DS 12: Layer Deposition Processes

Time: Monday 17:15–18:30 Location: GER 38

DS 12.1 Mon 17:15 GER 38

A growth model for the HfO_2 ALD process — •Marcel Michling, Massimo Tallarida, Krzysztof Kolanek, and Dieter Schmeisser — Brandenburgische Technische Universität Cottbus, Angewandte Physik / Sensorik, K.-Wachsmann-Allee 1, 03046 Cottbus

In this contribution we report on our in-situ[2] cycle-by-cycle (up to the 25 cycles) investigation of the HfO_2 atomic layer deposition (ALD) process using the method of x-ray photoelectron spectroscopy (XPS) and electron energy loss spectroscopy (EELS). We used Tetrakis-Dimethyl-Amino-Hafnium (TDMA-Hf) and H_2O as precursors and p-type Si wafer with native oxide as a substrate. The XPS measurements were carried out at BESSY II in Berlin with primary energies of 150 eV and 640 eV and the EELS measurements were done with a primary energy of 50 eV. We measured the O1s, Si2p core level and the valence band including the Hf 4f core level. From the Hf4f to Si2p ratios taken at each energy we developed a growth model for the first monolayer and for the following layers too. From our data we conclude, that in the first monolayer up to the fourth ALD cycle an island growth occurs. The height of these islands is about 0,5nm. After the first monolayer is completed, a layer- by-layer growth can be expected. In order to proof this observation we have simulated the Hf/Si ratio for different excitation energies and found a very good agreement with our measurement data. The EELS data especially the evaluation of the loss function onset confirm our growth model.

DS 12.2 Mon 17:30 GER 38

Atomic layer deposition of TiO_2 — •Massimo Tallarida, Nils Dessmann, Matthias Städter, Daniel Friedrich, Marcel Michling, and Dieter Schmeisser — BTU-Cottbus, Konrad-Wachsmann-Allee 17, 03046 Cottbus, Germany

We present a study of the initial growth of TiO_2 on Si(111) by *atomic layer deposition* (ALD). The Si substrate was etched with NH_4F before ALD to remove the native oxide film and to produce a Si-H termination. $In-situ$ experiments by means of photoemission and X-ray absorption spectroscopy were conducted with synchrotron radiation on Ti-oxide films produced using Ti-tetra-iso-propoxide (TTIP) and water as precursors. O1s, Ti2p, C1s, and Si2p core level, and O1s and Ti2p absorption edges show the transition of the Ti-oxide properties during the first layers. The growth starts with a very small growth rate (0.03nm/cycle) due to the growth inhibition of the Si-H termination and proceeds with higher growth rate (0.1nm/cycle) after 1.5nm Ti-oxide has been deposited.

DS 12.3 Mon 17:45 GER 38

Deposition and growth of antibacterial Ti-Cu films — •Vitezslav Stranak[1], Harm Wulff[1], Steffen Drache[1], Robert Bogdanowicz[1], Zdenek Hubicka[2], Carmen Zietz[3], Kathleen Arndt[4], Rainer Bader[3], Andreas Podbielski[4], and Rainer Hippler[1] — [1]University of Greifswald, Institute of Physik, Felix-Hausdorff-Str. 6, 17489 Greifswald, Germany — [2]Academy of Sciences of the Czech Rep., Institute of Physics, Na Slovance 2, 18221 Praha 8, Czech Republic — [3]University of Rostock, Department of Orthopaedics, Doberaner Str. 142, 18057 Rostock, Germany — [4]University of Rostock, Dept. of Med. Microbiol., Vir. and Hyg., Schillingallee 70, 18057 Rostock, Germany

Formation of Ti-Cu films prepared by advanced dual-magnetron sputtering techniques is presented. Three different methods of magnetron sputtering (dc, dual, and dual-HiPIMS) were employed to prepare intermetallic Ti-Cu films. Thin film properties were investigated by x-ray photoelectron spectroscopy and x-ray diagnostics. Preferential Cu crystallization is caused by a large density of Cu species in the discharge volume. The ion energy distribution in the substrate position (measured with a retarding field analyzer, RFA) corresponds with the crystallization process. The antimicrobial effect is caused by copper released from the Ti-Cu metallic structure; copper release was measured by atomic absorption spectroscopy. In vitro planktonic growth tests on Ti-Cu films prepared by dual-HiPIMS technique proved to kill bacteria efficiently.

DS 12.4 Mon 18:00 GER 38

Combination of ECR plasma and asymmetric bipolar pulsed bias voltage for deposition of hard *a*-C:H films — •Marcus Günther, Siegfried Peter, and Frank Richter — Technical University of Chemnitz, Institute of Physics, D-09107 Chemnitz, Germany

Thin hard layers of amorphous hydrogenated carbon *a*-C:H show a lot of special tribological, mechanical, electrical and optical properties. The commercial use of these films is mostly limited by the small deposition rate of usual deposition processes.

We have investigated a combination of magnetically supported microwave plasma and asymmetrical bipolar pulsed bias voltage in the mid-frequency region (100 kHz) which provides separate plasma generation and ion acceleration to the growing film. An electron cyclotron resonance (ECR) plasma source, operated at 400 W microwave power, generated a high density of film forming species (radicals and ions). A separate pulsed bias voltage of up to 550 V controlled the ion fluxes and as a consequence the layer properties.The *a*-C:H films were characterized with respect to hardness, deposition rate and surface topography. The chemical composition of the layers was analysed by ERDA and thermal desorption spectroscopy.

The deposition process was tested in mixtures of isobutene (C_4H_8) and argon at pressures below 2 Pa. The variation of the bias voltage allowed the deposition of both soft, hydrogen rich layers and hard *a*-C:H layers with less hydrogen. Thus, DLC films with a hardness of 25 GPa were deposited at high rates exceeding 10 μm/h.

DS 12.5 Mon 18:15 GER 38

Electrical and structural properties of magnetron sputtered hydrogenated amorphous Silicon films — •Frank Nobis, Hartmut Kupfer, Evelyn Breyer, Philipp Schäfer, Dietrich R. T. Zahn, and Frank Richter — Chemnitz University of Technology, Institute of Physics, 09107 Chemnitz, Germany

Magnetron sputtering could represent a valuable part of a low cost solar cell in line technology using amorphous silicon (a-Si) if a crucial problem could be overcome: In magnetron discharges, high energy particles are hitting the growing films. They cause a high defect density in the a-Si films, drastically reducing the efficiency of doping atoms.

We have investigated doped a-Si:H films sputtered by a pulsed DC magnetron discharge. The hydrogen content in the films was varied by changing the hydrogen partial pressure in the process gas. We found a saturation of the hydrogen content in the films at about 20 at.%. The electrical resistivity of the films was investigated at varied temperature to get information about the charge carrier transport. The results will be discussed in terms of different hopping conductivity mechanisms. The investigations have shown that only a negligible fraction of the incorporated doping atoms are electrically active. Therefore, the goal of continued investigations is to increase dopant activation by changing the process parameters and by deposition at elevated substrate temperatures. Furthermore, the influence of substrate bias voltage and hydrogen partial pressure during deposition on the surface and structure of the film is reviewed.