HL 9: SiC

Time: Monday 11:30–12:45 Location: H13

HL 9.1 Mon 11:30 H13

Temperature dependence of damage formation in Ag ion irradiated 4H-SiC — •Thomas Bierschenk[1], Elke Wendler[1], Werner Wesch[1], Johan Malherbe[2], and Erich Friedland[2] — [1]Institute of Solid State Physics, Friedrich Schiller University of Jena, Jena, Germany — [2]Department of Physics, University of Pretoria, Pretoria, South Africa

Rutherford backscattering spectrometry in channelling mode was used to study the defect formation in Ag ion irradiated SiC. The 4H-SiC samples were irradiated with 360 keV Ag^+ ions at different temperatures between 15 and 800 K over a wide range of fluences ($10^{11} \ldots 2 \times 10^{16}$ cm^{-2}). The results can be divided into two groups:

(i) For temperatures between 15 and 475 K the amorphisation of the implanted layer was reached. The over-all cross section of defect production at very low fluences, which comprises the formation of point defects and amorphous clusters, is almost identical in this temperature range. Differences in damage evolution occur for higher fluences and suggest that the relative contribution of amorphous clusters within a single ion impact decreases with rising temperature.

(ii) For implantation temperatures between 625 and 800 K no amorphisation was found even for the highest applied fluence. Due to the balance of production and recombination of point defects the defect concentration exhibits a distinctive plateau for medium ion fluences before increasing to saturation well below amorphisation. At this final stage our results indicate a mixture of point defect clusters and extended defects.

HL 9.2 Mon 11:45 H13

Analysis of the Temperature-Dependence of the Leakage Current of 3C-SiC p$^+$-n Diodes Caused by Extended Defects — •Bernd Zippelius[1], Michael Krieger[1], Heiko B. Weber[1], Gerhard Pensl[1], Takamitsu Kawahara[2], and Hiroyuki Nagasawa[2] — [1]Lehrstuhl für Angewandte Physik, Universität Erlangen-Nürnberg, Staudtstr. 7/A3, D-91058 Erlangen, Germany — [2]SiC Development Center, Hoya Corporation, 1-17-16 Tanashioda, Sagamihara, Kanagawa 229-1125, Japan

A large leakage current (I_R) is observed at reverse bias (V_R) in 3C-SiC p$^+$-n diodes. This leakage current is caused by a high density of stacking faults (SFs). We used an n-type 3C-SiC epilayer (thickness = 13 μm, [N] = 7×10^{15} cm^{-3}) and implanted Al ions to form the p-emitter (ϕ = 100 μm), which is surrounded by 6 guard rings (depth = 1 μm, [Al] = 1×10^{18} cm^{-3}). Al contacts are deposited on the emitter. The temperature dependence of I_R is studied in the temperature range from 100 K to 295 K. The extended defects under the contacts were investigated by Electron Beam Induced Current (EBIC) and Photo Emission Microscopy (PEM). It turns out that I_R is thermally activated for reverse voltages $V_R < |170|$ V. We propose that within this voltage range I_R originates from thermally assisted tunneling of electrons and holes from band-like states of the SFs into the conduction and valence band, respectively. For $V_R > |170|$ V, the thermal barrier is strongly reduced and direct tunneling dominates. These dependences are simulated in the framework of a simplified model which qualitatively describes the temperature behaviour of the experimental data.

HL 9.3 Mon 12:00 H13

Electrical activation of B$^+$-ions implanted into 4H-SiC — •Thanos Tsirimpis, Michael Krieger, Gerhard Pensl, and Heiko Weber — Lehrstuhl für Angewandte Physik, Universität Erlangen-Nürnberg, Staudtstrasse 7/A3, D-91058, Erlangen, Germany

Boron (B) acceptors reside on Si lattice sites in SiC and have an activation energy of ΔE(B)= 300 meV. In comparison to the heavier Al acceptors, implanted B$^+$-ions cause less damage in SiC, however, care has to be taken during the required subsequent annealing step, because B atoms are a strong diffusing species in SiC. In order to suppress the transient-enhanced B diffusion, two possible solutions have been reported in the literature. (a) The leading and trailing edge of the implanted B profile is encircled by implanted Gaussian carbon profiles. (b) A two-step annealing process at 900°C and at an additional elevated temperature T_A is conducted. In this paper, both techniques are evaluated by means of resistivity and Hall-effect measurements, and the electrical activation of Boron is discussed.

HL 9.4 Mon 12:15 H13

Apparently large ideality factors of MASS-diodes on the basis of the t-BN/SiC system — •Marc Brötzmann, Ulrich Vetter, and Hans Hofsäss — II. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen, Germany

A common feature of many heterojunction diodes is an anomalously large ideality factor above n=2 which has been observed in performed electrical characterizations. As the origin of such high ideality factors is not yet understood, we developed a quantitative model for the unusual diode characteristics on the basis of Metal - Amorphous Semiconductor - Semiconductor diodes (MASS-diodes) [1,2]. In this work, we investigate electrical properties of such diodes on the basis of heterostructure consisting of a crystalline semiconductor material, i.e. 6H-SiC, covered with a thin semiconducting film of amorphous or disordered material such as turbostratic boron-nitride (t-BN). These heterojunctions exhibit a pronounced rectifying behavior, low saturation current and low parasitic currents. Moreover, we observe an apparently giant ideality factor reaching values of n $>$ 25. We demonstrate that the I-V characteristics of these MASS-heterojunctions are well described by a serial arrangement of an ideal Schottky-diode, a Frenkel-Poole type resistance and an Ohmic contact resistance, emulating a p-n- or Schottky diode characteristic with giant ideality factor.

[1] M. Brötzmann *et al.*, JAP 106, 063704 (2009)
[2] M. Brötzmann *et al.*, Proc. ICFSI 12 in PSS C, accepted (2009)

HL 9.5 Mon 12:30 H13

Electrical and Chemical Passivation of SiC Surfaces by Halogen Termination — •Sebastian Schoell, Marco Hoeb, Marianne Auernhammer, John Howgate, Martin S. Brandt, Martin Stutzmann, and Ian D. Sharp — Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, D-85748 Garching

Despite the technological maturity of SiC, few methods of chemical and electronic passivation of its surfaces are available. Treatment of SiC with HF yields OH-terminated surfaces with high defect densities. Here, we demonstrate plasma processing methods which yield F- and Cl-terminated (0001) 6H-SiC surfaces. X-ray photoelectron spectroscopy (XPS) reveals a significant reduction of oxygen, and corresponding increase of F- or Cl-core level intensities, following halogen termination. XPS core level shifts are consistent with surface photovoltage (SPV) measurements which show approximately flat band surface potentials ($<$ 50 meV). Temperature programmed desorption (TPD) was performed and exhibited sharp peaks above 600 °C, indicating covalent surface termination rather than sub-surface incorporation of F and Cl. Measurements of both XPS and SPV as a function of ambient exposure time reveal slow oxidation with the magnitude of surface band bending increasing with time constants of approximately 40 hrs. Thus, halogen termination of SiC provides a practical method for both electronic and chemical passivation which has the potential to improve existing technological processes. Furthermore, this work offers the possibility for formation of self-assembled organic monolayers based on fluorine and chlorine chemistry.