DS 7: Layer Properties: Electrical, Optical and Mechanical Properties

Time: Monday 17:45–19:30 Location: GER 37

DS 7.1 Mon 17:45 GER 37

Ink-jet printing of silver tracks on porous surfaces and improvement of conductivity — •Anna Schuppert[1], Joachim Wollschläger[2], Lorentz Walder[3], and Wolfgang Schmidt[4] — [1]Max-Planck-Institut für Eisenforschung, Düsseldorf — [2]Fachbereich Physik, Universität Osnabrück — [3]Fachbereich Chemie, Universität Osnabrück — [4]Felix Schoeller Service GmbH und Co. KG, Osnabrück

Different porous coatings on polyethylene treated paper were checked as a support for ink-jet printed silver tracks. The goal of this work, was to achieve a good conductivity at short post processing and low temperatures. This was achieved by a presintering initialised by the surface.

For this purpose thin films of Al_2O_3 particles on PE-sealed paper were prepared and the pore size distribution was measured with Hg-Porosimetry. Using a Dimatix Materials Printer silver tracks were printed on these substrates. The resistance was measured with a four point probe and analysed as a function of the pore size.

It was found that smaller pore sizes yield higher conductivity, which is interpreted as a destabilisation of the ink immediately after printing. The initial conductivity can be improved by sintering for some minutes at 70 °C or 100 °C. Other important parameters influencing the conductivity found in this study are roughness, pH and added salts.

DS 7.2 Mon 18:00 GER 37

Statistical Analysis of Computer-simulated On-Chip Interconnect Electromigration Lifetimes under the Influence of Microstructure and Strengthened Top Interface — •Matthias Kraatz[1], Lijuan Zhang[2], Dieter Schmeisser[1], Ehrenfried Zschech[3], and Paul S. Ho[2] — [1]BTU Cottbus, Germany — [2]The University of Texas at Austin, USA — [3]Fraunhofer Institute for Non-Destructive Testing IZFP, Dresden, Germany

We are investigating the statistics of computer-simulated interconnect electromigration (EM) lifetimes with regard to the effects of microstructure and a strengthened top interface. The degradation process of EM once threatened the entire existence of integrated circuit industry in the 1960s and has remained a major reliability concern. Ongoing miniaturization and the introduction of new materials further complicate the task of EM-resistant chip manufacturing. We have developed a simple two-dimensional finite difference simulation that models the mass transport by electromigration along the grain boundaries and the top interface of interconnect segments that allows us to do calculations of void nucleation and growth. A parallel computer simulates hundreds of interconnects simultaneously and statistical analysis becomes feasible. A Monte Carlo grain growth algorithm (a modified Potts version) is applied to model the grain structure of the interconnect segments. We will show that the simulation can be used to compare simulation and experiment qualitatively. Four cases have been studied: interconnect segments with small/large grains and weak/strong top interface.

DS 7.3 Mon 18:15 GER 37

Entwicklung eines Messverfahrens zur Bestimmung der elektrostriktiven Konstante von dünnen Polymerschichten — •Christian Schirrmann, Kirstin Bornhorst und Florenta Costache — Fraunhofer-Institut für Photonische Mikrosysteme IPMS, Maria-Reiche-Str. 2, Dresden, Deutschland

Polymeraktoren sind aufgrund ihrer großen elektromechanischen Verformung sehr vielversprechend für den Einsatz in aktiven mikro-opto-elektro-mechanischen Systemen (MOEMS).
Es wurde ein Messverfahren für dünne elektrostriktive Polymerschichten entwickelt, welches es ermöglicht, die Verformung, hervorgerufen durch die dielektrische Anziehung der Elektrode und die im Material auftretende Elektrostriktion, zu unterscheiden. Dabei wurde die kombinierte dielektrisch-elektrostriktive Verformung interferometrisch gemessen. Der elastische Modulus wurde für dünne, elastische und transparente Schichten mittels eines optimierten interferometrischem Bulge-Test ermittelt. Weiterhin wurde die relative Permittivität mittels Impedanzspektroskopie bestimmt.
Anhand der gewonnen Materialkonstanten wurde das mechanische Verhalten eines elektrostriktiven Bimorphs mittels dreidimensionaler Finite-Elemente-Methode simuliert und mit auftretenden Deformationen eines mikromechanisch gefertigten Multilayerstacks verglichen.

DS 7.4 Mon 18:30 GER 37

Charging of internal interfaces in metal-insulator-metal heterosystems by low energy electron beams — •Johannes Hopster[1], Marika Schleberger[1], Andreas Wucher[1], and Detlef Diesing[2] — [1]Fakultät für Experimentalphysik, Universität Duisburg-Essen — [2]Fakultät für Physikalische Chemie, Universität Duisburg-Essen

Metal-insulator-metal (MIM) and metal-semiconductor (MS) heterosystems can be used to detect low energy electrons, which are for example released by a surface chemical reaction. These electrons usually do not have sufficient excess energy to overcome the work function of the metal film. But these electrons can overcome the internal barrier of the heterosystems since the internal barrier is usually 1-2 eV lower than the workfunction of the metal film. The transmission of electrons over the internal barrier is determined by its height and thickness. By exposing these heterosystems to a low energy electron beam in ultra high vacuum we studied the electron transmission. The barrier properties and the transmission of the device remain unchanged for small currents impinging on the device (< 1 nA). For primary electron currents > 100 nA the internal barrier can be reversibly changed. The barrier returns to its ground level state within some 10s following an exponential time law. The time constant depends clearly on the field strength in the device. A model considering charge exchange processes between the two interfaces of the device is presented to explain the beam induced barrier changes.

DS 7.5 Mon 18:45 GER 37

Mapping of internal photoemission in metal–insulator–metal heterosystems — Dominik Differt[1], Walter Pfeiffer[1], and •Detlef Diesing[2] — [1]Universität Bielefeld, Universitätsstr. 25, 33615 Bielefeld, Germany — [2]Fakultät für Chemie, Universität Duisburg-Essen, D-45117 Essen, Germany

Internal **p**hoto**e**mission (IPE) in heterosystems is determined by light absorption and **e**lectron **h**ole (e-h) pair generation in the layers of the systems. Lateral inhomogeneities of the dielectrical properties, layer thickness variations or local defects can for example cause lateral variations in the IPE signal. With photon energies smaller than the band gap of the insulator one can selectively probe e-h pair generation in the back and top metal layers. For the lateral mapping of IPE a Ag-TaO-Ta heterosystem is raster scanned across the focus of a Schwarzschild objective (NA=0.4). The illumination with 400 nm laser radiation results in a focus diameter of 7μm limiting the spatial resolution of the IPE microscopy. Mapping across the 70μm wide edge of the top metal film shows transport effects in the top silver electrode as well as the increasing excitation of carriers in the tantalum backelectrode with decrasing top electrode thickness. The variation of the top electrode thickness and comparison to simulated excitation profiles allows the investigation of excited electron transport in the metal-insulator-metal junction.

DS 7.6 Mon 19:00 GER 37

Determination of the electrically active Al fraction in Al doped ZnO grown by pulsed reactive magnetron sputtering — •Steffen Cornelius, Mykola Vinnichenko, Frans Munnik, René Heller, Andreas Kolitsch, and Wolfhard Möller — Helmholtz Zentrum Dresden-Rossendorf, Dresden, Germany

Al-doped ZnO (AZO) films which combine maximum carrier mobility, moderate free electron densities and high surface roughness are of special interest for application as transparent front electrode in thin film solar cells. They posses high transmission in the near infrared spectral range, close to the bandgap energy of absorber materials like Si (Eg=1.11 eV), and enable a superior light trapping behaviour. A key to tailor AZO film properties is understanding the mechanisms and effects of the Al-dopant incorporation into the ZnO matrix. It is well accepted that the mobilities in degenerately doped AZO are limited by ionized impurity scattering. A way to overcome this limitation would be to reduce the density of ionized impurities which either do not donate electrons themselves or compensate the Al donor. This is equivalent to increasing the fraction of electrically active Al in the ZnO host material. Systematic and quantitative information on this topic is still missing in literature. Therefore this work focuses on quantification of the Al concentration by ion beam analysis methods in conjuction with

Hall-effect measurements for AZO films grown by reactive pulsed magnetron sputtering. The influence of parameters like target composition and substrate temperature on the Al activation will be discussed.

DS 7.7 Mon 19:15 GER 37

Ellipsometric study of copper growth on silicon — •Francisc Haidu, Ovidiu D. Gordan, and Dietrich R. T. Zahn — Chemnitz University of Technology, Semiconductor Physics, 09107 Chemnitz, Germany

Thin copper films are of high interest for interconnect applications. However, optical studies, such as ellipsometry, of metallic thin films are still rare as the measurements are difficult to interpret due to the lack of a transparent range and often island-like growth at very low cowerages. We investigated by in situ Spectroscopic Ellipsometry the growth of thermally evaporated thin copper films on silicon substrates from 0.5 nm to more than 100 nm, a thickness for which bulk-like response is observed. A strong change in the optical response was observed for films thinner than 10 nm as a result of plasmonic effects. For the interpretation of the spectra Effective Medium Approximation theory was employed using the thicker films as reference. Furthermore, copper oxidation was also studied. Here a pronounced change in the optical response is observed within the first 10 minutes of oxidation. Thereafter the response changes at a slower rate without reaching saturation.