O 22: Poster Monday: Surface Structure, Epitaxy, Growth and Tribology

Time: Monday 18:00–20:00 Location: P4

O 22.1 Mon 18:00 P4

Ordering processes and phase transitions in amorphous carbon thin films induced by optical excitation — •Carl Arne Thomann[1], Adrian Wittrock[1], Alexandra Wittig[2], Filipe Lopes Dias[2], Dominic Stangier[2], Wolfgang Tillmann[2], and Jörg Debus[1] — [1]Experimentelle Physik 2, TU Dortmund — [2]Lehrstuhl für Werkstofftechnologie, TU Dortmund

Amorphous carbon is a metastable network of short-range ordered carbon atoms often used as protective coatings owing to their exceptional tribological properties. However, high temperatures in a tribological contact may cause considerable changes in the structural ordering, solid-to-solid phase transitions, and degradation of the film. In this work, we present an optical method to initiate and investigate the structural evolution including ordering processes of differently modified films. A pulsed pump laser with micrometer spot size introduces heat into the film, while a second laser probes the Raman scattering signatures. Increasing with laser power, five different stages of structural evolution are found: The first one is coined by thermally resistive amorphous carbon. It is followed by a continuous reduction in the number of lattice defects and non-sixfold aromatic rings. Further increasing pumping power induces a transition from a-C to defected graphite and eventually leads to graphite-dominant defect relaxation and an enhancement in hexagonal lattice areas. Our optical method provides a versatile tool to analyze temperature-induced structural surface changes in a controlled manner, which will improve the understanding about the conditions in tribological contacts.

O 22.2 Mon 18:00 P4

Interactions between bovine calf serum and metallic surface of hipimplant taper junctions — •Adrian Wittrock[1], Saskia Heermant[1], Christian Beckmann[1], Markus A. Wimmer[2], Alfons Fischer[2,3], and Jörg Debus[1] — [1]Experimental Physics 2, TU Dortmund University, Dortmund, Germany — [2]Department of Orthopedic Surgery, Rush University Medical Center, Chicago, USA — [3]Department Microstructure Physics and Alloy Design, Max-Planck-Institut für Eisenforschung GmbH, Düsseldorf, Germany

Within biomedical taper junctions metal surfaces interact with the human body fluid and sustain structural and chemical changes which are of particular interest from the medical and engineering point of view. To simulate the tribological contact of a hip implant taper junction, fretting tests of low-carbon CoCrMo alloys and high-nitrogen FeCrMnMoN steels are performed in bovine calf serum under different numbers of cycles. We investigate structural and chemical variations within the fretting contact by means of label-free and non-destructive Raman spectroscopy. A different absorption behavior of long-chained molecules is observed and the amide I band is shifted from $1655\,\mathrm{cm}^{-1}$ to about $1665\,\mathrm{cm}^{-1}$, which indicates that once a protein is bound to the surface the conformation changes from α-helix to a random or β-sheet structure. A general denaturation of proteins occurs during the fretting experiment. At the heavily worn sample positions lipids are not detected, but sp^2-hybridized amorphous carbon is sometimes measured. Our results contribute to a deeper understanding about structural and chemical properties of biomedical tribological surfaces.

O 22.3 Mon 18:00 P4

Distance dependence of local work function on Pb/Si(111) island — Thomas Späth[1], •Daniel Rothhardt[2], Manuel Schulze[2], and Regina Hoffmann-Vogle[2] — [1]Karlsruhe Institut Technology, D76131 Karlsruhe, Germany — [2]Universtity of Potsdam, Institute of Physics and Astronomy, Experimentelle Physik kondensierter Materie, D14469 Potsdam, Germany

In order to gain a better understanding of diffusion of Lead (Pb) islands on Si(111)-(7x7), it is extremely important to provide a complete description of the electronic properties and the forces acting on the system. Using a Scanning Force Microscope in non-contact mode with Pt coated Si-cantilever allows us to perform point bias-approach measurements at 115 K on Pb islands. We have investigated how the local work function changes as a function of tip-sample distance and how the electrostatic force changes as a function of the applied bias between tip and sample. The resulting force was calculated from the frequency shift distance curves using Baratoff's force inversion method. A significant change in the work function was found when the tip-sample distance was less than 1 nm, which could arise from the overlap of the tip wave functions and the sample wave functions.

O 22.4 Mon 18:00 P4

Epitaxial growth of gold films on elemental superconductors — •Dongfei Wang[1], Katerina Vaxevani[1], Jon Ortuzar[1], Stefano Trivini[1], Danilo Longo[1], Samuel Kerschbaumer[2], Maxim Ilyn[2], Celia Rogero[2], and José Ignacio Pascual[1] — [1]CIC nanoGUNE-BRTA, 20018 Donostia-San Sebastian, Spain — [2]Materials Physics Center (CSIC-UPV/EHU), San Sebastian 20018, Spain

In recent years, superconductivity proximity effect was employed in the designing of topological superconductors [1]. The basic principle in designing a topological superconductor is to introduce superconductivity, spin-orbital coupling and magnetism at the same time. Unfortunately, most of the available elemental superconductors shows less spin-orbital coupling. Gold (Au) is a material famous for its relatively large spin-orbital coupling strength. By placing Au on elemental superconductors, a superconducting system with strong spin-orbital coupling is expected [2]. In our research, Au films with different thickness were grown on elemental superconductors such as V(100) and Nb(110). The films quality were examined by STM as well as XPS technique. By placing magnetic molecules FeTPP on the surface Au/Nb(110), we demonstrate the tunability of magnetic exchange interaction between the molecule and the substrate with Yu-Shiba bound states. Moreover, great Kondo signal enhancements near the pyrrole sites are observed.

References
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[2] A. Gupta, et al., Physical Review B 69, 104514 (2004)

O 22.5 Mon 18:00 P4

Preparation of highly pure Cu(110) surfaces — •Manuel Seitz, Andreas Christ, Markus Leisegang, and Matthias Bode — Physikalisches Institut, Experimentelle Physik II, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany

Ballistic transport of hot charge carriers on the nanoscale becomes more and more important for the development of microelectronic components [1]. The molecular nanoprobe (MONA) technique [2] is a novel method to investigate ballistic charge transport which has already been applied to detect anisotropic transport on the Pd(110) surface [3]. For a more detailed understanding, a survey of other anisotropic fcc(110) surfaces, e.g. Cu(110), is aspired. To detect characteristics intrinsic to the Cu(110) surface, a highly clean and defect-free area of the surface is needed. However, cleaning (110) surfaces with such high purity has proven to be challenging. In this presentation, we summarize our experiences with the preparation of Cu(110) which are compared to similar experiments on Cu(111). While optimizing the preparation parameters, i.e., sputter and anneal cycles, we found a high mobility of surface atoms at room temperature on the Cu(110) surface. Furthermore, upon sputtering the Cu(111) surface, island formation is observed besides the expected vacancy islands [4].

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[4] T. Michely, et. al., Phys. Rev. B 50.15, 11156 (1994).

O 22.6 Mon 18:00 P4

Nanotribological properties of Nitrogen doping-induced modification graphene in ultrahigh vacuum — •Shuyu Huang[1,2], Antoine Hinaut[1], Yiming Song[1], Sebastian Scherb[1], Gema Gnavarro[1], Thilo Glatzel[1], and Ernst Meyer[1] — [1]Department of Physics, University of Basel, 4056 Basel, Switzerland — [2]Key Laboratory for Design and Manufacture of Micro-Nano Biomedical Instruments, School of Mechanical Engineering, Southeast University, Nanjing 211189, China

Graphene, as typical atomically-thin solid lubricant with potential applications in micro- and nano-electromechanical systems (MEMS/NEMS), has been extensively investigated on its nanotribological properties. In the present work, by using a novel experimental approach, for the first time we directly compare the frictional properties between pristine graphene and modified graphene on a single image, showing that atomic-scale friction can be significantly altered

by Nitrogen doping-induced modification. Specifically, C60 nano-flakes are deposited as a mask on graphene/Ir (111) surface by thermal evaporation. The sample is then exposed to a nitrogen radical flux produced by a remote RF plasma source. After thermal annealing, to desorb C60 molecules, both nano-patterned modified graphene and pristine graphene, located below former C60 islands, surface is obtained simultaneously. By the means of high-resolution ultrahigh vacuum atomic force microscopy, the topography of surface with two different regions are characterized and discussed in non-contact mode and friction force variation is measured in contact mode.

O 22.7 Mon 18:00 P4

Investigation of indium fluctuation inside Al0.81In0.19N layers — •Keyan Ji[1], Qianqian Lan[2], Yan Lu[2], Michael Schnedler[1], Philipp Ebert[1], and Rafal E. Dunin-borkowski[2] — [1]Peter Gruenberg Institut, Forschungszentrum Juelich, D-52425 Juelich, Germany — [2]Ernst Ruska-Centre for Microscopy and Spectroscopy with Electrons, Forschungszentrum Juelich, D-52425 Juelich, Germany

We report on the characterization of Al0.81In0.19N/GaN heterostructures grown by Metalorganic Vapor Phase Epitaxy. The specimen was investigated by Electron Holography, High-angle annular dark-field (HAADF) imaging, Secondary-ion mass spectrometry, and Energy-dispersive X-ray spectroscopy. We reveal with different techniques that the Indium concentration gradually increases from 15% to the nominal value of 19% inside Al0.81In0.19N layers. We conduct quantitative analysis on experimental phase images from off-axis electron holography by comparing them with images calculated from the self-consistent electrostatic simulations. Our results illustrated that to accurately determine the electrostatic potential in semiconductor materials from electron holographic phase images, comprehensive knowledge of surface conditions, chemical compositions, and strains is required.

O 22.8 Mon 18:00 P4

Measuring energy dissipation on Si(111) with Lateral Force Microscopy (LFM) — •Thomas Holzmann, Shinjae Nam, Oliver Gretz, Alfred John Weymouth, and Franz Josef Giessibl — Universität Regensburg, Deutschland

In Lateral Force Microscopy (LFM), a cantilever is oscillated parallel to a sample surface at a set amplitude. The forces acting on such an oscillating cantilever are not necessarily conservative. The energy gain or energy loss can be position dependent, depending on the surface. We observed a strong lateral dependence of dissipation around adatoms of the 7x7-resconstruction of Si(111). We used LFM to measure this energy dissipation and applied different bias voltages between tip and sample, which changed the energy dissipation. Certain mechanisms, that contribute to energy dissipation, such as CO-bending (when using a CO-terminated tip) and chemical bonding should not be sensitive to changes in the bias voltage. Only the electrostatic part of the ineraction should be influenced by a change in the bias voltage. We developed a model to simulate the energy dissipation due to electrostatic forces similar to that proposed in Ondracek et al. Nanotechnology 27, 274005 (2016). In this model, electrons tunnel to a local quantum dot on the tip or sample before diffusing to the bulk. It can predict the area where the dissipation occurs. But surprisingly the dissipation signal changes its sign, depending on which side of the quantum dot the tip is located. Following this observation we looked at possible explanations for this behaviour.