for the formation of QWS. Further investigations on their lineshape close to the substrate gap edge allow access to further many-body characteristics of the QWS.

DS 3.4 Mon 10:15 H34

Self-organization of multilayers during the co-deposition of — ●DOMINIKA LYZWA¹, HAYO ZUTZ¹, INGA GERHARDS¹, CARSTEN RONNING¹, HANS HOFSSÄSS¹, MICHAEL SEIBT², WAN-YU WU³, and JYH-MING TING³ — ¹Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1,37077 Göttingen — ²Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1,37077 Göttingen — ³Department of Materials Science and Engineering, National Cheng Kung University, Tainan, Taiwan, ROC

Multilayers grown by simultaneous deposition of carbon and Fe, Au, Cu or Ni ions reveal a self-organization process with alternately metal-rich and metal-deficient layers. These layers are of the size of a few nanometers. The metal-rich layers consist of crystalline clusters while the metal-deficient ones of amorphous carbon. Concentration distributions were analyzed by Rutherford backscattering (RBS) measurements while the structure induced by the ions was examined via transmission electron microscopy (TEM). A model of the multilayer formation can be described by an interplay of sputtering, surface segregation, ion induced diffusion, and the stability of small clusters against ion bombardment. First investigations on the optical and magnetic properties of such multilayers will be presented.

DS 3.5 Mon 10:30 H34

Triple junction and interface transport in nano-crystalline Cu/Ag bi-layers — ●HENNING GALINSKI and GUIDO SCHMITZ — Institut für Materialphysik der WWU Münster, Münster, Deutschland

Cu and Ag are distinguished by strongly repulsive chemical interaction. Thus no mixing or reaction between these two elements should be expected. We investigated the chemical stability of Cu/Ag bi-layers with state-of-the-art wide angle atom probe tomography (WATAP). This method provides an extended volume of analysis so that grain boundaries are reliably located and even minor chemical modifications are detected with improved statistical significance. Bi-layer samples were deposited on tungsten substrate tips and subjected to heat treatments up to 500°C/30 min. Two surprising observations are remarkable: i) In contrast to bulk thermodynamics an intermixing zone of 1.5 nm in thickness develops at the bi-layer interface. Since its apparent activation energy amounts to only 0.3 eV, we conclude that this intermixing is not controlled by diffusion kinetics. Instead, it may be understood quantitatively by the Cahn-Hilliard approach. Thus, our experiments allow a direct measurement of the gradient term in this theory. ii) One-dimensional, worm-like segregation zones develop at both sides of the interface. The geometric analysis proves that these zones represent triple junctions of the grain boundary structure. In consequence, the measurements demonstrate that triple junctions are distinguished by remarkably large segregation factors and the triple junction diffusion coefficient can be determined in the type C kinetic regime.

DS 3.6 Mon 10:45 H34

Investigation of the Mechanical Properties of Thin Iron and Molybdenum Films — ●ANDREAS SCHNEIDER¹, GUNTHER RICHTER², THOMAS WÜBBEN², and EDUARD ARZT^{1,2} — ¹Universität Stuttgart, Institut für Metallkunde, Heisenbergstraße 3, 70569 Stuttgart — ²Max-Planck-Institut für Metallforschung, Heisenbergstraße 3, 70569 Stuttgart

The mechanical properties of thin films and small structures with dimensions in the range of microns or below differ fundamentally from their bulk counterparts. Many experiments have shown that flow stresses of thin films are inversely related to the film thickness. However, so far this size effect has only been observed in fcc metal thin films. To date there is no evidence that thin films with a bcc crystal structure also show this effect. In the current investigation we want to shed light on this open question by studying the mechanical properties of thin α -Fe and Mo films. The films were deposited in ultra high vac-

uum conditions via molecular beam epitaxy and magnetron sputtering on different substrates. They were tested with the substrate curvature technique as well as micro tensile tests. Additionally, bulge tests

on freestanding films were performed to eliminate the influence of the substrate. Our results show that the mechanical behavior of the films depends on the film thickness and the microstructure.