# Wednesday Morning Poster Sessions

## Electronic Materials and Devices
## Room: Exhibit Hall B2 - Session EL+SC-WeP

### Poster Session

**EL+SC-WeP1 Mechanistic Aspects of SiC Oxidation**, *C. Radtke, **F.C. Stedile**, I.J.R. Baumvol,* UFRGS, Brazil, *I.C. Vickridge, I. Trimaille, J.-J. Ganem, S. Rigo*, Universite de Paris 6 et 7, France

SiC is the material of choice in the field of high band-gap semiconductors used in high-power, high-frequency, high-voltage, and/or high temperature applications. The possibility of obtaining an oxide film with good electrical characteristics ($SiO_2$) by thermal oxidation is one of its major advantages. In order to develop an oxidation model, the knowledge of the oxidation mechanism is of great importance. We investigated the incorporation of oxygen in surface and interface regions during different stages of the oxidation process of the C-face of 6H-SiC(0001) wafers as well as its dependence with the gas pressure. Oxidations in natural ultra dry $O_2$ followed by oxidations using isotopically enriched oxygen ($^{18}O_2$) were performed. Different times of oxidation in the natural gas and chemical etching of grown oxides were used to obtain samples representing different starting conditions. Amounts of incorporated $^{18}O$ and depth profiles were determined using nuclear reactions in plateau and resonance regions of their cross-section curves, respectively. The results evidence that in the whole range of oxidation times studied, the oxidation process was limited by the reaction rate of diffusing oxygen with SiC. These results present a new dynamical mechanism with remarkable differences from the oxidation of Si.

**EL+SC-WeP2 Comparison of the Decomposition of Metacarborane and Orthocarborane**, ***A.N. Caruso**, P.A. Dowben*, University of Nebraska, Lincoln

It is now recognized that there are several different polytypes of $B_5C$ (boron carbide) for which the electronic structure has remained obscure. We present a novel $B_5C$ polytype that is radically different from previous polytypes in that it forms an n-type semiconductor. Decomposition of closo-1,7 dicarbadodecaborane (metacarborane) and closo-1,2 dicarbadodecaborane (orthocarborane) due to adsorption of photons (32eV soft x-rays) has been observed. We compare adsorption and decomposition for these molecules and attempt to address why molecules with the same basic structure create materials that are wildly different in their electronic (semiconducting) properties.

**EL+SC-WeP3 Non Destructive Evaluation of Alternative Substrate Quality Using Glancing Incidence X-Ray Diffraction and Raman Spectroscopy**, ***H.J. Haugan**, A.M. Cain, T.W. Haas, K.G. Eyink,* Air Force Research Laboratory, *C.J. Eiting,* Uniroyal Optoelectronics, *D.H. Tomich, L. Grazulis, J.D. Busbee*, Air Force Research Laboratory

Alternate substrate technology holds promise for the growth of high quality lattice mismatched epitaxial films. Unfortunately, the technology has been plagued by difficulties in reproducibility of results. Some of this problem resides in a lack of characterization of the thin, twist bonded layer used as the template for subsequent epitaxial growth. In this work, grazing incidence diffraction (GID) and micro-Raman spectroscopy were used to characterize the alternative substrate prior to growth. The 14 nm and 50 nm thin GaAs layers were bonded to (100) GaAs substrates and subsequently exposed by standard thinning and etching techniques. The crystalline quality of the thin bonded substrates was studied by GID. The full widths at half maximum (FWHM) of the 004 peaks were used to monitor optimum bonding condition. The measured FWHM varied from 29 to 601 arcseconds with smooth surfaces exhibiting the lowest values. The effect of bond pressures on template layers were studied for a series of 50 nm alternative substrates prepared using pressures ranging from 75 psi to 25 psi with a constant bonding temperature of 450 °C. All transferred template layers prepared within this pressure range showed poor quality (FWHM ranged from 324 to 601 arcseconds) when compared to the bulk-GaAs of 12 arcseconds. Micro-Raman measurements were also carried out on these samples. A transverse optical (TO) phonon line is seen and the intensity ratio of the TO to longitudinal optical phonon were much higher than that of GaAs substrate, confirming that the bonding process is causing damage to the thin template layer.

**EL+SC-WeP4 Design and Simulation of AlGaN/GaN Heterojunction Bipolar Transistors**, ***K.P. Lee**, S.J. Pearton, F. Ren,* University of Florida, *J.-I. Chyi,* National Central University, Taiwan, *A. Dabiran, P.P. Chow*, SVT Associates

The progress in developing AlGaN/GaN HBTs has been very limited compared to HEMT devices in the same materials system.HBTs would have advantages of better linearity,higher output power,better radiation resistance and more uniform threshold voltage compared to field effect transistors.To date,dc current gains in HBTs have been limited to <30 at room temperature and the rf performance is poor.The high base resistance is one of the limiting factors in npn structures.We have used a drift-diffusion model to simulate the dc characteristics of a variety of structures designed to improve the HBT performance.These include a superlattice base to enhance the hole concentration due to incomplete ionization of the Mg acceptors,base grading and a regrown base contact structure.The anisotropy in transport properties of the superlattice base have been taken into account.Base transport enhancement is predicted by the introduction of a quasi-electric field in the base layer.The minority carrier lifetime in the base is also a critical parameter determining the HBT performance.A comparison will be given of the relative strengths of the different device structures and their prospects for realizing a high gain,high speed,robust AlGaN/GaN HBT technology.

**EL+SC-WeP6 Growth of Gallium Nitride on Silicon Substrate by MOCVD Using Multiple Buffer Layers**, *M.A. Al-Tamimi, **D.A. Gulino***, Ohio University

An attempt has been made to improve the crystalline quality of MOCVD-grown gallium nitride on silicon (111) substrate by the insertion of a second aluminum nitride buffer layer. The conventional method for growing GaN on heterosubstrates has been to first grow a thin, low-temperature layer of typically aluminum or gallium nitride to act as a compliant, or "buffer," layer to reduce the degree of crystalline defects and threading dislocations in the subsequently-grown GaN epilayer. In the work reported here, a second, low-temperature AlN buffer layer was grown on top of the first GaN epilayer, and this was followed by a second GaN epilayer. We have found improvement in the crystalline quality of the second GaN epilayer as measured by x-ray diffraction rocking curves. We also experimented with ramping the temperature during growth of both the first and second AlN buffer layers, and we discovered that the best quality GaN film obtained in this work occurred when the first buffer layer was grown as the temperature was ramped from 800 to 1060°C and the second buffer layer grown at a fixed temperature of 800°C.

**EL+SC-WeP7 Edge Termination Design and Simulation for Bulk GaN Rectifiers**, ***K.H. Baik**,* University of Florida, *Y. Irokawa*, Toyota Central Research Laboratories

GaN bulk rectifiers show excellent on-state resistances (in the milli-ohm.cm-2 range) forward turn-on voltages of ~1.8V and reverse-recovery times of <50ns. A key requirement is to develop effective edge termination techniques in order to prevent premature surface-induced breakdown. We have performed a simulation study of the effects of varying the dielectric passivation material(SiO2,SiNX,AlN,Sc2O3 or MgO),the thickness of the this material, the extent of metal overlap onto the dielectric and the ramp oxide angle on the resulting reverse breakdown voltage(VB) of bulk rectifiers. We find that SiO2 produces the highest VB of the materials investigated, that there is an optimum metal overlap distance for a given oxide thickness and small oxide ramp angles produce the highest VB. Initial experimental results on small-area devices show good agreement with the trends identified by the simulations. The dc characteristics are still dominated by the defect density in the substrate for large-area rectifiers.

**EL+SC-WeP8 Photoelectrochemical Oxidation of GaN and Fabrication of Metal-oxide-semiconductor Structures using Ga-oxide Dielectrics**, ***D.J. Fu**, T.W. Kang*, Dongguk University, Korea

GaN metal-oxide-semiconductor (MOS) capacitors were fabricated by using Ga oxide formed by photoelectrochemical oxidation of GaN. The electrical properties of the MOS structures as characterized by capacitance-voltage measurement were found to be dependent on the oxidation time and post-treatment. Positive flatband voltage was observed in devices with thin oxide layers indicating the existence of negative oxide charge. Very thin oxide exhibits high capacitance and reverse leakage, which can be reduced by rapid thermal annealing. Passivation of the interface by the annealing is partially responsible for the improvement. Thicker oxide layers exhibit improved electrical properties. Low density of interface states was obtained in the Ga-oxide/GaN structure grown under optimized conditions.

**EL+SC-WeP9 Relating Interfacial Structure and Composition of Pt/CdZnTe to Radiation Detector Device Performance**, ***D.J. Gaspar***, *M.H. Engelhard, V. Shutthanandan, S. Thevuthasan,* Pacific Northwest National Laboratory, *A.A. Rouse, C. Szeles, J.-O. Ndap, S.A. Soldner*, eV PRODUCTS

The interfacial structure and composition of platinum/CdZnTe interfaces was examined to establish correlations between surface and interfacial stoichiometry and radiation detector device performance. X-ray photoelectron spectroscopy (XPS), including depth profiling, and Rutherford backscattering spectroscopy (RBS) were used to determine surface and Pt/CdZnTe interfacial composition. The $^{57}$Co spectral response of five CdZnTe detector devices formed by deposition of Pt contacts on a CdZnTe crystal was correlated to the interfacial stoichiometry and the ideality factor. Non-ideal contact behavior was correlated to interfacial oxidation and to the bulk series resistance of the diode. XPS depth profiling revealed differences in the formation of the rectifying contacts, which correlated to device electrical performance.

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