DS 28: Thin Film Applications

Time: Wednesday 9:30–12:00 Location: H8

Invited Talk DS 28.1 Wed 9:30 H8

Surface analytics with electron spectroscopy on coated steel sheets — •David Stifter — Christian Doppler Laboratory for microscopic and spectroscopic material characterisation, Zentrum für Oberflächen- und Nanoanalytik, Johannes Kepler Universität Linz, Altenberger Straße 69, A-4040 Linz, Austria

Modern steel industry faces the challenge to provide new innovative materials and products with properties which fulfill the requirements of the market, especially including aspects related to high strength, light weight, reliable galvanizability, increased corrosion resistance and aesthetics. Phenomena like surface segregation of alloying elements, formation of oxide layers and corrosion products as well as gradient formation within organic top coatings call for advanced analytical studies of the developed materials down to the nanoscale.

In this contribution X-ray photoelectron spectroscopy (XPS), Auger electron spectroscopy (AES) and reflection electron energy loss spectroscopy (REELS) will be shown to provide as surface sensitive analytical methods valuable insight for understanding the structure and processes occurring on the surfaces and interfaces of modern coated steel materials. In this context it will be underlined in detail that utmost care has to be taken in the investigation of such uncooperative surfaces, which exhibit a highly complex and heterogeneous nature. Adverse effects - related to differential charging or material degradation of partly unstable compounds formed on the surfaces - have to be carefully taken into account to perform accurate surface analytics.

DS 28.2 Wed 10:00 H8

Screening of Copper-Nickel thin film combinatorial library for electrocatalytic applications — •Isabella Pötzelberger[1], Andrei Ionut Mardare[1,2], and Achim Walter Hassel[1,2] — [1]Institute for Chemical Technology of Inorganic Materials Johannes Kepler University Linz, Altenberger Str. 69, 4040 Linz, Austria — [2]Christian Doppler Laboratory for Combinatorial Oxide Chemistry at the Institute for Chemical Technology of Inorganic Materials, Johannes Kepler University Linz, Altenberger Str. 69, 4040 Linz, Austria

A Cu-Ni thin film combinatorial library was screened for electrocatalytic oxidation of formaldehyde in alkaline solution using a 3D-printed flow type scanning droplet cell microscope. The entire compositional spread (1 to 14 at.% Ni) showed suitability for being used in formaldehyde detection with different efficiencies as evidenced by cyclic voltammetry performed with and without formaldehyde addition to the electrolyte. This difference is directly linked to the electrocatalysis of the oxidation process. Therefore a surface microstructure evolution along the library was investigated by SEM. Kinetic studies performed by varying rates of potential increase revealed a diffusion limited process as evidenced by the observed linearity between the current density and inverse scan rate. Amperometric measurements performed at various applied potentials indicated a sufficiently large increase in the current density plateaus responsible for formaldehyde detection suitable for being implemented in device fabrication showing a good reproducibility and stability in the electrocatalytic oxidation of formaldehyde.

DS 28.3 Wed 10:15 H8

Oxidation behaviour of arc evaporated (Ti,Cr,Al)N coatings studied by SR-XRPD — •Daniel Michael Ostach[1], Norbert Schell[1], Andreas Schreyer[1], Jens Birch[2], Jeremy Schroeder[2], Lina Rogström[3], Chen Yu-Hsiang[3], and Mats Johannson-Joesaar[4] — [1]Helmholtz-Zentrum Geesthacht Zentrum für Material- und Küstenforschung, 21502 Geesthacht, Germany — [2]Thin film physics, IFM, Linköping University, 581 83 Linköping, Sweden — [3]Nanostructured materials, IFM, Linköping University, 581 83 Linköping, Sweden — [4]SECO Tools AB, Fagersta, Sweden

Hard and wear resistant cubic (c)-(Ti,Al)N based coatings have many applications, such as protection of the underlying bulk material and improved wear resistance. In the cutting tool industry, the improved wear resistance increases the lifetime of the coated tools. The mechanical properties of TiAlN deteriorates at high temperatures due to formation of the hexagonal (h) AlN phase, while by alloying of Cr in (Ti,Al)N coatings the detrimental effect of h-AlN on the mechanical properties can be reduced. Further, the oxidation resistance of CrAlN coatings is improved compared to that of TiAlN, thus, a TiCrAlN coating could be expected to have both, high oxidation resistance and high mechanical properties. In this study, in-situ high-energy synchrotron radiation x-ray powder diffraction (SR-XRPD) during annealing in an air atmosphere has been performed to study the oxidation process of TiCrAlN. The results reveal that the oxidation behavior changes with Al-content and Ti-content and TiCrAlN with low Ti-content show a higher oxidation resistance.

DS 28.4 Wed 10:30 H8

Hard X-Ray Microscopy with Multilayer Zone Plates — •Christian Eberl[1], Florian Döring[1], Markus Osterhoff[2], Tim Salditt[2], and Hans-Ulrich Krebs[1] — [1]Institut für Materialphysik, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Institut für Röntgenphysik, University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

X-ray microscopy is due to the small wavelength and high penetration depth an auspicious technique for improved investigations of materials on nm-scale. For this, multilayer zone plates (MZP) with well-defined and smooth multilayers of low thickness grown on wires are promising optical elements. The combination of pulsed laser deposition (PLD) and focused ion beam (FIB) has been proven to be extraordinarily suitable for the fabrication of MZPs and we could demonstrate a sub-5nm hard x-ray focus [1,2]. In order to make those MZPs applicable for nanoscopy basically a larger overall multilayer thickness is required. For this, a deep understanding of the underlying processes (such as target changes as well as resputtering and backscattering during film growth) is essential. Hence, detailed investigations have been carried out using complementary methods such as X-ray diffraction (XRD), X-ray reflectivity (XRR), transmission electron microscopy (TEM) in cross section as well as SDTrimSP simulations. Here we present our latest results demonstrating that a compound optics (formed by Kirkpatrick-Baez mirrors and a high quality MZP) is usable for microscopy applications.

[1] Döring et al., Opt. Expr. 21 (2013); [2] Eberl et al., Appl. Surf. Sci. 307 (2014)

15 min. break.

DS 28.5 Wed 11:00 H8

Gradient gold island films for the optimization and quantification of surface enhanced infrared absorption — •Christoph Kratz, Tom Oates, and Karsten Hinrichs — Leibniz-Institut für Analytische Wissenschaften -ISAS- e.V., Berlin, Deutschland

Surface enhanced infrared absorption (SEIRA) has gained large interest for biosensor applications. SEIRA enables to boost sensitivity of the label free and non-destructive technique of IR-spectroscopy for studying ultrathin films by a factor of about 10-100. In conjunction with optical modeling and simulations IR spectroscopy allows for the interpretation of molecule specific vibrational bands to determine chemical and structural changes as well as the adsorbed/desorbed amount of molecules and proteins. Application of enhancement substrates with a thickness gradient allows studying the influence of thickness effects on the enhancement on a single substrate. These effects have been studied with a model system of a self-assembled monolayer of 4-mercaptobenzonitrile. Structural and optical properties of the bare and modified enhancement substrate were determined by various methods. The investigations show that an a priori indication of the enhancement can be obtained by the observation of a band related to the native oxide below the island film.

DS 28.6 Wed 11:15 H8

Minimizing thermal conductivity in laser deposited multilayers — •Florian Döring[1], Christian Eberl[1], Bea Jaquet[1], Christina Klamt[1], Henning Ulrichs[2], Maria Mansurova[2], Markus Münzenberg[3], and Hans-Ulrich Krebs[1] — [1]Institute for Materials Physics, University of Göttingen — [2]1st Institute of Physics, University of Göttingen — [3]Institute for Physics, University of Greifswald

Modern materials featuring a minimized thermal conductivity are desired for a variety of applications such as thermal power storage, thermoelectricity, specialized thermal barrier coatings, or even solid state refrigeration. In fundamental research, a good approach towards such materials lies in the combination of metals and insulators in nanoscale thin films, which can be produced by Pulsed Laser Deposition (PLD). This versatile thin film method allows production of ultra-thin multilayer films, which can consist of metals, semiconductors, oxides and polymers enabling fabrication of material stacks with high a high number of interfaces between different materials with a high acoustic mismatch. This composition leads to our goal of a reduced thermal conductivity due to phonon scattering and reflection. In this work, predominantly multilayers consisting of W and ZrO_2 respectively W and PC are pulsed laser deposited and carefully analyzed by electron microscopy, x-ray reflectometry and x-ray diffraction. Afterwards, the phonon dynamics in those materials are studied using fs-pump-probe reflectivity measurements. For the final investigation in thermal conductivity, a transient thermal reflectometry setup was implemented.

DS 28.7 Wed 11:30 H8

Electric Conductivity of Ultrathin Gallium Layers — •Frank Lawrenz[1], Stephan Block[2], and Christiane A. Helm[1] — [1]Inst. for Physics, University Greifswald, 17487 Greifswald, Germany — [2]Chalmers University of Technology, 41296 Göteborg, Sweden

Fabrication of ultrathin conductive layers is important for many technological applications. We describe a simple method for the formation of 3 nm thin gallium layers that extent up to 1 cm^2. UV-vis, ellipsometry and conductivity measurements show that the Ga layers immediately oxidize at their surface under ambient conditions, followed by slow oxidation that is completed within three weeks. The specific conductivity as determined by Ohm's law is 1 order of magnitude smaller than that of bulk Ga even for fresh layers, motivating application of the Fuchs-Sondheimer law for ultrathin metal layers for accurate quantification. The decrease in conductivity shows the same time dependence as the Ga oxidation and is described by a developed rate model.

DS 28.8 Wed 11:45 H8

Creation of various nanoporous surfaces for physically induced osteogenic stem cell differentiation — •Martin Gottschalk[1], Matthias Schürmann[2], Peter Heimann[2], Barbara Kaltschmidt[2], Christian Kaltschmidt[2], and Andreas Hütten[1] — [1]Department of Physics, Center for Spinelectronic Materials and Devices, University of Bielefeld, D-33615, Germany — [2]2Department of Cell Biology, Faculty of Biology, University of Bielefeld, D-33615, Germany

The engraftment of orthopedic implants into bone tissue is mainly achieved by stem cells, which are differentiated into osteoblasts in the vicinity of the bone-implant-interface. It is known, that various surface topographies on the nanoscale are able to promote the differentiation process [2]. Thus, a physically induced differentiation by the topography of a titanium covered surface presents an interesting and promising alternative for future clinical use. It is known that anisotropically distributed 30 nm pores in a titanium coated polycarbonate membrane lead to cell differentiation [1]. The main approach is to generate a well-defined nanoporous surface in the pore-size-range of 30 nm by other approaches, like e-beam-lithography plus sputtering, to investigate further adjustments in the osteogenic cell differentiation. For a more precise analysis of the cell-pore-interaction in a TEM, a FIB-SEM-system is used to structure the needed pores into coated TEM grids.

References [1] M. Schürmann et al., Stem Cell Research 13, 98-110 (2014) [2] T. Sjöström et al., Nanomedicine 8, 89-104 (2013)