DS 21 Laser and plasma processes

Time: Thursday 16:30–18:00 Room: GER 37

DS 21.1 Thu 16:30 GER 37

Laser-induced formation and characterization of periodic nanostructures in polymer thin films with embedded metal particles — •Katrin Löschner[1], Marcel Dyrba[2], Andreas Kiesow[1], Gerhard Seifert[2], and Andreas Heilmann[1] — [1]Fraunhofer Institute for Mechanics of Materials, Heideallee 19, 06120 Halle — [2]Martin Luther University Halle-Wittenberg, Department of Physics, Hoher Weg 8, 06120 Halle

The nanostructural properties of metal particle containing plasma polymer films can be modified by the irradiation with linearly polarized, femtosecond laser pulses. The interaction of the metal nanoparticles with the oriented, intense electric field leads to the formation of line-like, periodically arranged nanoparticle structures in the laser-treated area. These structural modifications are characterized by longish regions with obvious changes in particle size and shape distribution which alternate with regions without apparent particle changes. The optical properties of such nanocomposite materials are mainly determined by the size, shape, and spatial arrangement of the particles. Therefore, the generation of anisotropic structure changes results in dichroitic properties of the irradiated area. The periodical structural changes were generated by systematic variation of laser irradiation parameters (also at varying the film properties, i.e., thickness, matrix material). As result a phenomenological model of the occurring physical processes is suggested. For the characterization of the structural changes transmission and scanning electron microscopy were applied. Optical modelling is used as a helpful tool for explanation of the resulting optical properties.

DS 21.2 Thu 16:45 GER 37

Ultrakurzpuls-Laserdeposition von Cr-Sc-Multilagenschichten — •Frank Ulmer and Thomas Höche — Leibniz-Institut für Oberflächenmodifizierung e.V.,

Multilagenspiegel sind für die Herstellung effizienter Röntgenspiegel von großem industriellen Interesse. Je nach Anwendung reichen die Periodenlängen von einigen Nanometern (etwa im Bereich der EUV-Lithographie mit 13,4 nm Wellenlänge) bis hin zu wenigen Nanometern (im Bereich des sogenannten Wasserfensters, in dem die Absorption des Wassers sehr gering ist, mit Röntgenwellenlängen von ca. 2 - 4 nm). Für die Abscheidung qualitativ hochwertiger, ultradünner Schichten mit alternierenden Chrom- und Scandiumlagen kommt, neben etablierten Verfahren, die Laserdeposition mit ultrakurzen Pulsen in Betracht. In einer dedizierten Ultrahochvakuumanlage wurde ein Femtosekundenlaser (Pulslänge: 130 fs) für die Ablation genutzt und es wurden drei Verfahren zu Reduktion von Partikulaten, welche im Ablationsplasma durch Kondensation entstehen, untersucht. Es konnte gezeigt werden, dass sowohl der Einsatz elektrischer und magnetischer Felder als auch die Streuung an einem Hintergrundgas (Argon) genutzt werden können, um weitgehend partikulatfreie Schichten zu erzeugen. Die abgeschiedenen Schichten wurden mittels Rasterelektronenmikroskopie, Sekundärionenmassenspektrometrie sowie Transmissionselektronenmikroskopie an Querschnittspräparaten eingehend charakterisiert.

DS 21.3 Thu 17:00 GER 37

Influence of energetic ions on the $L1_0$ ordering of FePt films fabricated by magnetron sputtering — •V. Cantelli, J. von Borany, J. Fassbender, and N. Schell — Institute of Ion Beam Physics and Materials Reserarch, Forschungszentrum Rossendorf, P.O.Box 51 01 19, 01314 Dresden

Due to the high uniaxial anisotropy $L1_0$-ordered FePt is currently the most favoured candidate for future high density storage applications. With respect to a feasible fabrication technology, it is necessary (i) to produce such films on amorphous substrates, and (ii) to enable a low processing temperature ($T \leq 400°C$). FePt films deposited at RT only exhibit the face-centered cubic A1-phase. Thus, either deposition or a post-deposition heat treatment at temperatures above typically 500°C is required in order to achieve the $L1_0$-phase. We report on the $L1_0$-ordering of stoichiometric FePt thin films fabricated on SiO_2/Si substrates by magnetron sputtering at various temperatures (RT- 400°C). Using a low deposition rate of approx. 0.6 Å/s and an Ar pressure of 0.3 Pa the ion/atom-ratio during deposition is $\gg 1$ where the ions exhibit energies of about 20 eV. In addition, FePt films have been irradiated subsequently with He ions of 50 keV and fluences between $1x10^{15}$ and $3x10^{16}$ cm^{-2} for comparison. The kinetics of $A1 \rightarrow L1_0$ transition and ordering have been investigated with *in − situ* X-ray diffraction at the Synchrotron-beamline ROBL at ESRF. $L1_0$ ordered FePt films with an ordering parameter $S \geq 0.8$ have been achieved already for an overall process temperature below 350°C. The results are discussed in terms of ion-assisted activation and segregation which supports the atomic relocation during $L1_0$ ordering.

DS 21.4 Thu 17:15 GER 37

Design and application of a UHV-compatible RF plasma source to remove the ligand-sphere from self-assembled layers of $CoPt_3$-nanoparticles — •B. Gehl[1], V. Aleksandrovic[2], A. Kornowski[2], J.-I. Flege[3], J. Falta[3], H. Weller[2], and M. Bäumer[1] — [1]Institut für Angewandte und Physikalische Chemie, Universität Bremen, Leobener Str. NW II, 28359 Bremen — [2]Institut für Physikalische Chemie, Universität Hamburg, Grindelallee 117, 20146 Hamburg — [3]Institut für Festkörperphysik, Universität Bremen, Postfach 330440, 28334 Bremen

Self-assembly from colloidal solution onto a substrate is an efficient way to create well-ordered arrays of cobalt-platinum nanoparticles on a range of substrates. To access and analyze the particles' chemical properties, it is necessary to remove the surrounding ligand sphere. A capacitively coupled rf-plasma-source was designed to strip the particles of their ligands and to let the treated samples be transferred into a UHV-environment without exposure to the atmosphere to avoid contamination. Compatibility to the standard omicron-type sample transfer system was maintained. In SE microscopy it was shown that the particles kept their identity and monodisperse size distribution after treatment in plasmas of oxygen or a mixture of argon and hydrogen. In SEM and GISAXS-measurements the two dimensional ordering of the particle layers was confirmed to be largely maintained. The plasma parameters were varied and the resulting effects on the chemical properties of treated layers such as carbon content, oxide formation and contamination with electrode material were analyzed with XP spectroscopy.

DS 21.5 Thu 17:30 GER 37

Determination of plasma parameters during deposition of ZnO-films with ceramic and metallic targets and correlation with film parameters — •Ruben Wiese[1], Holger Kersten[1], Florian Ruske[2], Volker Sittinger[2], Richard Menner[3], and Mario Hannemann[1] — [1]INP Greifswald — [2]IST Braunschweig — [3]ZSW Stuttgart

At ZnO-film sputter deposition, the plasma parameters essentially determine the physical properties of the deposited films. In the present case, the energy flux to the substrate was measured with special thermal probes. A thermally isolated substrate dummy was placed in the magnetron plasma at the position of the substrate. By the temporal behavior of the probe one can obtain the energy flux to the surface. Furthermore, it is possible to apply a substrate bias, whereby the energy flux of the charge carriers can be estimated. To determine further plasma parameters, Langmuir-probes were placed in the substrate region. The probes could be moved across the target axis, and thus, the profile of the parameters in the substrate plane across the target could be determined. For comparable sputter conditions, so called static prints were prepared to measure the film property profile across the target axis. By comparison of spatially measured plasma parameter profile across the target axis in the substrate level with the profile of the film properties, correlations could be obtained. Particularly, being aware of the thickness profile, the energy influx per deposited particle was estimated and a correlation with the film properties is discussed. The measurements have been carried out with ceramic targets as well as in reactive processes with metallic targets.

DS 21.6 Thu 17:45 GER 37

The effect of target aging on the structure formation of Zinc oxide during reactive sputtering — •Dominik Koehl, Daniel Severin, Oliver Kappertz, Andreas Pflug, and Matthias Wuttig — I. Institute of Physics (1A), Aachen University, 52056 Aachen, Germany

We present a comparative study of reactively sputtered Zinc oxide films deposited using (a) a new metallic Zn target and (b) an old one with a pronounced erosion trace. Depending on the shape of the target surface

there are remarkable differences in the film structure at different substrate positions. Our findings can be attributed to the influence of the inhomogeneous bombardment of the substrate surface by fast negatively charged oxygen ions. These ions are created at the poisoned/oxidized fraction of the target and accelerated towards the substrate. We show that the trajectory of these ions strongly depends on the shape of the target surface, as the electric field above the target is altered by the erosion trace. Hence, the spatial distribution of the ion bombardment depends on the geometry of the erosion trace and therefore on the age of the target.