DS 28: Nanoengineered Thin Films I

Time: Thursday 9:30–11:00 Location: GER 37

DS 28.1 Thu 9:30 GER 37

Magnetic properties of ion beam induced ripple pattered Fe layers — •Felix Büttner, Hans Hofsäss, and Kun Zhang — II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

There is a rapidly growing interest in nanopattered ferromagnetic films. Apart from fundamental investigations, one motivation is the search for materials which are ferromagnetic even at nanometer scales. It has been found that ion beam induced ripples of epitaxially grown Co induce a strong uniaxial magnetic anisotropy. Comparable experiments with epitaxial Fe films on MgO and polycrystalline Fe films on Si, both textured by ion beam erosion, showed similar magnetic properties. This study is about nanopattered thin epitaxial Fe layers grown on MgO by PLD. Pattering was done by grazing incidence sputter erosion using 5 keV Ar ions. Additional cosputtering of Fe was used to attenuate the effective sputter yield and to achieve a thickness gradient. Alternatively, pure MgO was irradiated with the same parameters using an Fe cosputtering target to achieve a very thin steady state Fe coverage on nanostructured MgO. We investigate the magnetic and structual properties of the nanopattered Fe layers as a function of the residual film thickness using MOKE, RBS and AFM. Both side polished MgO substrates were used to perform MOKE measurements of the Fe / MgO interface to determine the influence of the ion beam induced surface ripple patterns on the magnetic properties of the unirradiated underlying layer.

DS 28.2 Thu 9:45 GER 37

Transient electrical conductivity of W-based deposits during growth, relaxation and exposure to air — •Fabrizio Porrati, Roland Sachser, and Michael Huth — Johann Wolfgang Goethe University, Frankfurt am Main, Germany

W-based granular metals have been prepared by electron beam induced deposition from the tungsten-hexacarbonyl, $W(CO)_6$, precursor. In situ electrical conductivity measurements have been performed to monitor the growth process and to investigate the behavior of the deposit by electron beam post irradiation and by exposure to air. During the first part of the growth process, the electrical conductivity grows with the cube of time, $\sigma \sim t^3$, independently from the electron beam parameters. This behavior is interpreted as the result of the increase of the W-particles diameter. Once the growth process is terminated, the electrical conductivity decreases with the logarithm of time, $\sigma \sim ln(t)$. Temperature dependence conductivity measurements of the deposits reveal that the electrical transport takes place through two parallel channels: either by means of variable-range-hopping within the carbonaceous matrix or by electron tunneling between W-metal grains. After venting the electron microscope the electrical conductivity of the deposits shows a degradation behavior, which depends on the composition. Electron post-irradiation increases the electrical conductivity of the deposits, which can be attributed to the increase of charge carriers from the breakage of the carbon-carbon bonds in the matrix.

DS 28.3 Thu 10:00 GER 37

Development of α-$(Al_x,Cr_{1-x})_2O_3$ solid solution strengthened thin films by reactive magnetron sputtering — •Dominic Diechle, Michael Stüber, Harald Leiste, and Sven Ulrich — Forschungszentrum Karlsruhe GmbH, Institute for Materials Research I, Karlsruhe, Germany

Hard, tough, wear and oxidation resistant thin film materials are important for many applications such as cutting tools. We present a new combinatorial approach for the deposition of solid solution strengthened α-$(Al_x,Cr_{1-x})_2O_3$ thin films by reactive r.f. magnetron sputtering in an argon-oxygen atmosphere. The deposition experiments are carried out with a Leybold Z 550 PVD machine for the sputtering from a segmented target (Al and Cr) at non-equilibrium conditions. We adjusted the substrate temperature to 500 °C and we induced a substrate bias up to -400 V. The metastable thin films were characterized by determining their Vickers micro hardness, their residual stress, their chemical composition by Electron Probe Microanalysis, their microstructure by X-Ray diffraction and their constitution by scanning electron microscopy and transmission electron microscopy.

The chemical analysis revealed nearly stoichiometric $(Al_x,Cr_{1-x})_2O_3$ composition and the largest Vickers micro hardness was 2620 HV0,05. A comparison of the measured X-Ray diffraction spectrum with the peaks of α-Al_2O_3 and α-Cr_2O_3 showed six Bragg peaks positioned between the α-Al_2O_3 and α-Cr_2O_3 peaks of the same crystal lattice plane. Thus we assumed corundum-type α-$(Al_x,Cr_{1-x})_2O_3$ growth of the solid solution.

DS 28.4 Thu 10:15 GER 37

Reactive Magnetron Sputtering of (GeO_x-SiO_2) Superlattices for Nanocrystal Synthesis — •Manuel Zschintzsch, Nicole M. Jeutter, Johannes von Borany, and Arndt Mücklich — Institute of Ion Beam Physics and Materials Research, Forschungszentrum Dresden Rossendorf, 01328 Dresden, Germany

The underlying motivation of this research is the tailored growth of Ge nanocrystals (NC) for photovoltaic applications [1,2]. Of special interest is the study of confinement effects to design bandgap engineered materials enabling light absorption within a wide range of the solar spectrum. In this contribution, we enlighten the deposition process of (GeO_x-SiO_2) superlattice structures (SL) via reactive DC magnetron sputtering and the self-ordered Ge-nanocrystal formation during subsequent annealing. SL structure delivers a reliable method to control the NC size after phase separation. Main attention is directed to define proper deposition conditions for tuning the GeO_x composition between elemental Ge (x=0) and GeO_2 (x=2) by the variation of the deposition temperature and the oxygen partial pressure. A process window has been found which allows GeO_x / SiO_2 deposition without changing the oxygen flow during the deposition. The phase separation and Ge NCs formation after subsequent anneling was investigated with $in-situ$ X-ray diffraction, Raman spectroscopy and electron microscopy, confirming the existence of 2-5 nm Ge NCs. As the used technique allows to produce SL stacks with very smooth interfaces (roughness <1 nm), the Ge NC layers could be separated by very thin SiO_2 films (d >3 nm) which offers interesting possibilities for charge transport via tunneling.

DS 28.5 Thu 10:30 GER 37

Hierarchical nano-structuring of Si surfaces by combining top-down and bottom-up techniques — •Bashkim Ziberi, Frank Frost, Jochen Zajadacz, Klaus Zimmer, Renate Fechner, and Bernd Rauschenbach — Leibniz-Institut für Oberflächenmodifizierung (IOM), Permoserstrasse 15, D-04318Leipzig, Germany

Guided self-organization processes are currently in focus regarding their potential for hierarchical micrometer and nanometer scale structuring. In this regard, self-organized pattern formation due to low-energy ion beam erosion offers an alternative approach. A combination with conventional lithographic pre-patterning can lead to multi-scale structuring and an exact positioning of the nanostructures.

The principle of hierarchical nanostructuring is applied on Si surfaces during low energy Kr^+ ion beam erosion where different micron and nanometers scale pre-patterns fabricated by e-beam lithography and laser ablation technique are used. The results show that the formation of nanostructures depends strongly on the local incidence angle of ions, the orientation of the local surface with respect to the ion beam and the local surface curvature. Depending on these parameters and on the ion beam parameters different patterns like curved ripples, ripples with different orientations and perfectly squared dots form on the surface at exact defined positions. It is demonstrated that by combination of conventional lithography techniques with ion beam induced self-organization a hierarchical nanostructing with potential applications in micro- and nanooptics is possible.

DS 28.6 Thu 10:45 GER 37

A novel nanocomposite thin film deposition tool using plasma processes — •Ralph Schmittgens[1], Marcus Wolf[1], and Eberhard Schultheiss[1,2] — [1]Institut für Festkörperelektronik, Technische Universität Dresden — [2]Fraunhofer FEP, Dresden

Nanocomposites are a novel class of materials with a lot of promising applications. Many applications require the use of nanocomposites as thin films. Vacuum based deposition processes are specially suited to produce high quality thin films. In this work a novel vacuum deposition system is presented that allows a versatile deposition of thin film nanocomposites by incorporating inorganic nanoparticles into matrix materials made of plasmapolymers or inorganic composites. The system consists of a gas phase condensation process for the nanoparticle

fabrication using a hollow cathode discharge for the atomic vapor production and a very high frequency driven plasma for the deposition of the matrix materials. The design of the experimental setup allows the combination of metal, alloy and inorganic filler materials and polymeric and inorganic matrix materials. In this contribution details of the system concept and realization will be presented. Results of the characterization of copper nanoparticle size, size distribution and deposition rate will be demonstrated. Examples of the matrix film deposition process will be presented in the form of hydrophobic polymeric and titanium and silicon oxide coatings. First results of the nanoparticle incorporation of copper and copper oxide nanoparticles into plasmapolymer and inorganic matrices will be shown and possible applications discussed.