AN 357

Improved Precision in SIMS Measurements of B, Al, and N in SiC

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Discussion

SiC is a very important material for high-power, high-temperature, and high-radiation devices. Dramatic progress in SiC power transistors, LEDs, and sensors have made it imperative to accurately control the dopant and impurity levels. Requirements for high yields demand reproducible dies across a wafer. SiC material vendors and device manufacturers would benefit from the solution to this problem.

The criterion is to be able to distinguish differences in doping levels across a wafer (center to edge). Due to its unique capabilities of high detection sensitivity for a variety of elements under depth profiling mode, Secondary Ion Mass Spectrometry (SIMS) is an essential tool for characterization of dopants and impurities in SiC material. Previous precision levels have been as high as 50-100% or more. This is unacceptably high. In terms of SIMS this means better precision of concentration and thickness measurements to monitor possible variation in these parameters.

We have developed new protocols to measure B, N, and Al in SiC that have significantly improved precision. Figures 2-4 show the results of long term precision studies of the three major dopants in SiC demonstrating excellent precision for B = 6%, Al = 11%, and N = 10% (1σ). Thickness determinations can detect variations to within 1-2%. Figure 1 illustrates a typical SIMS investigation of N concentration and epi thickness uniformity at five positions across a single SiC wafer. The concentrations at position 1 ≠ positions 2 and 3 ≠ positions 4 and 5. The epi-layer has a different thickness at all five positions. SIMS is thus a vital tool for determining the uniformity in doping concentration and epi thickness.

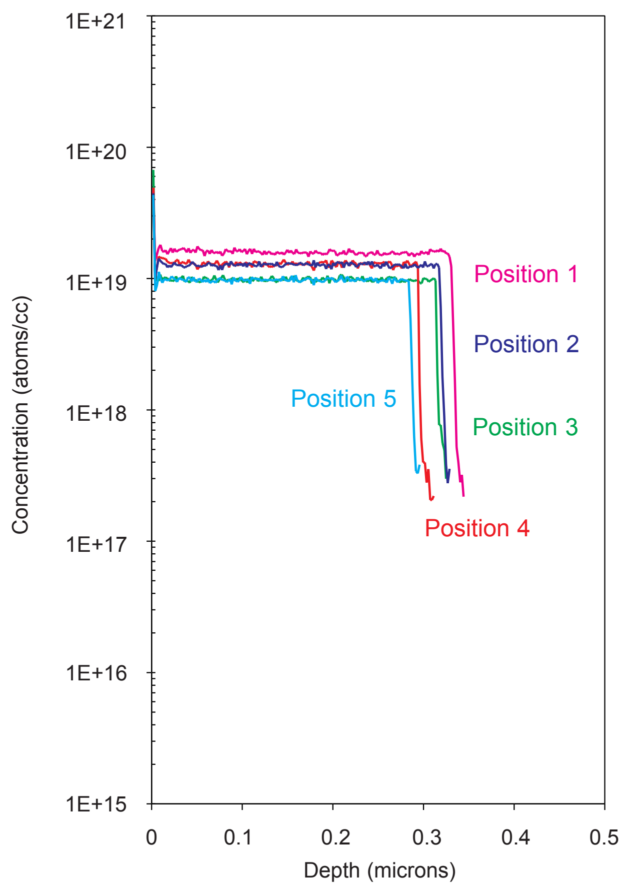

Figure 1. Variation of N Concentration and Epi Thickness Determined by SIMS

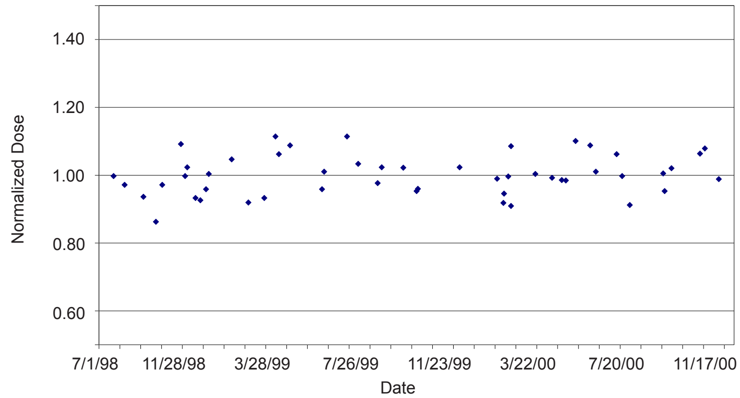

Figure 2. B in SiC: Standard Deviation (1σ) = ±6%, range <30%

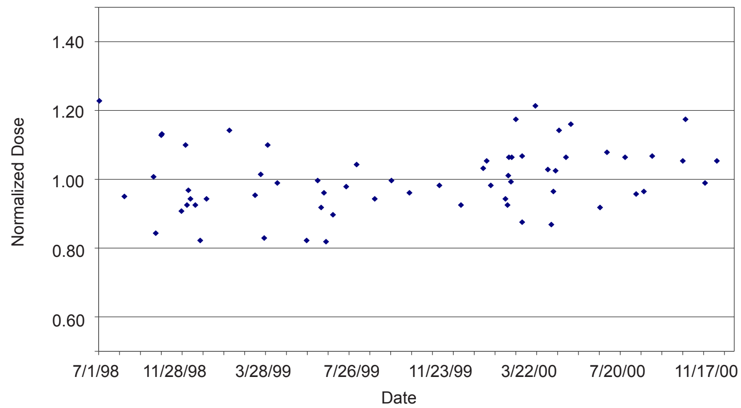

Figure 3. Al in SiC: Standard Deviation (1σ) = 11%, range of 40%

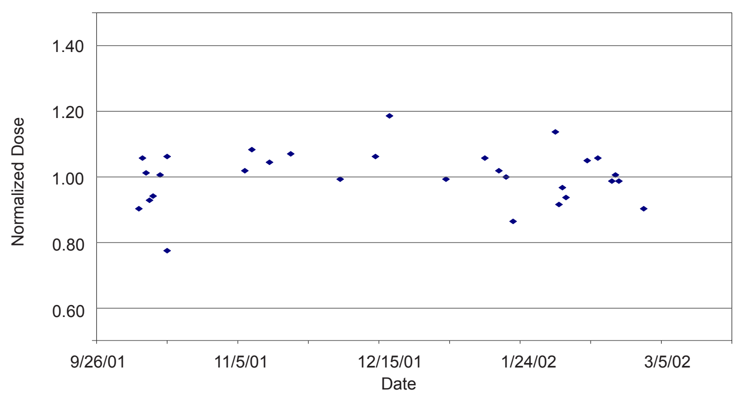

Figure 4. N in SiC: Standard Deviation (1σ) = ±10%, range of 30%.

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