MI 4: Analytische Elektronenmikroskopie

Chair: Hartmut S. Leipner

Time: Monday 15:15–17:00 Location: H5

Invited Talk MI 4.1 Mon 15:15 H5

Advanced IC failure analysis — •Frank Altmann, Michél Simon-Najasek, and Jörg Jatzkowski — Fraunhofer Center for Applied Microstructure Diagnostics (CAM), Halle, Germany

One of the major factors limiting the lifetime of integrated circuits is the occurrence of dielectric breakdowns in one of the circuit's field-effect transistors or capacitors. Process or stress related weaknesses in thin dielectrics can cause early failures in the gate or capacitor oxides. Physical analysis of failures caused by thin dielectric breakdowns can help to distinguish between process or overvoltage related root causes by analyzing the corresponding defect signature. Because of the small dimensions of dielectric breakdowns there is a high risk in modifying its original signature during localization procedure. A new approach based on Electron Beam Absorbed Current (EBAC) imaging within a Scanning Electron Microscope (SEM) will be introduced providing defect localization at extremely low dissipation power in the nW range preserving the original defect structure of thin dielectric breakdown failures. In order to optimize the performance of transistors and diodes there is a growing demand to investigate real dopant profiles to understand and correlate variations of the implant processes to the electrical performance of the devices. A new technique of advanced SEM imaging providing improved dopant contrast biasing the pn-junction combined with a reliable site specific cross section preparation based on precise mechanical grinding will be demonstrated.

MI 4.2 Mon 16:00 H5

Strain Analysis of SiGe-based Field Effect Transistors by Nano Beam Electron Diffraction — •Daniel Erben[1], Knut Müller[1], Christoph Mahr[1], Marco Schowalter[1], Andreas Rosenauer[1], Josef Zweck[2], and Pavel Potapov[3] — [1]Institut für Festkörperphysik, Otto-Hahn-Alle 1, 28359 Bremen (Germany) — [2]Universität Regensburg — [3]Globalfoundries, Dresden

Enhancing carrier mobility in silicon-based electronic devices such as Metal Oxide Field Effect Transistors (MOSFET) has become a large field in scientific research. To this end, one approach is the introduction of stressors near source and drain to strain silicon compressively below the gate contact. In this work, we present strain and composition measurements in a MOSFET sample. In particular, Strain Analysis by Nano Beam electron Diffraction (SANBED) at an FEI Titan facility is used to record series of CBED diffraction patterns, in which disc positions are detected accurately to measure strain according to Bragg's law. Subsequently three different algorithms can be used to calculate strain maps or profiles: edge detection, radial gradient maximisation and cross correlation with masks. In the present study, we focused on strain measurements in profiles through the MOSFET region below the gate in growth- and lateral direction, whereas first results of 2-dimensional strain mapping will be shown. By evaluating several reflections, a strain precision of $2 \cdot 10^{-3}$ is achieved. As SANBED allows for simultaneous evaluation of strain in both [001] and [110] direction, a reliable conversion to Ge-composition is possible, too.

MI 4.3 Mon 16:15 H5

Generation and propagation of dislocations and cracks in GaN single crystals — •Ingmar Ratschinski[1], Hartmut S. Leipner[1], Wolfgang Fränzel[2], Gunnar Leibiger[3], Frank Habel[3], William Mook[4], and Johann Michler[4] — [1]Interdisziplinäres Zentrum für Materialwissenschaften, Martin-Luther-Universität Halle-Wittenberg, 06099 Halle, Germany — [2]Institut für Physik, Martin-Luther-Universität Halle-Wittenberg, 06099 Halle, Germany — [3]Freiberger Compound Materials GmbH, 09599 Freiberg, Germany — [4]Laboratory for Mechanics of Materials and Nanostructures, EMPA Materials Science & Technology 3602 Thun, Switzerland

(0001) GaN single crystals have been deformed at room temperature using different indenter types (Vickers, Berkovich, cube corner) in a load range from 5 mN to 4.9 N. The investigations range from the generation of dislocations at the pop-in event to the formation and propagation of radial and lateral cracks. Dislocations and cracks at the indentations were investigated by optical microscopy as well as scanning electron microscopy in secondary electron contrast and by cathodoluminescence (CL). The dislocation arrangement conforms to the symmetry of the indented surface, whereas the crack formation depends on the shape and the orientation of the indenter. Furthermore, the propagation of dislocations in the strain field of indentations was analyzed by heating and subsequent CL imaging at seven temperature levels up to 1000 °C.

MI 4.4 Mon 16:30 H5

Investigation of D3-like luminescence in mc-solar silicon — •Christoph Krause[1], Daniel Mankovics[1], Tzanimir Arguirov[1], and Kittler Martin[2] — [1]Joint Lab IHP/BTU, Brandenburgische Technische Universität, Cottbus — [2]Joint Lab IHP/BTU, IHP GmbH, Frankfurt (Oder)

In the last years we observed an increasing number of detections of a very intense luminescence in the spectral region of D3 during investigations at multicrystalline silicon. The defects which cause this luminescence even at room temperature could affect the efficiency of solar cells. Furthermore cathodoluminescence revealed a beam current of just a few pico ampere is enough to excite this kind of luminescence which could be interesting for building up some kind of light emitting diode for semiconductor based laser and also on-chip optical data transfer devices. For this reasons we tried to identify the origin with the help of photo-and cathodoluminescence as well as electron beam induced current measurements (EBIC). The temperature dependent correlation between intense luminescence and very strong EBIC-contrast could maybe point to luminescent transitions as main recombination path. We also observed a possible relation between the temperature induced shift of the center wavelength and the band gap energy.

MI 4.5 Mon 16:45 H5

Recent developments in characterization of ultrafine-grained materials by EBSD — •Florian Heidelbach — Bruker Nano GmbH, Schwarzschildstrasse 12, 12489, Berlin, Germany

Electron BackScatter Diffraction (EBSD) examines the relation between structure and properties of materials by providing quantitative microstructural information of inorganic crystalline materials such as metals, minerals, semiconductors, ceramics, etc. EBSD results can be used to assess the grain size, the grain boundary nature, grain orientation and thus texture. The EBSD technique can also be used to perform phase identification and distribution analysis especially when combined with Energy Dispersive X-Ray Spectroscopy (EDS).

We will show how an advanced combination of EBSD and EDS is a powerful tool to successfully identify the different present phases and separate those creating similar patterns. Recent developments also enable the investigation of nanostructured materials in the scanning electron microscope (SEM) by Transmission Kikuchi Diffraction (TKD). Application examples will demonstrate the high spatial resolution (<10 nm) of this technique compared to conventional EBSD.

This presentation aims to reveal the advantages brought by these new developments while presenting application examples.