DS 26: Thin film characterization: structure analysis and composition (Ion assisted methods and analysis)

Time: Wednesday 15:00–16:30 Location: H 2032

DS 26.1 Wed 15:00 H 2032

Investigation of the effect of the incorporated Fe atoms in the ion-beam induced nanopatterns on Si (001) — •Behnam Khanbabaee[1], Andreas Biermanns[1], Marina Cornejo[2], Frank Frost[2], and Ullrich Pietsch[1] — [1]Universität Siegen, Festkörperphysik,Siegen, Germany — [2]Leibniz-Institute für Oberflächenmodifizierung e. V. (IOM), Leipzig, Germany

Ion beam erosion of semiconductor surfaces can modify the surface and depends on main sputtering parameters; different surface topographies such as ripple or dot like pattern are fabricated on the surface. Recent experiments have shown that the incorporation of foreign metallic atoms during the sputtering process plays a crucial role in pattern formation on surfaces. In the result of investigation we report on the depth profile of Fe atoms incorporated in sputtering process on Si (100) with low energy Kr ion beam. X-ray reflectivity (XRR) measurements determine the concentration profile of Fe atoms. X-ray absorption near edge spectroscopy (XANES) at the Fe K-edge (7112 eV) shows the formation of Fe rich silicide near surface region. X-ray photoelectron spectroscopy (XPS) shows a shift in the binding energy of Si2p levels at the surface compared top bulk confirming the formation of different phases of Fe-silicide on tope and below the surface. The depth profiles obtained by XRR are compared to results obtained by complementary secondary-ion mass spectrometry (SIMS).

DS 26.2 Wed 15:15 H 2032

Pattern transfer on fused silica samples using sub-aperture reactive ion beam etching — •André Miessler and Thomas Arnold — Leibniz-Institut für Oberflächenmodifizierung (IOM), Permoserstrasse 15, D-04318 Leipzig, Germany

In comparison to sole Ar ion beam sputtering Reactive Ion Beam Etching (RIBE) reveals the main advantage of increasing the selectivity for different kind of materials due to chemical contributions during the material removal. Therefore RIBE is qualified to be an excellent candidate for pattern transfer applications. The goal of the present study is to apply a sub-aperture reactive ion beam for pattern transfer on large fused silica samples. Concerning this matter, the etching behavior in the ion beam periphery plays a decisive role.

Using a Kaufman-typed ion source with NF_3 as reactive gas, XPS measurements of the modified surface exposes impurities like Ni, Fe and Cr, which belongs to chemically eroded material of the plasma pot and a layer formation of silicon nitride, handicaps the etching process mainly in the beam periphery where the sputtering contribution decrease. These side effects influence the pattern transfer of trench structures, produced in AZ MIR 701 photoresist by lithography on a 2" fused silica plate, by changing the selectivity due to modified chemical reactions of the resist layer. Concerning this we investigate a RF-Ion source for sub aperture reactive ion beam applications and finally we examine the pattern transfer on large fused silica plates using NF_3-sub-aperture RIBE.

DS 26.3 Wed 15:30 H 2032

In situ X-Ray Reflectivity measurements during DC Sputtering of Vanadium Carbide thin films — •Marthe Kaufholz[1], Baerbel Krause[1], Sunil Kotapati[1], Sven Ulrich[2], Michael Stüber[2], and Tilo Baumbach[1] — [1]ISS, Karlsruher Institute for Technology — [2]IAM-AWP, Karlsruher Institute for Technology

Vanadium Carbide (VC) is a promising candidate for new hard coatings used e.g. in medical applications. For optimising the coating properties, the relation beween the microstructure formation, deposition conditions and mechanical properties has to be understood. In situ X-Ray Reflectivity (XRR) is a powerful tool to investigate the changes in thickness, electron density and roughness during deposition. In situ XRR measurements during sputtering were performed at ANKA (MPI-Beamline). Several VC films were deposited on Si with different growth conditions. Before and after deposition a full specular XRR curve was taken. During sputtering, the intensity changes e.g. due to the thickness increase were measured at fixed angular position of the detector. For the analysis of the angle - and time-dependent XRR a simulation tool is used based on the Parratt Algorithm. This tool can be adapted to other materials and deposition techniques. First measurements show that the electron density of the thin films depends strongly on the plasma properties during the deposition. This might give the possibility of a controlled growth of layers with different electron density by tuning the plasma conditions.

DS 26.4 Wed 15:45 H 2032

Composition and microstructure of r.f. magnetron sputter-deposited Cr-Zr-O thin films — •Stefanie Spitz, Michael Stüber, Harald Leiste, and Sven Ulrich — Karlsruhe Institute of Technology (KIT), Institute for Applied Materials (IAM-AWP), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany

Cr-Zr-O thin films were synthesised by reactive r.f. magnetron sputtering in an argon-oxygen atmosphere at a pressure of 0.4 Pa. While keeping the substrate temperature constant at 500 °C, the r.f. substrate bias was systematically varied between 0 V and -200 V to investigate the effect of ion bombardment during film growth on microstructure and phase formation. Following a combinatorial approach for thin film deposition by using a segmented Cr-Zr-sputter-target, thin films of five different elemental compositions from Cr-rich to Zr-rich could be obtained in one deposition process.

The evolution of the microstructure and phase formation has been studied by X-Ray Diffraction (XRD) and Transmission Electron Microscopy (TEM). In addition, a Rietveld simulation was done on selected films. The elemental composition of the films was analysed by Electron Probe Micro-Analysis (EPMA).

XRD reveals nanocrystalline microstructures for all films. It is shown that at low substrate bias and high Cr content thin films with a corundum structure are obtained. With increasing substrate bias and increasing Zr content ZrO_2 like structures are observed, even the high temperature cubic and tetragonal phases.

DS 26.5 Wed 16:00 H 2032

Sputter Yield Amplification upon reactive sputtering of TiO_2 — •Rüdiger M. Schmidt[1], Tomas Kubart[2], Michael Austgen[1], Dominik Wagner[1], Thomas Nyberg[2], Andreas Pflug[3], Sören Berg[2], and Matthias Wuttig[1] — [1]I. Institute of Physics, RWTH Aachen University, Germany — [2]Solid State Electronics, The Ångström Laboratory, Uppsala University, Sweden — [3]Fraunhofer IST, Braunschweig, Germany

Titanium Dioxide (TiO_2) is a material with attractive properties which have led to various applications such as anti-reflective coatings or self cleaning surfaces. One of the most frequently applied deposition techniques used for TiO_2 is reactive magnetron sputtering. Unfortunately TiO_2 suffers from a comparatively low deposition rate when reactively sputtered. To increase the deposition rate, Sputter Yield Amplification (SYA) can be used through recoil of the sputtering species at implanted heavy dopants below the target surface. Here we present experimental results showing a large increase of the TiO_2 deposition rate when doped with Tungsten. Although SYA has been proposed earlier, the production of doped targets was complicated. We have built a designated sputter deposition tool which enables systematic studies of SYA. In this study the rate increase by SYA is investigated for two different dopants, namely Tungsten and Bismuth. Our experiments show that the rate increase of TiO_2 by Bismuth is surprisingly low. Tungsten on the other hand results in a large rate increase of 160% in DC and 220% in HiPIMS mode. A number of additional experiments have been carried out to verify and explain this observation.

DS 26.6 Wed 16:15 H 2032

Characteristics of TiCrN films deposited by inductively coupled plasma assisted DC magnetron sputtering — •Byungchul Cha, Ahram Kwon, Uoochang Jung, and Hyungho Jo — Korea Institute of Industrial Technology, 1274, Jisa-Dong, Gangseo-Gu, Busan 618-230, Korea

In this study, Titanium Chromium Nitride (TiCrN) films were deposited on 316L stainless steel by inductively coupled plasma assisted DC magnetron sputtering. The effects of the N2/Ar gas ratio and the power of the ICP source on the properties of the TiCrN films were investigated. The thickness of films decreased with the increase nitrogen content in the inlet gas. The TiCrN film deposited at the 0.3 gas ratio showed maximum hardness of 3900 HK0.3 and excellent corrosion re-

sistance. Increasing the ICP power during the sputtering, the hardness and the compressive stress of the TiCrN films increased, but the thickness of the films decreased linearly. XRD results of the TiCrN films showed the preferred orientation of (111), (200) and (220). The surface roughness of the TiCrN films analyzed by atomic force microscope decreased with the increase ICP power.