DS 18 Thin semiconducting films

Time: Thursday 09:30–11:15 Room: GER 38

DS 18.1 Thu 09:30 GER 38

Characterisation of Si and SiGe layers with different strain by spectroscopic ellipsometry — •Jürgen Moers, Dan Mihai Buca, and Siegfried Mantl — Institute for Thin Films and Interfaces; Research Center Jülich; D-52425 Jülich; Germany

For further improvement of MOSFET devices high mobility materials as strained silicon are under investigation. Strained silicon is produced by growing thin silicon layers on relaxed SiGe-buffers, where the Ge-content determines the in-plane lattice constant and the incorporated strain. For process characterization it is mandatory to measure the thickness of the epitaxially grown layers and the homogeneity of the Ge-content. In order to provide a non-destructive characterization method, spectroscopic ellipsometry was investigated for thickness and composition measurement, as well as for wafer mapping.

Measurements were performed with a SENTECH SE800 spectroscopic ellipsometer and the appendant SpectraRay software was used for data analysis and simulation. The accuracy of the method is strongly dependent on the provided optical indexes. For SiGe as well as for the strained silicon an extended 4-oscilator-Leng-Model was used to describe analytically the refractive indexes and the absorption coefficient of the materials. SiGe-buffers with different Ge-content and strain were used to investigate the dependence of the model-parameters. Similar measurements were done with strained silicon layers directly on insulator. With the acquired optical data simulations where done to estimate the limits of spectroscopic ellipsometry as characterization method for strained silicon and SiGe layers.

DS 18.2 Thu 09:45 GER 38

On the epitaxy of twin-free cubic (111) praseodymium sesquioxide films on Si(111) — •Thomas Schroeder, Christian Wenger, and Hans-Joachim Müssig — IHP-Microelectronics, Im Technologiepark 25, 15236 Frankfurt - Oder

The preparation of truly single crystalline oxide films on Si substrates is a challenge in modern oxide physics. Twin-free epitaxial cubic (111) praseodymium sesquioxide films were prepared on Si(111) by hexagonal to cubic phase transition. Synchrotron radiation grazing incidence X-ray diffraction and Transmission electron microscopy were applied to characterize the phase transition and the film structure. As-deposited films grow single crystalline in the (0001) oriented hexagonal high-temperature phase of praseodymium sesquioxide. In-situ X-ray diffraction studies deduce an activation energy of 2.2 eV for the hexagonal to cubic phase transition. Transmission electron microscopy shows that the phase transition is accompanied by an interface reaction at the oxide / Si(111) boundary. The resulting cubic(111) low-temperature praseodymium sesquioxide film is single crystalline and exclusively shows B-type stacking. The 180° rotation of the cubic oxide lattice with respect to the Si substrate results from a stacking fault at the substrate / oxide boundary.

DS 18.3 Thu 10:00 GER 38

Contribution by M. Wagner was moved to the end of session DS 9. — • —

DS 18.4 Thu 10:15 GER 38

Atomic vapour deposition of high-k HfO_2: Growth kinetics and electrical properties — •Anil Mane[1], Christian Wenger[1], Jarek Dabrowski [1], Grzegorz Lupina[1], Thomas Schroeder[1], Gunther Lippert[1], Roland Sorge[1], Peter Zaumseil[1], Günter Weidner[1], Ioan Costina [1], Hans-Joachim Müssig[1], Sergej Pasko [2], Ulrich Weber[2], Vincent Méric [2], and Marcus Schumacher[2] — [1]IHP-Microelectronics, Im Technologiepark 25, 15236 Frankfurt (O), Germany — [2]AIXTRON AG, 52072 Aachen, Germany

Atomically smooth thin layers of HfO_2 were grown by atomic vapour deposition (AVD) from tetrakis(ethylmethlyamido)Hf {$Hf(NEtMe)_4$} precursor and O_2. All the depositions are carried at substrate temperature 400 °C on thermally grown SiO_2 (≈2 nm) on 200 mm p-Si(100) wafers under various deposition conditions. These layers were amorphous as deposited, as shown by x-ray diffraction and transmission electron microscopy. The atomic force microscopy and ellipsometry scans confirm the HfO_2 layers were deposited uniformly over the substrate in the thickness of 4 to 50 nm. Chemical compositions of these layers were studied by time-of-flight secondary ion mass spectrometry (TOFSIMS) and x-ray photoelectron spectroscopy (XPS). Deposited layers demonstrated well behaved capacitance as function of gate voltage (C-V) curve and leakage current density as low as 10^{-8} A/cm^2 at 1 V. The effective permittivity of theses layers ranges from 9 to 20 depending on growth conditions. Post deposition annealing in oxygen ambient improve the dielectric properties in great extent, which could explain the role of oxygen partial pressure and temperature for HfO_2 growth.

Invited Talk

DS 18.5 Thu 10:30 GER 38

Formation and Decay of Si/Ge Nanostructures at the Atomic Level — •Bert Voigtländer — Institut für Schichten und Grenzflächen ISG 3 and cni - Center of Nanoelectronic Systems for Information Technology, Forschungszentrum Jülich, 52425 Jülich, Germany

The step-flow growth mode is used to fabricate two-dimensional Si and Ge nanowires with a width of 3.5 nm and a thickness of one atomic layer (0.3 nm) by self-assembly on a Si(111) surface. Alternating deposition of Ge and Si results in the formation of a nanowire superlattice covering the whole surface. One atomic layer of Bi terminating the surface is used to distinguish between the elements Si and Ge. A difference in apparent height is measured in scanning tunneling microscopy (STM) images for Si and Ge, respectively. The reason for the height difference observed in STM will be discussed. Also different kinds of two-dimensional Si/Ge nanostructures like alternating Si and Ge nanorings having a width of 5-10 nm were grown. The method to distinguish between Si and Ge allows to study intermixing on the nanoscale and to identify the fundamental diffusion processes giving rise to the intermixing.