DS 8 Functional thin films I

Time: Tuesday 09:30–11:00 Room: GER 37

Invited Talk

DS 8.1 Tue 09:30 GER 37

Strained silicon - transistor performance increase with new materials — •Michael Hecker, Liang Zhu, Jochen Rinderknecht, Holm Geisler, and Ehrenfried Zschech — AMD Saxony LLC & Co. KG Dresden, Wilschdorfer Landstrasse 101, D-01109 Dresden

In semiconductor industry, there is an ongoing tendency of downscaling device dimensions, accompanied by a continuous improvement of transistor performance. However, there are physical limits of downscaling within the present CMOS technology. One possibility to improve the device performance nevertheless is to introduce dedicated strain into the channel region of the field-effect transistors. Whereas global strain on the whole wafer level has been extensively investigated in the previous years, there is a rapidly increasing interest in generating local strain on the scale of single transistor channels. The talk compares several methods to create strain in the active regions for N- and PMOS transistors. To achieve the desired performance gains, huge strains and related stresses ranging into the GPa region are necessary in silicon. Detection and measurement of such stresses in unpatterned films can be achieved by several methods, whereas actually stress or strain determination with high spatial resolution in local device regions is crucial. As a promising technique to measure the local strain state, a Raman spectroscopy approach is discussed.

DS 8.2 Tue 10:15 GER 37

ELS to determine the band gap of thin dielectric layers — •Matthias Bergholz, Rakesh Sohal, and Dieter Schmeisser — Brandenburgische Technische Universität Cottbus, Angewandte Physik-Sensorik, Konrad-Wachsmann-Allee 17, 03046 Cottbus

In ultra thin layers of high-K materials the value of the band gap can be derived not explicitly although it is a key quantity in the electric behavior. We use ELS with a monochromatized (50 meV - 150 meV) electron gun and primary energies between 20 eV and 30 eV. Starting with the native SiO_2/Si(001) layers we find that loss function of the substrate dominates for using primary energies beyond 50 eV. In contrast at energies below 50 eV the loss intensity can be used to derived the band gap with an accuracy of ±200 meV. We compare thin (<3 nm) films of HfO_x, Pr_2O_3, Al_2O_3 and Si-Oxynitrides and discuss the band gap values as well as the scattered intensity observed within the gap.

DS 8.3 Tue 10:30 GER 37

Phase stability and epitaxial growth of NiMn-based magnetic shape memory thin films using MBE technique — •R. Hassdorf[1], J. Feydt[2], and M. Moske[1] — [1]Thin adaptive films, Research center caesar, 53175 Bonn, Germany — [2]Electron microscopy, Research center caesar

In a theoretical approach using *ab initio* calculations, we established that in the system Ni-Mn-Al the magnetic ground state close to the Heusler stoichiometry is ferromagnetic ordered [1]. Moreover, as for the lattice dynamics of the system, the cubic $L2_1$ Heusler structure is shown to be unstable against shear displacement along the [110] direction which confirms the tendency to form modulated martensitic structures in this regime. Indeed, such structures, namely 2M and 14M, are found experimentally in coexistence within thin film samples grown by MBE technique, with a composition around $Ni_{50}Mn_{30}Al_{20}$.

The structural transition from the disordered B2 to the fully ordered $L2_1$ phase is subject of current investigations. Hereto, NiMn(Ga,Al) alloy thin films were realized by co-deposition of Ni, Mn, and Al on top of single-crystal GaAs at elevated temperatures. As demonstrated from XPS and Auger depth profiling, Ga is incorporated into the film structure almost homogeneously due to its high diffusion mobility. An epitaxial relationship between film and substrate has been confirmed by RHEED. The compositional and microstructural aspects will be discussed.

[1] T. Büsgen, J. Feydt, R. Hassdorf, S. Thienhaus, M. Boese, A. Zayak, P. Entel, and M. Moske, Phys. Rev. B 70, 014111 (2004).

DS 8.4 Tue 10:45 GER 37

Ultra thin dielectric film on silicon — •Ali Bahari P. — Physics Department, Mazandran University, Iran

In the current CMOS CPU generation the silicon gate oxide is 1.2 nm thick. A shrinking of this thickness with one atomic layer for the next generation will lead to a couple of orders of magnitude increase in tunneling current. Another critical issue for future generations is gate oxide degradation due to boron penetration into the oxide from the polysilicon gate electrode. We have recently demonstrated a number of new processes to grow ultra thin silicon nitride and aluminium oxides, based on the self limiting nature of the direct interaction between atomic nitrogen produced in a microwave discharge and heated silicon surfaces. The procedure to grow ultra thin films of aluminium oxide (and nitride) employ a two step process including evaporation of aluminium to less than monolayer coverage followed by gas exposure at room temperature. The pure ultrathin silicon nitride and aluminium oxide (and nitride) films have been grown and studied on silicon in ultrahigh vacuum and studied by XPS and synchrotron in SDU and Aarhus facilities in Denmark. The obtained results indicate that it might be possible to substitute silicon oxide with silicon nitride or aluminium oxide films.