MI 9: Poster: Microanalysis and Microscopy

Chair: Hartmut S. Leipner, Enrico Langer

Time: Wednesday 15:00–17:00 Location: Poster B2

MI 9.1 Wed 15:00 Poster B2

A new soft X-ray microscopy endstation for time-resolved experiments at PETRA III — •Philipp Wessels[1], Moritz Schlie[1], Marek Wieland[1], Johannes Ewald[2], Gennaro Abbati[2], Stefan Baumbach[2], Johannes Overbuschmann[2], Thomas Nisius[2], Jens Viefhaus[3], Thomas Wilhein[2], and Markus Drescher[1] — [1]Institute for Experimental Physics, University of Hamburg, Germany — [2]Institute for X-Optics, RheinAhrCampus Remagen, Germany — [3]Deutsches Elektronen-Synchrotron DESY, Hamburg, Germany

We present first results of a new full-field transmission microscope for the soft X-ray beamline P04 at the high brilliance synchrotron radiation source PETRA III. A flat-top illumination field of 20 μm diameter is generated by a grating condenser and the sample plane is imaged by a micro zone plate with outermost zone width of 50 nm. The microscope is built into a mobile endstation vacuum system with in-house developed encoded three-axis piezo motorized stages for high accuracy positioning of all microscopy-components inside the chambers. In the first images a resolution of 70 nm was achieved.

For future applications, the microscope can be equipped with a mobile synchronized femtosecond laser system to perform time-resolved pump-probe experiments for example on magnetic nanostructures via X-ray magnetic circular dichroism (XMCD) spectro-microscopy with a time-resolution limited only by the PETRA III pulse duration of 44 ps root mean square.

MI 9.2 Wed 15:00 Poster B2

Ring Laser Gyroscope with Varying Arm Lengths — •Kathrin Schaller and Lothar Kador — University of Bayreuth, Institute of Physics and Bayreuther Institut für Makromolekülforschung (BIMF), Bayreuth, Germany

Variations of the lock-in threshold of a ring laser gyroscope upon slight changes of its arm lengths have been investigated. The setup features a HeNe discharge tube and a rectangular ring cavity encompassing about 0.2 square-meters and is built on a precision rotating stage. Two of the cavity mirrors are mounted on piezo translators, so that their positions can be changed in the range of a few micrometers with or without varying the total cavity length. The influence of variations of the arm lengths on the lock-in threshold was studied in the regime of single-mode and dual-mode operation of the laser and for different rotation rates.

MI 9.3 Wed 15:00 Poster B2

Beam characteristics of the new positron source NEPOMUC *upgrade* — •Thomas Gigl, Christian Piochacz, Florian Lippert, Samantha Zimnik, Markus Reiner, Philip Pikart, Hubert Ceeh, Josef-Andreas Weber, Sebastian Vohburger, and Christoph Hugenschmidt — Technische Universität München, Physik-Department E21 und FRM II, 85748 Garching

The neutron-induced positron source NEPOMUC at the FRM II provides a mono-energetic positron beam of high intensity for a variety of experiments in the field of solid state and surface physics. In order to increase the beam brightness the first version of NEPOMUC was improved and now replaced by NEPOMUC *upgrade*[1]. At the end of 2012 we succeeded to extract a slow positron beam (0,2-1 keV) with enhanced brightness. Detailed measurements of the beam characteristics such as intensity and beam shape will be presented. Furthermore an overview of recent and planed positron beam experiments for fundamental research and application in solid state physics is given.

References:

[1] C. Hugenschmidt, C. Piochacz, M. Reiner, K. Schreckenbach, The NEPOMUC *upgrade* and advanced positron beam experiments, New Journal of Physics 14, 2012

MI 9.4 Wed 15:00 Poster B2

Novel techniques and applications in (C)DB-spectroscopy at the NEPOMUC positron beam — •Markus Reiner[1], Benjamin Löwe[2], Philip Pikart[1], and Christoph Hugenschmidt[1] — [1]Technische Universität München, Physik-Department E21 und FRM II, 85748 Garching — [2]Universität der Bundeswehr München, Institut für Angewandte Physik und Messtechnik LRT2, 85577 Neubiberg

In (Coincident) Doppler Broadening Spectroscopy ((C)DBS) the positron is used as a nanoprobe, which is highly sensitive to open volume defects, vacancy-atom complexes and atom clusters of higher positron affinity. The coincident detection of the Doppler shifted annihilation quanta enables the characterization of the chemical vicinity of the annihilation site. The high intensity positron beam NEPOMUC at the FRM II has been successfully used for depth dependent and in-situ investigations at high temperatures. Due to the short measurement times, CDBS at NEPOMUC enables novel applications like studies on thin film annealing and alloying. Currently, a new sample heating device is installed in order to allow in-situ measurements at temperatures up to 1300 K. Furthermore, a new detector system of two pixelated HPGe detectors is set up and will be used for the 3D detection of electron momenta. Within this contribution, recent measurements as well as new developments at the CDB-spectrometer will be presented. Financial support within the project no. 05KI0WOB by the BMBF is gratefully acknowledged.

MI 9.5 Wed 15:00 Poster B2

Investigations of Co-Ni-Al ferromagnetic shape memory alloys by means of X-ray Kossel diffraction and the EBSD method — Enrico Langer[1], Siegfried Däbritz[1], •Mateus Melo[1,2], Leonid Potapov[1,3], and Jaromir Kopeček[4] — [1]Technische Universität Dresden, Institut für Festkörperphysik, Helmholtzstraße 10, 01062 Dresden, Germany — [2]Universidade Presbiteriana Mackenzie, Departamento de Engenharia de Materiais, Rua da Consolação, 930, CEP: 01302907, Consolação - São Paulo - SP, Brazil — [3]St. Benno-Gymnasium Dresden, Pillnitzer Straße 39, 01069 Dresden, Germany — [4]Academy of Sciences of the Czech Republic, Institute of Physics, Na Slovance 2, 18221 Prague, Czech Republic

Current research activities are focussing on a complete understanding of the structure and the behavior of ferromagnetic shape memory alloys (FSMA). The Co-Ni-Al system attracts special attention in the area of FSMA due to certain features such as good oxidation resistance, low density and appreciable ductility at room temperature. The present work studied austenitic single crystals with nominal composition $Co_{38}Ni_{33}Al_{29}$ (matrix B2-β-phase with precipitates of A1-γ-phase) by means of X-ray Kossel diffraction and EBSD within a scanning electron microscope. The samples were prepared by the Bridgman method and grown in [100] direction. Overlaps of Kossel reflections of two different crystal phases were observed which allowed to determine precisely the orientation relationship as Kurdjumow-Sachs: $(111)_{A1} \parallel (110)_{B2}$, $[\bar{1}10]_{A1} \parallel [\bar{1}1\bar{1}]_{B2}$. Moreover, remarkable dark regions (lower backscatter coefficient η) between the B2 matrix and the γ-phase were seen using backscattered electrons. On the basis of the Kossel investigations it may be concluded that this structure along the boundary is connected to the measured exact plane orientation relationship (misorientation within a few tenths of a degree) and therefore reveals areas of excellent crystal quality with very low dislocation density.

MI 9.6 Wed 15:00 Poster B2

Characterization of Mechanical Properties of qPlus Sensors — •Jan Berger, Martin Švec, Martin Müller, Martin Ledinský, Antonín Fejfar, Pavel Jelínek, and Zsolt Majzik — 1Institute of Physics of the Czech Academy of Science, Prague, 162 00, Czech republic

Tuning fork based sensors (qPlus) became frequently used in non-contact atomic force microscopy (nc-AFM) last years. However, precise characterization of mechanical properties of each sensor is crucial for proper estimation of measured quantities such as forces or the dissipation energy. If a prong of the tuning fork is shortened to achieve higher electrical sensitivities (i.e. to produce more charge per oscillation) the mechanical parameters must be calibrated again.

In this poster we present a comparison of three different methods that can be used for estimating the stiffness of qPlus sensors. The first method is based on continuum theory of elasticity. The second (Cleveland's method) uses change in the eigenfrequency, which is induced by loading of small masses. Finally, the stiffness is obtained by analyses of the thermal noise spectrum. We show that all three methods give similar results. Surprisingly, neither the gold wire nor the gluing rise to significant changes of the stiffness.

We describe a fast and cost-effective way to perform the Cleveland's method, based on gluing small pieces of a tungsten wire. The mass is obtained from the volume of the wire, which is measured by optical microscope. For detection of oscillation eigenfrequencies under ambient conditions, we designed and built a device for testing qPlus sensors.

MI 9.7 Wed 15:00 Poster B2

Detecting the Water Bridge Formation in Atomic Force Microscopy Using Dynamic Force Spectroscopy: Numerical Simulations and Experiments — •Mahfujur Rahaman[1], Raul D. Rodriguez[1], Lilibeth Leal[1], Alexander Villabona[1], Emmanuelle Lacaze[2], Jacques Jupille[2], and Dietrich R.T. Zahn[1] — [1]Semiconductor Physics, Chemnitz University of Technology, Chemnitz, Germany — [2]Institut des Nano-Sciences de Paris (INSP), Paris, France

Experimental analysis of force spectroscopy is a challenging issue due to the high non-linearity of the tip-sample interaction forces. In this work, numerical simulations are used in order to support experimental results in dynamic mode force spectroscopy obtained on hydrophilic-hydrophilic and hydrophilic-hydrophobic systems. Several tip-sample interaction forces such as long-range van der Waals force, short-range adhesive and repulsive forces are taken into account for simulating amplitude and phase vs. distance curves (APD). In addition to these forces, it is found that capillarity plays an important role in the AFM dynamics. The capillary force arises from the formation of water meniscus due to the liquid condensation between tip and sample under ambient conditions. In this contribution we propose that the attractive/repulsive transition in APD curves are affected by this capillary force. Numerical simulations are performed taking into account capillarity with exact simulated solutions for a meniscus at different relative humidity and tip-sample distances. A good agreement between our numerical model and the experimental results has been observed.

MI 9.8 Wed 15:00 Poster B2

Optimization of the differential conductance contrast in spin-polarized room-temperature scanning tunneling microscopy of e-fct Mn on Co/Cu(001) — •Jiaming Song, Chii-Bin Wu, and Wolfgang Kuch — Freie Universität Berlin, Fachbereich Physik, Institut für Experimentalphysik, Arnimallee 14, 14195 Berlin, Germany

Spin-polarized scanning tunneling microscopy is an effective technique to study the magnetic structure of magnetic surfaces at the nanoscale. We have used a ferromagnetic Fe-ring probe with in-plane spin sensitivity to record differential conductance maps from ultra-thin epitaxial antiferromagnetic Mn layers on Co/Cu(001) at room temperature. We observe a clear contrast between areas of different Mn thicknesses, which reverses as a function of bias voltage. To compare to dI/dV-V curves of the respective areas obtained at a certain bias voltage and constant tip height, one needs to take into account the effect of different bias voltages on the tip height in areas with different spectroscopic contrast. Correcting the dI/dV-V curves correspondingly using a simultaneously recorded I-V curve leads to a good agreement with the bias dependence of the contrast that is observed in constant-current scans of differential conductance maps. This can be used to quickly estimate the bias voltages at which a contrast reversal occurs, and to identify the conditions for maximum spectroscopic spin contrast. We demonstrate this for 4.6 monolayers (ML) antiferromagnetic e-fct Mn on 4.8 ML Co/Cu(001).

MI 9.9 Wed 15:00 Poster B2

Coupling Kelvin Probe Force Microscopy and Raman Spectroscopy — •Susanne Müller, Raul D. Rodriguez, Evgeniya Sheremet, Alexander Villabona, and Dietrich R.T. Zahn — Semiconductor Physics Group, Chemnitz University of Technology, 09126 Chemnitz, Germany

The Atomic Force Microscope (AFM) is currently one of the most used tools to investigate the topography of samples with nanometer resolution in three dimensions. However, the AFM lacks chemical sensitivity. Therefore, in order to simultaneously achieve chemical information, the AFM needs to be equipped with electrical or optical capabilities. The most prominent techniques in these fields are Kelvin probe force microscopy (KPFM) and tip-enhanced Raman spectroscopy (TERS). In this work we aim at combining these methods, with the goal of achieving high-resolution Raman, while scanning a surface in KPFM. We are able to fulfill this goal by investigating a test sample consisting of a thin organic film of manganese phthalocyanine deposited on a two dimensional array of silver coated polystyrene spheres. We found that strong interactions between the two methods take place and should be further investigated when KPFM and TERS are being used at the same time.

MI 9.10 Wed 15:00 Poster B2

Three-dimensional Scanning Near-field Optical Microscopy with Single Color Centers — •Thomas Oeckinghaus, Julia Tisler, Rainer Stöhr, Roman Kolesov, Rolf Reuter, Friedemann Reinhard, and Jörg Wrachtrup — 3. physikalisches Institut, Universität Stuttgart

We are using single color centers as a light source for apertureless scanning near-field optical microscopy. Specifically, we use a nanodiamond of a size below 20 nm, containing only a single nitrogen-vacancy color center (NV), which we attach to the tip of an AFM.

This technique offers the opportunity to investigate near-field effects between the NV and another object that only occur at a range below a few nanometers. For example, we were able to map the fluorescence quenching of the NV caused by a graphene monolayer in all three dimensions.

Beside these result, I will present our implementation of a technique to acquire three-dimensional fluorescence images from a single tapping-mode AFM scan. [Mangum et al., Nano Letters, 2009, 9]