O 34: New Methods and Developments III: Spectroscopy and Tribology

Time: Tuesday 14:00–15:45 Location: H13

O 34.1 Tue 14:00 H13

Atomic Scale Structure and Frictional Response of Swift Heavy Ion Irradiation Induced Defects on Graphitic Surfaces — •Dilek Yildiz[1,2], Cem Kincal[1], Umut Kamber[1], Cornelis J. van der Beek[3], and Oguzhan Gürlü[1] — [1]Istanbul Technical University, Department of Physics, 34460, Istanbul, Turkey — [2]University of Basel, Department of Physics, Basel, Switzerland — [3]Ecole Polytechnique, Palaiseau, France

Hillock and comet-like structures on swift heavy ion (SHI) irradiated highly oriented pyrolytic graphite (HOPG) surfaces were previously reported. It was shown that chains of hillocks were formed on HOPG due to SHI irradiation under grazing incidence. Using Scanning Tunneling Microscopy (STM) we have obtained atomic resolution on the tail sections of the comets as well as on the chains forming around them. Such data indicates that the interaction of SHI with the bulk of HOPG damages the atomic order on the surface layer only locally. SHI irradiation induced corrugation changes on flat surfaces can be imaged by STM to a certain extent. Friction force microscopy showed complementary results. We have observed that the tail sections of the comets appeared on friction maps, although they could not be seen in simultaneously taken contact mode AFM topography images. Our data on SHI irradiation of moire zones that formed due to rotated graphene layers on HOPG surfaces indicate that the structure of the SHI induced defects on graphene/HOPG system varies due to local conductivity differences between moire zones.

O 34.2 Tue 14:15 H13

Ultrasensitive charge detection to study contact electrification between a steel ball and a gold surface — •Andre Mölleken, Hüseyin Azazoglu, Doris Tarasevitch, Tobias Roos, Detlef Utzat, Hermann Nienhaus, and Rolf Möller — Fakultät für Physik/Cenide, Universität Duisburg-Essen, Germany

Contact electrification and charge transfer between particles in granular matter are of high technological and fundamental interest. As a model system, we have studied the free fall of a single steel ball of 1mm in diameter on a gold coated copper plate of a parallel plate capacitor. The ball hits the surface with an initial velocity of approximately 0.6m/s and bounces afterwards repeatedly on the surface. If the moving steel ball is charged it creates an image charge in the plate which is measured as a function of time. The induced and the transferred charge is measured using an extremely sensitive and fast charge detector [1], capable of detecting a few thousand elementary charges with a 50 kHz bandwidth. Kinetic parameters and energy transfer coefficients can be extracted from the data. In addition, the charge transfer between ball and plate is precisely determined for every collision. Different kinds of charge transfer are found, e.g., reduction and increase of the charge on the ball as well as polarity changes. A complete discharging as expected for a metallic contact occurs only very rarely. However, there is a significant tendency that the charges before and after collision are related to each other and the total amount of transferred charge correlates with the impact velocity. [1] P. Graf. et al., Rev. Sci. Instrum. 88, 084702 (2017).

O 34.3 Tue 14:30 H13

Nano-scale surface steps as the origin of friction anisotropy of snake scales — •Weibin Wu[1], Shudong Yu[2], Christian Greiner[3], Guillaume Gomard[1,2], and Hendrik Hölscher[1] — [1]Institute of Microstructure Technology (IMT), Karlsruhe Institute of Technology (KIT) — [2]Light Technology Institute (LTI), Karlsruhe Institute of Technology (KIT) — [3]Institute for Applied Materials (IAM), Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany

Snakes exhibit special locomotion styles because they are legless and slide in direct contact with the ground. Therefore, their ventral scales feature interesting tribological properties. Previous studies analyzed oriented micron-sized fibril structures on the scales which seem beneficial for controlling friction during sliding but the actual nano-scale interaction mechanism was rarely explained. We characterized the friction behavior of this fibril structure by AFM and measured friction while scanning the step edges of the fibrils up and down. The mirco-fibril structures on the ventral scale of snakes produce comparable large friction peaks during upward scans but considerable lower friction for downward scans. This behavior leads to friction anisotropy in the direction of locomotion. The same result is found for the dorsal scales of sandfish (Scincus scincus) and a polymeric replica of scales of the Chinese cobra (Naja atra). The overall effect increases linearly with step height. Although different snake species exhibit diverse step heights, the distribution of step heights along the body of the examined snakes is very similar indicating dedicated friction anisotropy in different sections along snake bodies.

O 34.4 Tue 14:45 H13

surface characterization of ruthenium as novel barrier layer during the chemical mechanical polishing process of integrated circuit for sub-10 nm technology node — •jie cheng[2], xinchun lu[1], and jinshan pan[2] — [1]state key lab of tribology, tsinghua university, beijing, china — [2]division of surface and corrosion science, kth royal institute of technology, Stockholm, Sweden

Ruthenium (Ru), as a novel diffusion barrier layer, is quite promising in the application of the sub-10 nm technology node of integrated circuit. During the chemical mechanical polishing process of Ru, complex changes will occur on Ru surface and Cu/Ru interface under the function of both mechanical abrasion and the chemical corrosion. This paper focuses on the study of surface properties of Ru in potassium periodate solutions: chemical and physical properties of surface films on Ru such as thickness, compactness, uniformity, and chemical compositions; tribology and corrosion properties of Ru like corrosion, galvanic corrosion (between Ru and Cu), and tribo-corrosion during the abrasion process. On this basis, the material removal mechanism of Ru is fully revealed during the chemical mechanical polishing process, the technique of which is widely used to realize local and global planarization of wafer surfaces. Results explores the nature of tribo-corrosion: the galvanic corrosion between the abrasion induced depassivation area and the passivation area. The evolution of three periodical changes between Ru and Cu interface was also fully revealed by microscopic methods. The findings in the research have guiding significance to the smooth application of Ru as substitutive barrier layer.

O 34.5 Tue 15:00 H13

Projection Analysis of EXAFS Modulations — Alireza Bayat[1], Angelika Chassé[1], Reinhard Denecke[2], Stefan Förster[1], Paula Huth[2], Eva-Maria Zollner[1], and •Karl-Michael Schindler[1] — [1]Martin-Luther-Universität Halle-Wittenberg, Institut f. Physik, D-06099 Halle, Germany — [2]Wilhem-Ostwald-Institut f. Physikalische und Theoretische Chemie, D-04103 Leipzig, Germany

EXAFS modulations have been analysed using a direct projection method known from structure determinations using photoelectron diffraction [1]. In this method experimental EXAFS modulations are projected onto calculated ones with just one singular neighbouring atom at a series of distances. Compared to the usual analysis with a Fourier transform of the EXAFS modulation function, the systematic errors in initial values for nearest neighbor distances are significantly reduced from 40 - 80 pm to below 10 pm. This improvement results from the correct treatment of the energy dependence of the phase shift within the scattering process at the neighboring atom. Tests of the method are presented with experimental EXAFS modulations from strontium titanate and barium titanate single crystals as well as from a newly discovered barium titanate derived quasicrystalline film on a Pt(111) substrate [2].

References:
[1] P. Hofmann and K.-M. Schindler, Phys. Rev. B 47, 13941 (1993).
[2] S. Förster et al., Nature 502, 215 (2013).

O 34.6 Tue 15:15 H13

Removing Photoemission Features from Auger-yield NEXAFS Spectra — •Ole Lytken, Daniel Wechsler, and Hans-Peter Steinrück — Universität Erlangen-Nürnberg

Auger-yield is widely used for surface-sensitive NEXAFS measurements, but suffers from errors introduced by photoemission features travelling through the measured Auger peaks. We will present two-dimensional NEXAFS images, measured at the Materials Science beamline at Elettra in Trieste, and a procedure for removing the photoemission features travelling through the images. The procedure relies on describing the measured Auger-yield NEXAFS images as three

simple, one-dimensional spectra: NEXAFS, Auger and XPS, which are extracted through an iterative process. The procedure requires no additional reference measurements other than photon flux and the success of the cleanup process is easily verified by the resulting images.

O 34.7 Tue 15:30 H13

New reconstruction method for Metastable Induced Electron Spectra of molecules on solid surfaces — •Tobias B. Gäbler, Wichard J. D. Beenken, and Erich Runge — Technische Universität Ilmenau, Institute for Physics, Ilmenau, Germany

The Metastable Induced Electron Spectroscopy (MIES) allows an extremely sensitive electronical characterization of liquid and solid surfaces by deexcitation of metastable rare gas atoms. We present ab initio calculations of MIES spectra of molecules physisorbed on solid surfaces. For this purpose, we calculate spatially distributed transition rates of the Auger deexcitation process without the simplifying assumptions as proposed by Kantorovich et al. [1]. Thereby, we model the density of metastable Helium atoms along a series of trajectories approaching the sample molecule. According to experimental results for benzene [2], our calculations demonstrate - in contrast to the approach of Kantorovich et al. [1] - an anisotropy of the MIES spectra in respect not only to the molecule orientation but also to the electron detection direction. Thus, due to the ajustable direction of the incidence of metastable helium and of the detection of emitted Auger-electrons in the simulation, our method is able to forecast MIES spectra for arbitrary experimental setups.

[1] L.N. Kantorovich, A.L. Shluger, P.V. Sushko, A.M. Stoneham, Surf. Sci. 444 (2000) 31-51

[2] J. Günster, G. Liu, V. Kempter, D.W. Goodman, Surf. Sci. 415 (1998) 303-311