

O 75: Metal Substrates: Growth Studies

Time: Wednesday 15:00–17:00

Location: WIL C107

O 75.1 Wed 15:00 WIL C107

Growth studies of the potential Rashba surface alloy Tl on Ag(111) — ●PATRICK HÄRTL and MATTHIAS BODE — Physikalisches Institut, Experimentelle Physik II, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany

It is well known, that surface alloys of Ag(111) with heavy post-transition metals, such as the group V element Bi or the group IV element Pb, i.e., BiAg₂ [1] or PbAg₂ [2], respectively, exhibit a giant spin-orbit coupling resulting in Rashba spin-split surface states. Looking in the periodic system it can be speculated whether surface alloying of Ag with the group III element thallium (Tl) results in a comparable electronic structure. As a first step towards this goal we have studied the growth of Tl on Ag(111) by low-energy electron diffraction (LEED), Auger electron spectroscopy (AES), and scanning tunneling microscopy (STM). LEED reveals a $(\sqrt{3} \times \sqrt{3})\text{Tl}/\text{Ag}(111)R30^\circ$ structure at submonolayer coverage and additional $(4\sqrt{3} \times 4\sqrt{3})$ spots for thicker films. The intensity and sharpness of the $(\sqrt{3} \times \sqrt{3})$ is used to identify optimal growth conditions. The LEED results are compared to real space data by making use of Fourier transformed STM images. STM data obtained on Tl films with a thickness of several atomic layers still show a pronounced moiré pattern, thereby indicating a sizable rotation of the Tl lattice with respect to the underlying Ag(111) substrate. The results will be discussed by comparison with Bi and Pb films.

[1] L. El-Kareh *et al.*, Phys. Rev. Lett. **110**, 176803 (2013).

[2] L. El-Kareh *et al.*, New Jour. Phys. **16**, 045017 (2014).

O 75.2 Wed 15:15 WIL C107

Submonolayer growth of Te on Cu(111) — ●TILMAN KISSLINGER, ANDREAS RAABGRUND, MAXIMILIAN AMMON, M. ALEXANDER SCHNEIDER, and LUTZ HAMMER — Lehrstuhl für Festkörperphysik, Universität Erlangen-Nürnberg, D-91058 Erlangen, Germany

Tellurium (Te) based alloys play an important role in metallurgy, thermoelectricity and photovoltaics [1]. Thus, an accurate knowledge of the crystallographic surface structure and elemental composition of such systems is the first step to any understanding of their diverse physical properties. We studied the adsorption of Te on Cu(111) for submonolayer coverages with quantitative low-energy-electron diffraction (LEED), scanning tunneling microscopy (STM) and density-functional theory (DFT).

Below $\Theta = 1/12$ ML we find Te atoms to form a disordered structure. Above this threshold a $(2\sqrt{3} \times \sqrt{3})R30^\circ$ structure evolves that is fully developed at a coverage of $1/3$ ML. STM shows a well-ordered surface phase that is solved by our LEED-analysis ($\Delta E = 8.7$ keV, $R = 0.127$) to consist of Te₂Cu₂ chains in hcp-sites of the first substrate layer in perfect agreement with the structure calculated by DFT. Furthermore, we show that the finding of a $(\sqrt{3} \times \sqrt{3})R30^\circ$ structure at similar coverages reported in [2] is the consequence of an adsorbate induced phase transition as observed e.g. for H₂ or CO.

[1]: Ibers J., Nat. Chem. **1**, 508 (2009)

[2]: Lahti *et al.*, Surf. Sci. **622**, 35 (2014)

O 75.3 Wed 15:30 WIL C107

STM investigations of Bi thin films on oxidized and clean Nb(110) — ●ROBIN BOSHIUS, ARTEM B. ODOBESKO, JOHANNES JUNG, and MATTHIAS BODE — Physikalisches Institut, Experimentelle Physik II, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany

Motivated by the still ongoing quest for topological superconductivity, the proximity coupling of strongly spin-orbit-coupled Bi films with superconducting substrates gained wide interest. In this context a precise control of the surface termination via the epitaxial relationship at the interface between the superconductor and the Bi film may crucially influence the electronic structure.

We perform STM and STS investigations to study the growth of Bi thin films on Nb(110). We find that the surface structure of Bi crucially depends on the surface quality of the niobium substrate. While Bi grows in a hexagonal (111) structure on the oxygen-reconstructed surface of Nb(110), deposition on the clean Nb surface results in a Bi(110) surface with a rectangular atomic lattice. The different epitaxial relationships of Bi on clean and oxygen-reconstructed Nb(110) offer a versatile platform to investigate strongly spin-orbit-coupled supercon-

ductors and their interaction with magnetic nanostructures towards topological superconductivity.

O 75.4 Wed 15:45 WIL C107

Investigation of the lithium fluoride growth on the silver (100) surface — ●VLADYSLAV ROMANKOV and JAN DREISER — Swiss Light Source, Paul Scherrer Institut, 5232 Villigen PSI, Switzerland

Lithium fluoride (LiF) has been shown to be an interesting material for spintronic applications [1], and it is a potential candidate for decoupling single-molecule magnets (SMMs) from metallic substrates, which helps to enhance their magnetic stability [2]. To understand the growth of LiF on Ag, we have investigated samples of up to a few nominal monolayers deposited in ultra-high vacuum from an effusion cell onto the Ag(100) surface held at room temperature. Our study combines scanning tunneling microscopy (STM), low energy electron diffraction (LEED) and polarized X-ray absorption spectroscopy (XAS).

The XAS results show that the fluorine local environment of the samples is virtually identical to the one in bulk LiF, while the appearance of the linear dichroism is consistent with a small tetragonal distortion, arising from the LiF-substrate interaction. STM and LEED reveal that LiF forms islands with a dendritic shape, whose branches extend along the $\langle 010 \rangle$ directions of the Ag(100) plane. We also observe an inhomogeneous vertical growth of the dendrites with increasing amount of deposited material. By deposition onto the hot Ag(100) substrate, we expect to obtain flat, two-dimensional islands, which are suitable for decoupling of SMMs.

References: [1] - A. J. Drew *et al.*, Nature Materials, **8**, 109, (2009); [2] - C. Wäckerlin *et al.*, Advanced Materials, **28**, 5142, (2016).

O 75.5 Wed 16:00 WIL C107

Investigation of the stability of bimetallic surface alloys: A kinetic Monte Carlo study — ●DAVID MAHLBERG and AXEL GROSS — Institut für Theoretische Chemie, Universität Ulm, 89069 Ulm, Germany

Bimetallic surfaces are attractive substrates for catalytic purposes, due to the possibility to tailor their structure and hence, their stability and reactivity on an atomic scale. This offers great potential, e.g., with respect to rational catalyst design. However, operation conditions are often extreme in terms of temperature and pressure. Therefore, it is necessary to have detailed knowledge about the properties and stability of surface alloys when composition and/or temperature is modified. In our work, we use first principles-based kinetic Monte-Carlo (kMC) simulations to analyse AgPd/Pd(111), PtRu/Ru(0001), and InCu/Cu(100) bimetallic surface alloys.

We have studied the stability of these surface alloys by monitoring the changes that occur via vacancy diffusion. In order to simulate vacancy diffusion, first-principles electronic structure calculations are used to derive the energy barriers that enter kMC simulations. Thus, the structure formation of surface alloys on macroscopic time scales and mesoscopic length scales as a function of composition and temperature can be monitored for varying concentrations of the alloyed metal, respectively. The energy barriers and diffusion behaviour are analysed in terms of the interaction between constituents that change with the particular local arrangements.

O 75.6 Wed 16:15 WIL C107

Comparative investigation of strain induced effects in Dy-Ag and Dy-Cu surface alloys — ●SINA MOUSAVION, JOHANNES SEIDEL, LU LYU, BENJAMIN STADTMÜLLER, and MARTIN AESCHLI-MANN — Department of Physics and Research Center OPTIMAS, Erwin Schrodinger Straße 46, 67663 Kaiserslautern, Germany

Intermetallic compound systems such as surface alloys offer the intriguing possibility to tailor the structural and electronic and ferromagnetic properties [1,2] in low dimensions. Here we focus on surface alloys formed between the lanthanide atoms and fcc(111) noble metal surfaces. These types of surface alloys are particularly interesting since their intermetallic structure is typically dominated by complex Moiré pattern. We combine LEED and STM to determine the surface structure of two distinctive surface alloys: a Dy-Ag and a Dy-Cu surface alloy. Both reveal the formation of different incommensurate superstructures along with different Moiré patterns. We correlate these different Moiré patterns of to strain effects induced by the different lattice constant

of the substrates. We propose that the surface strain in these surface alloys can have significant influences of the magnetic order of lanthanide-noble metal surface alloys which has been reported for low sample temperature. [1] Nano Lett., 16, 4230*4235 (2016) [2] Phys. Rev. B 88, 125405 (2013)

O 75.7 Wed 16:30 WIL C107

Epitaxy on (quasi-)liquid surfaces: A new paradigm for 2D materials growth? — •DOMINIK STEINER, THOMAS MAIREGGER, and ERMINALD BERTEL — Physikalische Chemie, Universität Innsbruck, Österreich

Lattice matching is usually an important consideration when choosing templates for epitaxial growth. Recently, Lee et al. achieved large-scale single-domain growth of hexagonal Boron Nitride (h-BN) on a liquid gold surface¹. We obtained excellent single-domain growth of h-BN on Pt(110), despite the vastly different symmetries of D_{3h} versus C_{2v} . We observed a transition from growth conditions yielding a strongly perturbed multi-domain film on a rough substrate to single-domain growth on large terraces at a critical temperature of ~ 1100 K².

Intensity analysis of low-energy electron diffraction spots shows the hallmarks of a true phase transition suggesting a relation to the deconstruction or the roughening temperature of the clean Pt(110) surface³. Paradoxically, smooth, nearly perfect film growth is obtained only above the roughening temperature. The observations raise questions about the role of lattice matching in 2D crystal growth. Apparently, a high surface atom mobility of the template at growth conditions is superior to precise lattice matching in promoting 2D epitaxial growth.

¹ Lee, J.S. et al., Science **362**, 817(2018).

² Steiner, D., Mittendorfer, F., Bertel, E., ACS Nano **13**, 7083(2019).

³ Krzyzowski, M. A. et al., Phys. Rev. B **50**, 18505(1994).

O 75.8 Wed 16:45 WIL C107

Reaction of Na/Br-carbenoid on NaBr surface investigated by scanning tunneling microscopy — •ABHIJIT BERA¹, KATHARINA DILCHERT², VIKTORIA DÄSCHLEIN GESSNER², and KARINA MORGENSTERN¹ — ¹Ruhr-Universität Bochum, Chair of Physical Chemistry I, Bochum, Germany — ²Ruhr-Universität Bochum, Chair of Inorganic Chemistry II, Bochum, Germany

Understanding of active radicals is important as they are short-lived intermediates in almost all chemical reactions, but because of their limited life-time, there is very little fundamental knowledge about it. For investigating radicals on surface science approach, we have grown sodium bromide (NaBr) layers on Ag(111) at room temperature and investigated layer formation, atomic resolution, defects and a moiré pattern by scanning tunneling microscopy. We employ this spacer layer to analyse a carbenoid compound, which is a reactive intermediate of many reactions. Recently metal halide (M/X) carbenoids attracted interest of many chemists due to their strong electrophilic character. However, the major concern is the stability because of their tendency of M-X eliminations. In solutions, it is possible to stabilize the carbenoid by addition of metal salt. We have deposited the Na/Br carbenoid with the type of [Ph₂P(S)]₂CMX on Ag(111) and also on the NaBr surface at 100-110 K and imaged at 120-140 K. We found that this compound tends to dissociate on Ag(111) surface and lose its character. But on the NaBr surface it is uniformly distributed and keeps its shape intact, which strongly suggests that, Na/Br-carbenoid makes coordination with NaBr salt.