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SIMS Measurements of Silicon Carbide (SiC)

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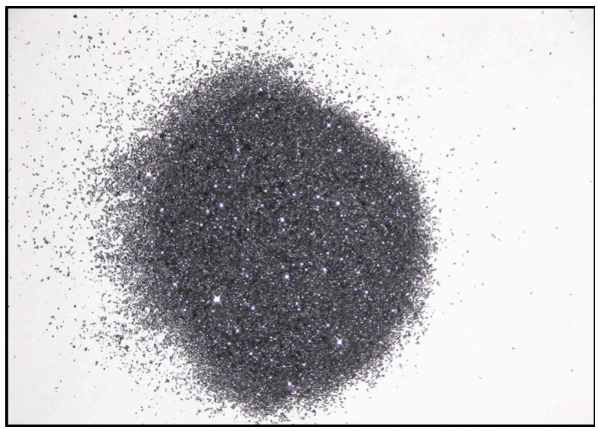
Silicon Carbide is a very important material for high-power, high-temperature, high-frequency, and high-radiation devices due to its superior electronic and thermal properties. Dramatic progress in SiC-based power transistors, LEDs, and sensors have made it imperative to accurately control dopant and impurity levels.

Secondary Ion Mass Spectrometry (SIMS) has very high detection sensitivity for a variety of elements. Its unique profiling capability can provide quick and precise feedback in dopant level, junction depth, and impurity distribution in SiC sample, including patterned device structures. It is an essential tool for process control and problem solving in wafer growth and device manufacturing.

Using a special sample preparation technique and a new SIMS analytical protocol, individual SiC particle with a size ranging from 100 µm to 500 µm in a SiC powder sample can be analyzed. This innovative approach eliminates contributions from surface contamination to bulk concentration.



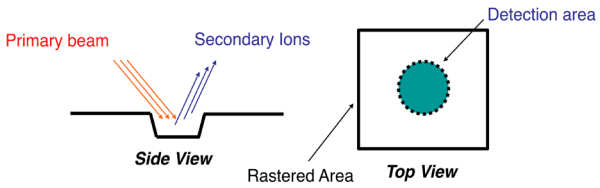
Basics of SIMS Analysis of SiC

Primary Beam

Either oxygen (O_2+) or cesium (Cs+) primary ion beams are used for SIMS analysis. The spot size of a focused primary ion beam is typically 2 to 20 µm. This primary beam is rastered over a square area, usually on the scale of up to several hundred microns on a side.

Detection of Secondary Ions

Secondary ions generated from the central portion of the rastered area are measured after being mass separated in a mass spectrometer. In magnetic sector SIMS instruments, secondary ions can be detected using electron multipliers, faraday cups or ion imaging detectors.



Quantification of SiC

Concentration Calibration

Concentrations are calibrated based on ion implant standards into clean SiC.

Depth Calibration

The acquisition time of a depth profile is converted to depth using the measured analytical crater depth (using a stylus profilometer).

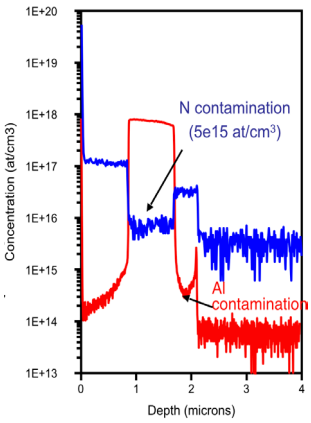
SIMS Detection Limits (AT/CM^3) in Depth Profiling Mode*

*Detection limits in a semi-bulk or bulk mode may be significantly lower than those obtained in depth profiling mode.

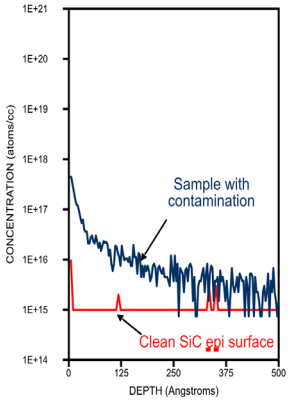
O_2^+ Primary Ion Beam Positive Ions			
Li	1E+13	Cr	5E+13
B	2E+13	Mn	5E+13
N	5E+16	Fe	2E+14
Na	2E+13	Ni	5E+14
Mg	2E+13	Cu	2E+14
Al	2E+13	Nb	2E+14
K	5E+12	Zr	1E+14
Ca	1E+14	Mo	1E+14
Ti	1E+13	Ta	5E+13
V	1E+12	W	2E+14

Cs^+ Primary Ion Beam Negative Ions	
H	2E+17
B	1E+15
N	2E+15
O	5E+16
F	5E+14
P	1E+14
S	1E+15
Cl	5E+14
As	5E+14

SIMS Analysis of SiC SIMS Depth Profiling Mode



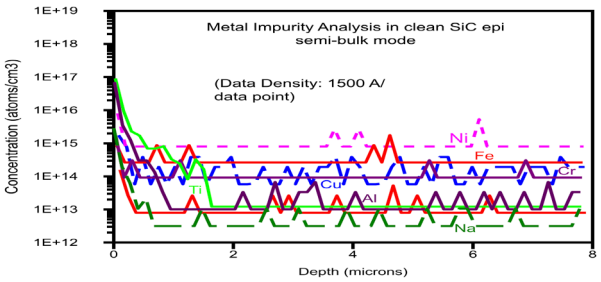
SiC Surface Contamination Measurement Using SIMS



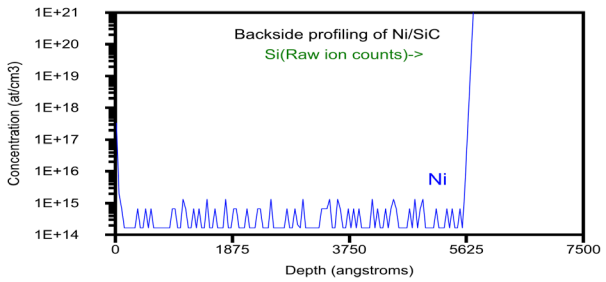
Typical SiC Analyses

- Depth profiling of dopants and impurities, including in small devices
- Semi-bulk mode analysis of metallic impurities
- SurfaceSIMS for surface contamination measurement on SiC surfaces
- SIMS analysis with sample polishing to access deeper or buried layers (frontside or backside)
- Extremely low concentration nitrogen analysis
- SiO_2/SiC interface analysis

Semi-Bulk Mode Analysis of Metal Impurities

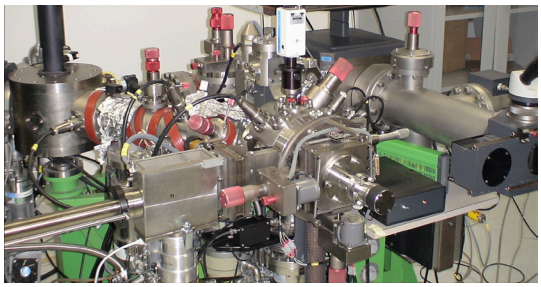


SIMS Analysis of Back-polished Sample Ni on Sic

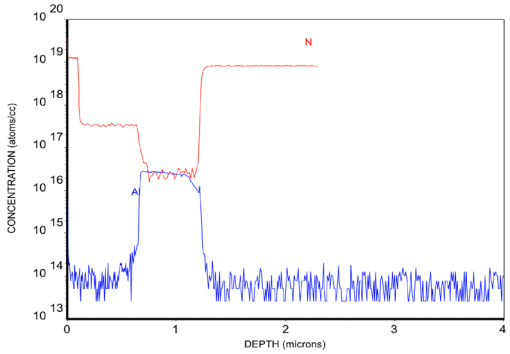


SiC 8-inch Whole Wafer Analysis

SIMS profile of Al and N from a 4" SiC wafer. The Al profile was acquired using oxygen beam sputtering, and N profile was acquired using Cs beam sputtering. The whole wafer capability provides doping concentration and thickness of each epi layer without breaking the wafer. A N detection limit of ~2e16 atoms/cc can be achieved after ~2 hours of pumping.



Modified Cameca 4f with 4" Sample Intro System



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SIMS Analysis at EAG

EAG is the industry standard for SIMS analysis, offering the best detection sensitivity along with accurate concentration and layer structure identification. No other analytical laboratory can match EAG's depth of experience, as well as dedication to research and development in the SIMS field. We have the highest number of SIMS instruments worldwide (more than 50 SIMS instruments), highly qualified scientists, and the world's largest reference material library of over 6000 ion-implanted and bulk-doped standards for accurate SIMS quantification. EAG has been doing SIMS analyses for over 40 years; longer than any other commercial laboratory.