VACUUM SCIENCE AND TECHNOLOGY

VAKUUMPHYSIK UND VAKUUMTECHNIK (VA)

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Homepage des Fachverbandes:
www.vakuumphysik.de

OVERVIEW OF INVITED TALKS AND SESSIONS

(lecture rooms HSZ 101)

Invited Talks

VA 1.1	Mon	10:00	(HSZ 101)	**High performance coatings for UV and EUV (Next Generation Lithography)**, Norbert Kaiser
VA 3.1	Mon	14:00	(HSZ 101)	**The Positron Beam Facility NEPOMUC and Positron Experiments at FRM-II**, Christoph Hugenschmidt, Thomas Brunner, Stefan Legl, Jakob Mayer, Christian Piochacz, Klaus Schreckenbach, Martin Stadlbauer
VA 5.1	Tue	14:00	(TRE Phys)	**Understanding Scanning Tunneling Microscopy Experiments on Transition-Metal Structures**, Stefan Heinze

Sessions

VA 1	**Vacuum coatings**	Mon	10:00–10:40	HSZ 101	VA 1.1–1.1
VA 2	**Surfaces, instruments and systems**	Mon	10:40–12:40	HSZ 101	VA 2.1–2.6
VA 3	**Positron beam facility**	Mon	14:00–14:40	HSZ 101	VA 3.1–3.1
VA 4	**Instruments for neutrons**	Mon	14:40–17:40	HSZ 101	VA 4.1–4.9
VA 5	**Gaede-Preis-Vortrag**	Tue	14:00–14:45	TRE Phys	VA 5.1–5.1

Annual General Meeting of the Section Vacuum Science and Technology

Mon 17:45–18:15 HSZ101

Tagesordnung:
TOP 1: Bericht des FV-Vorsitzenden
TOP 2: Fachliche Ausrichtung des FV
TOP 3: Namen des FV
TOP 4: Verschiedenes

Sessions

– Invited, Contributed Talks and Posters –

VA 1 Vacuum coatings

Time: Monday 10:00–10:40 Room: HSZ 101

Invited Talk VA 1.1 Mon 10:00 HSZ 101

High performance coatings for UV and EUV (Next Generation Lithography) — •Norbert Kaiser — Fraunhofer IOF, Albert Einstein Str. 7, 07745 Jena

High laser pulse energy, ultra-short pulse lengths, high repetition rates as well as short wavelengths have given ultraviolet radiation a prominent role in optics. It is mainly excimer lasers which show potential for future applications such as ultra-precision machining and measurement, minimal invasive brain, vascular, and eye surgery, data communication, and LSI electronic devices. The main problem is efficiency. Only very few of the expensively generated UV photons can be used. Stable and efficient UV configurations require stable and efficient optics with extreme technical demands. Efficient optics can only be coated optics and, consequently, stable coatings are one of the most important prerequisites for solving the problem of low efficiency. Laser fusion and optical lithography are the technology drivers for developing optical components and coatings for shorter and shorter wavelengths. Investigations are being concentrated on the excimer laser wavelengths (248 nm, 193 nm). Even much shorter wavelength of about 13.5 nm (EUV) are becoming important now for the Next Generation Lithography.

VA 2 Surfaces, instruments and systems

Time: Monday 10:40–12:40 Room: HSZ 101

VA 2.1 Mon 10:40 HSZ 101

Preparation of Heusler alloys – Evaporation chamber design and results — •Andreas Volland and Christian Heyn — Institut für Angewandte Physik, Universität Hamburg, Jungiusstraße 11, 20355 Hamburg

One major challenge for the development of hybrid spintronic devices is the injection of spin-polarized electrons through the interface between the semiconductor material and the metallic ferromagnet. We grow InGaAs based high electron mobility heterostructures with solid-source molecular beam epitaxy. In order to avoid oxidation and contamination of the interface layer between semiconductor heterostructure and ferromagnetic metal contact, it is essential to install the metallization chamber at the vacuum system of the semiconductor growth chamber. In this presentation we show technological aspects of our growth system and first results of Heusler alloy Ni_2MnIn deposition on GaAs and InGaAs surfaces.

VA 2.2 Mon 11:00 HSZ 101

STM study on surface modifications on vacuum fired 304L stainless steel — •Axel Stupnik and Manfred Leisch — Institute for Solid State Physics, Graz University of Technology, Petersgasse 16, 8010 Graz, Austria

In UHV and XHV applications high temperature bakeout (vacuum firing) is a common method to reduce the hydrogen outgassing rate from stainless steel surfaces. This procedure reduces the amount of hydrogen in the bulk. At low bulk concentration hydrogen outgassing is basically limited by surface recombination. The surface of glass bead blasted 304L steel samples was investigated by STM after normal bakeout procedure at 300°C and after vacuum firing at 1000°C. During vacuum firing a complete reconstruction of the surface can be observed. Already after 5 min of vacuum firing the formation of (111) terraces with monoatomic steps can be found. Slightly tilted crystallites exhibit (111) terraces intersected by bunched steps and facets. These facets form a nearly regularly pattern corresponding in orientation almost to the (100) and (110) planes. After 15 min vacuum firing large (111) terraces with extensions up to 200nm intersected by bunched steps can be observed. The general appearance of the surface after vacuum firing indicates a significant reduction of active sites for recombination of hydrogen. This supports the present understanding of outgassing for this material.

Supported by Zukunftsfonds des Landes Steiermark.

VA 2.3 Mon 11:20 HSZ 101

The Radiation Source ELBE at Forschungszentrum Rossendorf — •Peter Michel — Forschungszentrum Rossendorf, 1314 Dresden, Pf 510119

The radiation source ELBE (Electron Linac of high Brilliance and low Emittance) at Forschungszentrum Rossendorf is based on a superconducting linac that produces a high power continuous wave (cw) electron beam up to 40 MeV and 1 mA. The linac is used to drive two free-electron lasers producing infrared radiation from 5 to 150 microns wavelength. Additionally, from several conversion targets MeV-bremsstrahlung ($<$ 20 MeV) and X-rays (10-100 keV) from electron channelling are generated. In the future even neutron and positron beams will be available at ELBE. The used superconducting RF accelerator technology and details of the machine instrumentation, in particular the electron beam diagnosis will be described.

VA 2.4 Mon 11:40 HSZ 101

Development of a Superconducting RF Photoelectron Injector — •Jochen Teichert — Forschungszentrum Rossendorf, P.O. Box 510119, 01314 Dresden, Germany

A superconducting rf photo electron injector (SRF gun) is under development at the Forschungszentrum Rossendorf. The project aims at several issues: improvement of the beam quality for the ELBE superconducting electron linac, demonstration of feasibility of this gun type, investigation of critical components, and parameter studies for future application (BESSY-FEL, 4GLS). The design layout of the SRF photoinjector, the parameters of the superconducting cavity and the expected electron beam parameters are presented. The SRF gun has a 3+1/2-cell niobium cavity working at 1.3 MHz and will be operated at 2 K. The three full cells have TESLA-like shapes whereas the half-cell has an special form obtained from numerical optimization. In the half-cell a Cs2Te photocathode is situated which will be cooled by liquid nitrogen. In 2005, the main parts for He cryostat like vacuum vessel, cryogenic and magnetic shields were fabricated. Test benches for the cathode cooling system and the cavity tuner were assembled and the measurements performed. The photo cathode preparation lab has been arranged, and the diagnostic beam line has been designed. After delivery of the Nb cavity, its rf properties were measured. The cavity was tuned and its chemical treatment is started.

VA 2.5 Mon 12:00 HSZ 101

Traceability and calibration of the new static expansion system of metas. — •Christian Wuethrich[1] and Moussa Coulibaly[2] — [1]metas, Lindenweg 50, CH-3003 Bern-Wabern — [2]Ecole des mines de Douai, 941 rue Charles Bourseul, BP 838, F-59508 Douai

The pressure laboratory of Metas, the Swiss National Metrological Institute, performed the characterisation and the first calibrations of the new static expansion system MSE1 in 2005. The system consists of 4 expansion stages mounted in cascade and allowing an ultimate calculable pressure of 5*10-6*Pa. The volumetric ratios of the system have been measured using the well known technique of gas accumulation by successive expansion and also with the newly developed technique of gas depletion by successive expansion. The results of the two techniques are equivalent within the uncertainties. The consistency of the pressures generated has been demonstrated by comparison in the range 1*Pa to 1000*Pa with a digital piston manometer. The consistency of the system at lower pressure has been demonstrated by determining the accommodation factor of two spinning rotating gauges over 5 decades of pressure, using two different expansion schemes in the system. The standard deviation of the accommodation factors remains well below the uncertainties.

VA 2.6 Mon 12:20 HSZ 101

Modell zur Beschreibung der Kompression von Wälzkolben-Pumpen — •Gerhard Voss — Leybold Vacuum Köln

Mit einer Methodik, die für die Berechnung der Kompressions-Kurven von Klassischen Turbo-Molekularpumpen entwickelt wurde [G. Voss in Vakuum in Forschung und Praxis 17 (2005) Nr. 6], können auch die Kompressions-Kurven von Wälzkolben-Pumpen berechnet und systematisch analysiert werden. Für die Abhängigkeit des Hochvakuum-Drucks und der Kompression vom Vorvakuum-Druck liefert das Modell einfache analytische Funktionen. Aus den Kompressions-Kurven bei endlichem Gas-Durchsatz (Q > 0) kann die Kompressions-Kurve für Gas-Durchsatz Null gewonnen werden, wobei die Rückförderung der Wälzkolben-Pumpe zu berücksichtigen ist. Der Vergleich mit experimentellen Daten zeigt, dass das vorgestellte Modell eine exzellente qualitative und quantitative Beschreibung der beobachteten Phänomene liefert.

VA 3 Positron beam facility

Time: Monday 14:00–14:40 Room: HSZ 101

Invited Talk

VA 3.1 Mon 14:00 HSZ 101

The Positron Beam Facility NEPOMUC and Positron Experiments at FRM-II — •Christoph Hugenschmidt[1,2], Thomas Brunner[2], Stefan Legl[2], Jakob Mayer[2], Christian Piochacz[1], Klaus Schreckenbach[1,2], and Martin Stadlbauer[2] — [1]ZWE FRM II, Technische Universität München, Lichtenbergstraße 1, 85747 Garching — [2]E21, Physik Department, Technische Universität München, James-Franck-Straße, 85747 Garching

The in-pile positron source NEPOMUC (NEutron induced POsitron source MUniCh) of the Munich research reactor FRM-II delivers a low-energy positron beam of highest intensity. The primary kinetic energy of the positrons can be varied in the range between 15 eV and 1 keV. The maximum yield of positrons was up to $5 \cdot 10^8$ moderated positrons per second. New instruments for beam diagnostics have been implemented for the determination of the positron intensity and for positron beam profile measurements.

In the present arrangement of NEPOMUCs instrumentation the mono-energetic positron beam is magnetically guided to different experiments: a coincident Doppler broadening spectrometer (CDBS) and a PAES (positron induced Auger electron spectroscopy) analysis chamber. At present an apparatus for the production of the negatively charged Positronium ion is connected to the beam line in a collaboration between TUM and the Max-Planck Institute for nuclear physics. An overview of the current status of the positron beam facility is given and first experimental results are presented.

VA 4 Instruments for neutrons

Time: Monday 14:40–17:40 Room: HSZ 101

VA 4.1 Mon 14:40 HSZ 101

Implementation of the Munich Spm at Nepomuc — •Christian Piochacz[1], Gottfried Kögel[2], Werner Egger[2], Peter Sperr[2], Werner Triftshäuser[2], and Günther Dollinger[2] — [1]TU München, ZWE FRM-II, Lichtenbergstr. 1, 85747 Garching — [2]UniBw München, LRT/2, Werner-Heisenberg-Weg 39, 85577 Neubiberg

The Munich scanning positron microscope (Spm) permits positron lifetime measurements with a lateral resolution down to 2 μm. A limit in using the SPM was set by the long measurement times of several days per picture due to the low intensity positron beam produced by standard ^{22}Na source. This disadvantage will be overcome by installing the Spm at the high intensive positron beam facility Nepomuc at the research reactor FRM-II in Garching. Thus the time for one measurement will be shorten by a factor 60 and the lateral resolution will improve to about 100 nm.

Because of the beam characteristic of the Nepomuc source an interface is needed, which enhances the phase space density of the beam. The requirements, which have to be fulfilled by the interface, will be pointed out and an overview of the different components (bunching units, remoderation stage and rf-elevator) will be given.

VA 4.2 Mon 15:00 HSZ 101

MIRA - A flexible instrument for long wave length neutrons — •Robert Georgii[1], Sebastian Mühlbauer[2], and Peter Böni[2] — [1]ZWE FRM-II, TUM, Lichtenbergstr.1, 85747 Garching — [2]E21, Physikdepartment, TUM, James-Frankstr., 85747 Garching

MIRA, the beam line for very cold neutrons at the FRM-II provides a beam of cold neutrons ($7\AA < \lambda < 30\AA$). The instrument has several different operation modes. Currently it can be used as a reflectometer and as a SANS machine. Both modes can be combined with a spin echo-option or a full 3D-polarisation analysis. Magnetic fields up to 10 Tesla and temperatures in the range of mK to 2000 K can be provided using the FRM-II standard sample environment. The instrument is furthermore ideally suited as a testing platform for new experimental set-ups as it is constructed in a modular way allowing for quick configuration changes. Here the instrument and its sample environment together with selected measurements showing the use of the different modes of operation will be presented.

VA 4.3 Mon 15:20 HSZ 101

Horizontal ToF-Reflectometer REFSANS at FRM-II: Potential and First Results — •Reinhard Kampmann[1], Martin Haese-Seiller[1], Valery Kudryashov[1], Bert Nickel[2], Christian Daniel[3], Wilhelm Fenzl[3], Kirstin Seidel[2], Andreas Schreyer[1], Erich Sackmann[3], and Joachim Rädler[2] — [1]Institut für Werkstoffforschung, GKSS-Forschungszentrum Geesthacht GmbH, D-21502 Geesthacht, Germany — [2]Lehrstuhl für Experimentelle Physik/Biophysik, Sektion Physik, Ludwig-Maximilians-Universität, Geschwister-Scholl Platz 1, D-80539 München, Germany — [3]Physik-Department E22, Technical University Munich, 85748 Garching, Germany

The reflectometer REFSANS allows the performce of comprehensive analyses of vertical and lateral surface and interface structures by means of specular and off-specular neutron reflectivity as well as small-angle neutron scattering at grazing incidence (GISANS). All measurements can be performed on air-water interfaces with horizontally aligned samples. This is achieved by a novel ToF- and neutron optical design of the instrument that allows settings of very different scattering geometries and resolutions. The performance of REFSANS will be discussed with relation to the minimum specular reflectivity achievable both for a strongly and a weekly incoherently scattering substrate. Furthermore, the potential of REFSANS for the investigation of laterally structured surfaces by means of GISANS is presented. REFSANS can optionally be operated with polarized neutrons including polarization analysis (3He-filter) from autumn 2006.

VA 4.4 Mon 15:40 HSZ 101

PANDA - first results from the cold three axes spectrometer at FRM-II — •Astrid Schneidewind[1], Peter Link[2], and Michael Loewenhaupt[1] — [1]TU Dresden, Inst. f. Festkörperphysik, 01062 Dresden — [2]TU München, FRM-II, Lichtenbergstr. 1, 85747 Garching

We report about the commissioning and first experimental results of the cold neutron three axes spectrometer PANDA at the new research reactor FRM-II. The obtained data are within our expectations with respect to resolution and intensity from previously reported simulations confirming the design concept of PANDA.

VA 4.5 Mon 16:00 HSZ 101

New facilities of the JCNS for ultra-high resolution neutron spectroscopy — •Michael Monkenbusch, Olaf Holderer, Michael Ohl, Ralf Biehl, and Dieter Richter — IFF, Forschungszentrum Juelich, D-52425 Juelich

The Jülich Centre of Neutron Science (JCNS) will in the near future supply two neutron spin-echo spectromteres to the user community. These ultra-high resolution spectrometers will be located at the new FRMII reactor and at the new MW-spallation source in Oak-Ridge. The FRMII instrument is an enhanced version of the FRJ2-NSE which is in operation at the FRJ2-DIDO reactor since 1996. With new electronics, improved correction elements and adjustment degrees of freedom it will benefit from increased flux and better neutron extraction allowing the usage of neutrons from 4.5Å to $\simeq$ 16Å or longer if the intensity is sufficient. The flux gain on the sample due to reactor power and larger beam cross section will be in the range of a factor of 10. With a maximum field integral of 0.5Tm Fourier times beyond 200ns will be accessible at 13Å wavelength. The scattering angle range extends from 2^0 to 90^0. It is planned that the instrument will be operational at the FRMII end of 2006. With a somewhat longer time horizon we are constructing a NSE instrument at the SNS spallation source in Oak Ridge. Using short fully compensated superconducting main solenoids it allows for a magnetically shielded enclosure necessary for stable and undisturbed operation. The design field integral is 1.5Tm, using a broad band of incoming neutrons a dynamical range of $1{:}10^6$ will be achieved and a maximum Fourier time at 18Å is one of the design goals.

VA 4.6 Mon 16:20 HSZ 101

The new V12a diffractometer at HMI and neutron computerized tomography — •Markus Strobl[1,2], Wolfgang Treimer[1,2], and André Hilger[1,2] — [1]Hahn Meitner Institut, Glienickerstr. 100 14109 Berlin — [2]University of Applied Sciences (TFH) Luxemburger Str. 10 13353 Berlin

Double crystal diffractometers (DCD) are widely used for structural investigations at the limit between macroscopic and microscopic inner structures of sample materials. Operating in an ultra small angle neutron scattering (USANS) q-range between 10^(-4) nm^(-1) and 10^(-1) nm^(-1) structures between 50 nm and nearly 100 micrometer can be resolved. Hence the DCD connects the resolvable ranges of small angle neutron scattering (SANS) instruments and neutron tomography facilities. However, the DCD does not only link the resolvable size ranges but can also be operated to yield both, q-space information on microscopic structures combined with real space information in the range of macroscopic inner structures. This method was developed in recent years at the V12 DCD at HMI by introducing refraction and USANS contrast for tomography. The new V12 DCD set-up has now been optimised to exploit all the opportunities of USANS measurements, refraction and USANS contrast tomography and conventional attenuation contrast tomography with an intense monochromatic neutron beam. The new contrast methods will be introduced as well as the final set-up of the V12 instrument. Additionally several examples and results achieved by the new techniques and instrument will be given.

VA 4.7 Mon 16:40 HSZ 101

The new cold neutron radiography and tomography instrument CONRAD at HMI Berlin — •Nikolay Kardjilov[1], André Hilger[1,2], Ingo Manke[1], Markus Strobl[1,2], Wolfgang Treimer[1,2], and John Banhart[1] — [1]Hahn-Meitner-Institut Berlin — [2]University of Applied Sciences Berlin (TFH), FB II

The new cold neutron radiography instrument CONRAD is a multifunctional facility for radiography and tomography with cold neutrons at Hahn-Meitner-Institut Berlin. It is located at the end of a curved neutron guide, which faces the cold neutron source of the BER-II research reactor. The geometry provides a cold neutron beam with wavelengths between 0.2 nm and 1.2 nm. Two measuring positions are available for radiography and tomography investigations. The first one is placed at the end of the guide and it is optimized for in-situ experiments in which a high neutron flux is required. The available flux at this position is app. 10^9 cm^-2s^-1. The second measuring position uses a pin-hole geometry which allows better beam collimation (L/D up to 500) and higher image resolution in the range of 200 microns in the CCD based detector system (15 x 15 cm^2). The use of cold neutrons for radiography purposes increases the image contrast and improves the sensibility for e.g. the detection of small amounts of water and hydrogen containing materials in metal matrixes. On the other hand the cold neutron beam can be modified easily by using diffraction and neutron optical techniques. This enables to perform radiography and tomography experiments with more sophisticated measuring techniques. Recent examples of research and industrial applications will be presented.

VA 4.8 Mon 17:00 HSZ 101

A double monochromator device for the CONRAD radiography instrument at HMI and applications — •Markus Strobl[1,2], Nikolay Kardjilov[1], André Hilger[1,2], Wolfgang Treimer[1,2], and Ingo Manke[1] — [1]Hahn Meitner Institut Glienickerstr 100 14109 Berlin — [2]Univerity of Applied Sciences (TFH) Luxemburger Str. 10 , 13353 Berlin

CONRAD is the new cold neutron radiography and tomography instrument at the Hahn Meitner Institute in Berlin which recently started operation as a part of the Berlin Neutron Scattering Centre (BENSC). It includes two measurement positions of which the first one directly at the end of the NL1b neutron guide was used to install a flexible monochromator device as an additionally available insert. While the CONRAD instrument uses in standard operation the full cold spectrum of the lower part of the guide a first PCG[002] monochromator with a mosaic spread of app. 1 degree is placed in the upper beam part deflecting neutrons downwards. The initial lower beam part is blocked by a shutter and on a linear manipulation table behind it the second corresponding graphite crystal is installed. Hence, while both crystals can be rotated to chosen Bagg angles, the second one can be positioned in along the original beam direction in order to reflect the monochromatic beam from the first crystal into the initial beam path of the CONRAD instrument. This construction enables to choose a monochromatic beam with wavelengths between 0.25 nm and 0.65 nm for high resolution imaging at the second measurement position of CONRAD app. 5 m downstream. Applications are ranging from energy selective radiography to stress mapping.

VA 4.9 Mon 17:20 HSZ 101

Strain mapping by energy selective neutron radiography — •Nikolay Kardjilov[1], André Hilger[1,2], Ingo Manke[1], Markus Strobl[1,2], Wolfgang Treimer[1,2], and John Banhart[1] — [1]Hahn Meitner Institut Glienickerstr. 100, 14109 Berlin — [2]University of Applied Sciences (TFH) Luxemburger Str. 10, 13353 Berlin

The neutron attenuation coefficient is resulting from different interactions of neutrons with matter. It can be divided into absorption, scattering and diffraction effects attenuating a neutron beam. While all of them are energy dependent especially the diffraction at crystalline and polycrystalline materials has a significant influence on the energy dependence of the attenuation coefficient by introducing so called Bragg-edges to the spectrum of the coefficient. Hence the spectroscopic analyses of the attenuation of a neutron beam passing a polycrystalline sample can identify and quantify crystalline phases, determine applied and residual stresses or the orientation distribution of crystallites. Inserting an energy selecting double monochromator device in the cold neutron radiography instrument (CONRAD) at HMI Berlin enables two dimensional mapping of these spectra on sample sizes up to at least 10 x 10 cm^2 with high spatial resolution. The device accesses a spectrum between 1.94 meV and 15.5 meV including e.g. Fe, Cu and Al Bragg edges. The first results of strain mapping obtained at the neutron radiography instrument CONRAD at HMI using its new energy-selective option will be presented.

VA 5 Gaede-Preis-Vortrag

Time: Tuesday 14:00–14:45 Room: TRE Phys

Prize Talk VA 5.1 Tue 14:00 TRE Phys

Understanding Scanning Tunneling Microscopy Experiments on Transition-Metal Structures — •Stefan Heinze — Institut für Angewandte Physik, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg

Scanning tunneling microscopy (STM) is one of the most important techniques to characterize nanostructures on surfaces with a resolution down to the atomic scale. However, the interpretation of such measurements is not trivial, especially on the atomic scale, due to contributions to the tunneling current from various sources such as structural, electronic, chemical, and magnetic properties. Successful interpretation approaches, e.g. the Tersoff-Hamann model, rely on an accurate description of the electronic structure of the sample. Hence, the combination with modern density functional theory (DFT) calculations has proven a powerful tool for the understanding of STM experiments.

Here, the theory of STM is applied to structures on transition-metal surfaces and a transparent method is introduced to correlate bandstructure features with STM measurements. With this approach surprising effects such as bias-dependent corrugation reversal, imaging of buried nanostructures, and even the detection of small spectroscopic signals due to spin-orbit coupling can be explained based on the electronic structure. Further, the theory of spin-polarized STM (SP-STM) is presented and the potential of SP-STM to unravel complex, e.g. non-collinear, magnetic structures on the atomic scale is demonstrated. A particular striking example is the verification of a two-dimensional antiferromagnetic structure in a monolayer of Fe, the prototypical ferromagnet, on W(001).