DS 15: Thin Film Metrology for Electronics, Photonics, and Photovoltaics II

Time: Tuesday 15:15–16:30 Location: GER 38

Topical Talk DS 15.1 Tue 15:15 GER 38

Investigations of electrophysical properties of thin films with embedded nanoparticles by means of an immitance meter
— Viktoria V. Malyutina-Bronskaya, •Valerii B. Zalesskii, and Tamara R. Leonova — B. I. Stepanov Institute of Physics NAN of Belarus, Minsk, Belarus

Recently we have undertaken an attempt to use the C-V characteristics measurement method for analyses of the properties of thin films with embedded nanoparticles on a silicon substrate. We have produced ZnO thin films doped with rare earth's elements on silicon by the reactive magnetron sputtering. C-V dependences measurements at frequencies of 500 kHz and 1 MHz were carried out by the E7-20 immitance meter at room temperature. SEM images of surface and cross-section of the films show the presence of large grains in the size range ≈ 0.1 - 0.3 mkm. Characteristic properties of the C-V dependences, in the forms of humps were observed for both frequencies in the capacitance modulation area. Magnitude of the hump decreases with lowering frequency. Calculations show, that similar characteristics take place when the discreet states have energy level sufficiently narrow energy distribution and are in close vicinity of the Fermi level. Therefore, the results obtained in our investigation show a good conformance of theoretical and experimental data. This gives one a possibility to use this method for investigations of the films with embedded nanoparticles.

DS 15.2 Tue 15:45 GER 38

Characterization of strained Si films by variable angle spectroscopic ellipsometry and Raman spectroscopy
— •Zhijiat Chong, Martin Weisheit, Michael Hecker, and Ehrenfried Zschech — AMD Fab 36 LLC & Co. KG, Wilschdorfer Landstr. 101, D-01109 Dresden, Germany

Strain applied to silicon films modifies the mobility of charge carriers and is thus employed to enhance the performance of semiconductor devices. Methods to determine the thickness and the stress in these films non-destructively are indispensable in the manufacturing process, in which both precision and speed are crucial for high yield. Two optical methods are investigated here for this purpose. Due to the effect of stress on the electronic band structure and the lattice phonon frequencies, stress can be measured via variable angle spectroscopic ellipsometry (VASE) and Raman spectroscopy respectively. Based on bending experiments to induce stress in silicon-on-insulator stripes, VASE was used to characterize the change of the dielectric function at 1.2-6.4 eV due to stress. A novel stress-parameterized model of the dielectric function was constructed from the data using a summation of Tauc-Lorentz functions. This can be applied to determine the stress in silicon layers from ellipsometric measurements. The stress induced on the sample was also measured by the sample curvature and verified by Raman spectroscopy. The result shows that stresses can be measured with a sensitivity of about 30 MPa in thin silicon films by VASE.

DS 15.3 Tue 16:00 GER 38

Polarization dependent interface properties of ferroelectric Schottky barriers studied by soft X-ray
— •Hermann Kohlstedt[1], Adrian Petraru[1], Matthias Meiner[1], Jonathan Denlinger[2], Jinghua Guo[2], Wanli Yang[2], Andreas Scholl[2], Byron Freelon Freelon[2], Theo Schneller[3], Rainer Waser[3], Pu Yu[4], and Ramamoorthy Ramesh[4] — [1]Institut für Festkörperforschung, Forschungszentrum Juelich, D-52425 Juelich, Germany — [2]Advanced Light Source, Lawrence Berkeley National Laboratory, Berkeley California 94720, USA — [3]Institute of Materials for Electronic Engineering 2, RWTH-Aachen, Sommerfeldstr. 24, D-52074 Aachen, Germany — [4]Department of Materials Science and Engineering and Department of Physics, University of California, Berkeley, California 94720 USA

We applied soft X-ray absorption spectroscopy to study the Ti L-edge in $Pt/PbZr_{0.3}Ti_{0.7}O_3/Pt$ ferroelectric capacitors using a modified total electron yield method. The inner photo currents and the X-ray absorption spectra were polarization state dependent. The results are explained on the basis of photo electric effects and the inner potential in the ferroelectric capacitors as a result of back-to-back Schottky barriers superimposed by the potential due to the depolarization field. In general, the presented method offers the opportunity to investigate the electronic structure of buried metal-insulator and metal-semiconductor interfaces in thin film devices by applying simultaneously soft X-rays and an electric dc field.

DS 15.4 Tue 16:15 GER 38

Piezoelectric phenomena in barium titanate thin films observed in nanoscale using piezoresponse force microscopy
— •Grzegorz Wielgoszewski[1], Teodor Gotszalk[1], Piotr Firek[2], Jan Szmidt[2], and Aleksander Werbowy[2] — [1]Wrocław University of Technology, Faculty of Microsystem Electronics and Photonics, ul. Z. Janiszewskiego 11/17, PL-50372 Wrocław, Poland — [2]Warsaw University of Technology, Institute of Microelectronics and Optoelectronics, ul. Koszykowa 75, PL-00662 Warszawa, Poland

Piezoelectric effect in the nanoscale, especially in single crystals of piezoelectric materials, is getting attention of microelectronics researchers very quickly. Thin films of ferroelectric materials (e.g. barium titanate) have a wide variety of application, e.g. high-density dynamic random access memories (DRAMs) or infrared detectors. In order to apply those materials in the most optimal way, one have to completely analyze and diagnose the piezoelectric effect in materials of various thickness and composition. One of the most expected result of the research is calculating the piezoelectric constant of the material.

To investigate such thin films in nanoscale, we constructed a piezoresponse force microscope (PFM). Applying ac voltage between the microtip of a PFM's probe and metal layer placed under the piezoelectric layer causes mechanical oscillation in the investigated film, which is measured using a lock-in amplifier.

We present the PFM construction and results of simultaneous measurements of the topography and piezoelectric response of the barium titanate layers, which thickness was less than 100 nm.