DS 41: Layer Deposition Processes

Time: Friday 14:30–16:00 Location: H 2032

DS 41.1 Fri 14:30 H 2032

On the correlation between process parameters and deposition rate in High Power Pulsed Magnetron Sputtering (HPPMS) discharges — •Dominik Koehl and Matthias Wuttig — I. Institute of Physics IA, RWTH Aachen University

In recent years, High Power Pulsed Magnetron Sputtering (HPPMS) has increasingly attained the focus of actual research on modern sputter deposition techniques. Due to its potential to apply an extremely high peak power to the sputter target, it enables thin film deposition with a very high degree of ionization of the sputtered material. The generation of a large amount of low energy ions in the plasma facilitates the possibility to tailor film properties by ion bombardment in a very wide range. Several authors have demonstrated e.g. the deposition of metal films showing an increased mass density and reduced surface roughness compared to the respective dc-sputtered films. Despite these and other promising advantages of HPPMS, its application for large scale industrial processes is still limited. This is mainly due to the fact that the deposition rates in many cases are reported to be significantly smaller than in dcMS at identical average powers or currents, so that the energy efficiency of the process is considerably reduced. This finding has been correlated to self-sputtering and gas rarefaction, which in turn has been attributed to the very high peak current during the pulse. We present a study that facilitates the development of a more fundamental understanding of the deposition rate with respect to several process parameters.

DS 41.2 Fri 14:45 H 2032

Magnetoelectrodeposition of CoFe — •Koza Jakub, Uhlemann Margitta, Gebert Annett, and Schultz Ludwig — IFW-Dresden, Dresden, Germany

The effect of a uniform magnetic field with flux density up to 1 T and different configuration on the electrodeposition of CoFe from simple sulphate electrolyte has been investigated. Voltammetric and chronoamperometric experiments have been carried out coupled with the electrochemical quartz crystal microbalance for the in situ mass measurements. The structure and morphology were determined by scanning electron microscopy, atomic force microscopy and X-ray diffraction measurements and the magnetic properties by VSM and MFM measurements. Results show that when the magnetic field is applied parallel to the electrode surface the limiting current density and deposition rate are increased due to the MHD-effect. The nucleation process is also affected in parallel configuration; this effect is attributed to hydrodynamic response of the electrochemical system. No significant influence on electrochemical reaction was observed when magnetic field was applied perpendicular to electrode. But in this configuration morphology and magnetic properties of deposited layers are changed by the magnetic field.

DS 41.3 Fri 15:00 H 2032

Interface roughness of MgO/Ti and ZrO_2/Ti multilayers — •Tobias Liese, Andreas Meschede, and Hans-Ulrich Krebs — Institut für Materialphysik, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

MgO/Ti and ZrO_2/Ti multilayers with double layer periods in the nanometer range were deposited by pulsed laser deposition (PLD) on Si(111) substrates in ultrahigh vacuum. The roughness of these films was investigated by atomic force microscopy (AFM), X-ray reflectometry (XRR), and transmission electron microscopy (TEM), which are sensitive on the surface and interface roughness, respectively. In both cases, the Ti layer grows in island growth, while the layer-by-layer growth of MgO and ZrO_2 layers leads to a smoothening of the layers. Therefore, with increasing number of bilayers no cumulative roughness is observed. The interfaces were studied by *in-situ* deposition rate and stress measurements. In this contribution, the underlying growth processes and their influence on the interface roughnesses are discussed.

DS 41.4 Fri 15:15 H 2032

Investigation of the Nucleation and Growth Mechanisms of Nanocrystalline Diamond Films — •Christian Sippel[1], Cyril Popov[1], Wilhelm Kulisch[2], Dieter Grambole[3], and Johann Peter Reithmaier[1] — [1]Universität Kassel, Institut für Nanotechnologie und Analytik, Heinrich-Plett-Straße 40, 34132 Kassel, Germany — [2]European Commission Joint Research Centre, Institute for Health and Consumer Protection, TP 203, Via Enrico Fermi 1, 21020 Ispra, Italy. — [3]Forschungszentrum Dresden-Rossendorf e. V., Institute of Ion Beam Physics and Materials Research, P. O. Box 510119, D-01314 Dresden, Germany

Nanocrystalline diamond (NCD)/ amorphous carbon composite films were deposited on Si substrates from CH_4/N_2 gas mixtures by microwave plasma chemical vapor deposition. Scanning electron microscopy (SEM), atomic force microscopy (AFM), Raman and Fourier transformed infrared (FTIR) spectroscopies, and nuclear reaction analysis (NRA) were applied to characterize the films. Ultrasonic pretreatment of the substrates with NCD powder suspended in n-pentane leads to nucleation densities on the order of 10^8 cm^{-2}; the variation of the grain size from 1 μm to 250 nm brings only marginal changes. In contrast, the addition of ultradispersive diamond powder increases the nucleation density by two orders of magnitude. Once the films are closed, their surface consists of larger features whose substructure is composed of much smaller features as revealed by SEM and AFM. The results from FTIR and NRA elucidate the complex mechanisms of hydrogen incorporation in the films and its role in the growth mechanism.

DS 41.5 Fri 15:30 H 2032

Rapid metal-sulphide-induced crystallization of highly textured tungsten disulphide thin films. — •Stephan Brunken[1], Rainald Mientus[2], and Klaus Ellmer[1] — [1]Hahn-Meitner-Institut, Glienicker Straße 100, 14109 Berlin — [2]Optotransmitter-Technologie-Umweltschutz e.V., Köpenicker Straße 325b, 12555 Berlin

Highly (001) textured tungsten disulphide (WS_2) thin films are grown by rapid metal(Co, Ni, Pd)-sulfide-induced crystallization of amorphous reactively sputtered sulphur-rich tungsten sulphide (WS_{3+x}) films. The rapid crystallization is monitored by real-time in-situ energy dispersive X-ray diffraction (EDXRD). Provided that a thin metal film is deposited prior the deposition of WS_{3+x} the films crystallize very fast (about 20 nm/s). The crystallization starts in the range of the Ni-S eutectic temperature of 637 °C. After crystallization isolated MeS(Me = Co, Ni, Pd)-crystallites are located on the surface of the WS_2-layer, which is proved by scanning electron microscopy and transmission electron microscopy. Taking into account the crystallization temperature this leads to the model of the rapid crystallization from liquid MeS_x droplets, which dissolve WS_x, oversaturate, release WS_2 while floating on the top of the crystallizing volume to the top of the layer. These metal-sulphide-induced crystallized $WS_2$2-layers exhibit a pronounced (001) orientation with large crystallites up to 3 μm. They show photoactivity and high hole mobilities (about 50 cm^2/Vs). Combined with the high absorption coefficient of 10^5 cm^{-1} and a direct band gap of 1.8 eV these properties make such films suitable for absorber layers in thin film solar cells.

DS 41.6 Fri 15:45 H 2032

Preparation of $CuInS_2$ chalcopyrite films by reactive magnetron sputtering: Influence of the Particle Energy on morphological, electrical and optical properties — •Stefan Seeger and Klaus Ellmer — Hahn-Meitner-Institut, Dep. Solar Energetics, Glienicker Str. 100, 14109 Berlin

Today magnetron sputtering is a common technique for large area depositions and already used to fabricate layers for thin film solar cells: the back contact (molybdenum) and front contact (zinc oxide) or for the deposition of metallic precursors. Nevertheless it is astonishing that this technique is not yet used for preparing the absorber layer in photovoltaic devices. Recently we have demonstrated that reactive magnetron sputtering from an indium and a copper target in an Ar/H_2S atmosphere is suited to prepare $CuInS_2$ absorber films and solar cells with an efficiency of more than 10% in a one-step process without additional annealing procedures. In order to make full use of the advantages of a plasma-assisted deposition process:
i) deposition at lower temperatures compared to pure thermal processes,
ii) high chemical reactivity,
iii) compact and well adherent films,
we have investigated in this work the influence of the particle energies on the film growth and the electronic properties.