Identification of Pair Defects in SiC

Mary Ellen Zvanut (University of Alabama at Birmingham, Physics)

Introduction

Silicon Carbide (SiC) is one of the leading contenders in the search for a suitable semiconductor for high power, high temperature devices. Although commercial substrates are available, incorporation of nitrogen during growth remains a critical issue. We have studied a nitrogen-related point defect present in a wide variety of 4H and 6H polytypes of SiC using electron paramagnetic resonance (EPR) spectroscopy. High frequency EPR measurement and the dependence of the defect concentration on nitrogen incorporation supports the identification as a nitrogen-donor pair as has recently been suggested by others [1,2].

Experimental

The samples studied were grown by physical vapor transport by three different vendors. The amount of nitrogen, as determined by secondary ion mass spectroscopy (SIMS), ranged from $10^{16} – 10^{18}$ cm^{-3}, and the electrically measured net carrier concentration (N_d-N_a) varied between $5x10^{15}$ and $7x10^{17}$ cm^{-3}. EPR was performed between 15 and 30 K in the dark and after illumination using an in-house 10 GHz spectrometer and the 240 GHz spectrometer at NHMFL. Dr J. van Tol performed the high frequency EPR measurements.

Results and Discussion

Originally, the EPR spectrum addressed in our work was thought to be part of the isolated nitrogen donor; however, recent measurements clearly show that it is a separate defect, likely a nitrogen pair [1]. Comparison of our 240 Hz and 10 GHz measurements show that the center in $7x10^{16}$ cm^{-3} N-doped 4H SiC confirms that pair center involves nitrogen on a site of cubic symmetry and a second, as yet unidentified defect. The concentration dependence seen for the entire range of doping concentration also supports the pair model. The nature of the second half of the pair may be gleaned from comparison of data obtained from 4H and 6H substrates. A consistently higher concentration of the pair in the 4H polytype compared to that in the 6H is consistent with a model in which the second half of the pair is a nitrogen atom substituting at a site of hexagonal symmetry. Further experiments using samples with higher nitrogen concentration are planned to test this hypothesis.

Acknowledgements

This work is supported by the National Science Foundation, Dr. Colin Wood (ONR), and Dow Corning Compound Semiconductor Solutions.

References

[1] U. Gerstmann, et. al., Mat. Sci. Forum **556**, 391 (2007)
[2] S. Greulich-Weber, Phys. Stat. Sol. a **182**, 95 (1997).