DS 5: Layer Deposition (ALD, MBE, Sputtering, ...)

Time: Monday 11:45–13:15 Location: H 0111

DS 5.1 Mon 11:45 H 0111

Atomic Layer Deposition of Titanium Nitride Thin Films for Plasmonic Applications — •Gül Dogan, Umut T. Sanli, Gisela Schütz, and Kahraman Keskinbora — MPI for Intelligent Systems, Stuttgart

Titanium Nitride (TiN) emerged as an alternative to gold as a material for refractory plasmonics, mainly due to their similar optical responses in the visible and near-infrared regions. Atomic Layer Deposition (ALD) offers highly conformal coatings over complex geometries, accurate thickness, atomic smooth interfaces and composition control. Here, we deposited TiN thin films at 350 °C by a plasma-enhanced (PE)-ALD, using TiCl4 and N2-H2 as co-reactants. The deposition rate was 0.03 nm/cycle. The prepared polycrystalline films exhibited a strong (200) preferred orientation. The XPS analysis indicated that the Cl impurity concentration was ~4 at. % and the atomic ratio of Ti to N was ~1:1. A low resistivity of 290 uohm.cm was measured by Four Point Probe (FPP). The optical-resistivity values were determined via Spectroscopic Ellipsometry using a Drude-Lorentz model, which were in agreement with FPP measurements, for ~10 nm grain size. When the grain size was <10 nm, large deviations were observed between optical and electrical resistivity measurements, which was attributed to electron scattering at grain boundaries. Low electrical resistivity in combination with a high carrier concentration and carrier mobility are two important parameters for plasmonic applications. Furthermore, a discrepancy between optical and electrical measurements is a reliable indicator of grain boundary scattering.

DS 5.2 Mon 12:00 H 0111

Atomic Layer Deposition of Iridium: Nucleation and Film Growth — •Paul Schenk[1,2] and Adriana Viorica Szeghalmi[1,2] — [1]Fraunhofer-Institute for Applied Optics and Precision Engineering IOF, Albert-Einstein-Straße 7, D-07745 Jena, Germany — [2]Friedrich-Schiller-University Jena, Institute of Applied Physics, Albert-Einstein-Straße 15, D-07745 Jena, Germany

Ultrathin and smooth metal films are essential for numerous optical systems for spectroscopy and sensing in material, life sciences and astronomy, lightning or automobile components, and other applications. Complex shaped substrates or nano- and microstructured components are increasingly necessary in modern applications. However, the conformal deposition of thin metal layers on such elements, using established coating technologies such as physical vapor deposition (PVD), is challenging. In contrast, atomic layer deposition (ALD) is a highly suitable coating technology for the uniform deposition of thin films onto complex shaped surfaces.

Iridium thin films are of interest for applications in broadband metal wire grid polarizers, mirrors and Fresnel zone plates, or even for medical implants. It is essential to control their morphology and topography as well as the mechanical and optical properties to enable components with a high performance. Therefore, one needs to understand the layer growth from the initial nucleation to the formation of a dense and compact thin metal film. In the presented work, we studied the nucleation and film growth of iridium thin films on various substrate materials with regard to their morphology and properties.

DS 5.3 Mon 12:15 H 0111

Energy and mass selective ion beam assisted epitaxy for deposition of thin nitride films — •Philipp Schumacher[1], Michael Mensing[1], Jürgen W. Gerlach[1], Stephan Rauschenbach[2,3], and Bernd Rauschenbach[1] — [1]Leibniz-Institut für Oberflächenmodifizierung (IOM), Leipzig — [2]University of Oxford, UK — [3]Max-Planck-Institut für Festkörperforschung, Stuttgart

Ion-beam assisted deposition (IBAD) represents a frequently applied concept in thin film growth. For hyperthermal kinetic energies (few 1 eV-few 100 eV), the impinging ions provide energy for enhancing the mobility of adatoms, ideally only on the surface. Thus, ion irradiation induced creation of point defects below the surface is minimized. Therefore, IBAD using hyperthermal ions can be applied for growing thin films, for which a high crystalline quality is required. In general, the versatility of IBAD is limited depending on the type of ion source applied. Typical ion sources generate ion beams which contain a multitude of different ion species, each possessing certain kinetic energies, which are possibly different from one another. In order to define the deposition conditions more precisely, a setup for energy and mass selective ion beam assisted deposition (EMS-IBAD) was created, to be used for the deposition of nitride thin films. The feasibility of EMS-IBAD by applying this setup has exemplarily been shown for the growth of non-polar GaN thin films on $Al_2O_3(1\bar{1}02)$. In this contribution, the EMS-IBAD setup is presented, subsequently a brief characterization of such thin films by x-ray diffraction and reflection high-energy electron diffraction is added.

DS 5.4 Mon 12:30 H 0111

Modifying the texture of epitaxially grown chalcogenide thin films — •Marc Pohlmann, Marvin Kaminski, and Matthias Wuttig — I. Institute of Physics, Physics of New Materials, RWTH Aachen University, 52056 Aachen, Germany

A significant number of chalcogenides offers a unique portfolio property. They can be rapidly switched between the amorphous and crystalline state. This transition is accompanied by large changes in optical and electrical properties, which creates significant application opportunities. Hence, these materials are employed for rewriteable optical data storage and have also recently been introduced as electronic phase change memory devices, trying to close the gap between non-volatile but slow devices (such as Flash memories) and volatile but extremely fast devices, like DRAMs. To improve the application range of these materials, it is mandatory to further improve phase change devices. A promising route to do so is via material optimization. This approach requires an understanding of the material properties on a very fundamental level. Therefore, in the frame of this work, we want to investigate the texture formation of different chalcogenides via RHEED and XRD to obtain MBE-grown thin films of high crystal quality. We employ heterostructures of GeTe, SnTe and Sb_2Te_3 to demonstrate how different textures and surfaces can be achieved on the same substrate.

DS 5.5 Mon 12:45 H 0111

Deposition-Flux dependent Intrinsic Film Stress: Scaling — •Marcel Rost[1], Andreas Jamnig[2], Clarisse Furgeaud[2], and Gregory Abadias[2] — [1]Huygens-Kamerlingh Onnes Laboratory, Leiden University, Leiden, The Netherlands — [2]Institut P, CNRS, Université de Poitiers, Poitiers, France

The growth of polycrystalline films at temperatures above ~0.2 of the melting temperature is accompanied by compressive stress development after film closure. A significant part of this stress has a reversible nature: it disappears when the deposition is stopped and re-emerges upon resumption. Based on the variation of the chemical potential of the surface, the grain boundaries, and the film, we have developed a thermodynamic description that predicts the magnitude of the reversible compressive stress [1], and that agrees so far with published experimental results.

Moreover, in analogy to the often observed scaling in growth phenomena, our model also predicts that the stress jumps are proportional to "deposition flux"/"surface mobility". Here we show the first experimental evidence for this scaling, which delivers additional proof for the validity of our model.

[1] A.Saedi and M.J. Rost; Nature Communications, 7:10733 (2016)

DS 5.6 Mon 13:00 H 0111

Aluminum nitride films prepared by plasma atomic layer deposition using different plasma sources — Małgorzata Kot[1], Franziska Naumann[2], Samiran Garain[1], Emilia Pożarowska[1], Hassan Gargouri[2], •Karsten Henkel[1], and Dieter Schmeisser[1] — [1]Angewandte Physik - Sensorik , Brandenburgische TU Cottbus-Senftenberg, K.-Wachsmann-Allee 17, 03046 Cottbus, Germany — [2]SENTECH Instruments GmbH, Schwarzschildstraße 2, 12489 Berlin, Germany

Aluminum nitride (AlN) thin films are promising for versatile applications in optoelectronics, electronics, piezoelectrics, and acoustics due to their remarkable properties such as wide band gap, high dielectric constant, low electrical conductivity, good piezoelectric coefficient and high ultrasonic velocity. We present a comparative study of AlN films grown by plasma-enhanced atomic layer deposition at 350°C silicon wafers in the SENTECH SI ALD LL system using TMA and NH_3 where either a capacitively coupled plasma (CCP) or a direct PTSA (planar triple spiral antenna) source was applied. The films were characterized by ellipsometry, XPS and electrical measurements. The layer properties are discussed concerning the varied ALD process parameters. In general, the process using the direct PTSA source delivered films with higher refractive index and better homogeneity over the wafer achieving also higher growth rates per cycle (GPC) in reduced total cycle durations. Films with refractive index in the range of 2.05 and permittivity around 8 could be realized with a GPC of 1.54 Å/cycle.