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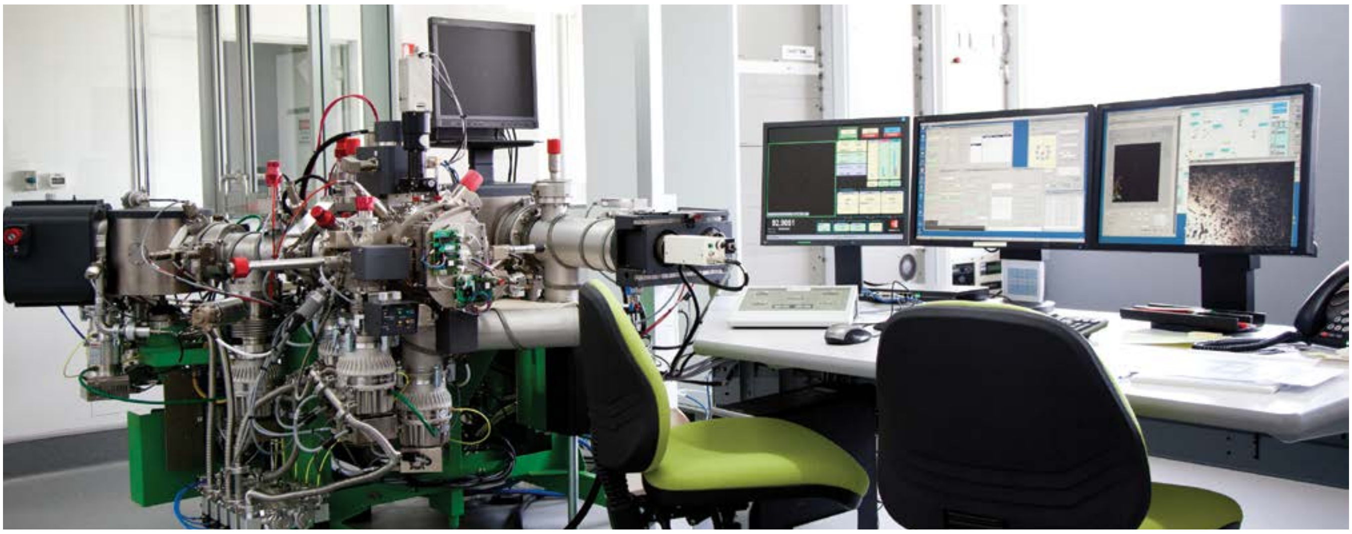
RESEARCH ENGAGEMENT | DEVELOPMENT | INNOVATION

SECONDARY ION MASS SPECTROMETRY (SIMS)



SEMICONDUCTORS

SEMICONDUCTOR CHARACTERISATION AND DEVICE ANALYSIS

With capabilities ranging from the detection of impurities through bulk characterisation to elemental mapping, SIMS is able to solve a variety of problems in the semiconductor business.

The expanding and ever-changing world of semiconductor materials and devices requires high-calibre analysis to ensure device and materials performance. Impurities, dopant concentrations and interface sharpness can all play an important role in determining your level of performance and quality. Whatever material you use, SIMS can help you characterise your devices.

SIMS can be employed to provide an overall picture of complex devices. Depth profiling capabilities with a resolution of 2-5nm allows you to characterise crucial interfaces, ranging from surface contacts through to the substrate barrier layers. Analysis can be performed on layers as thin as 5nm and to a maximum depth of 8µm.

The applications of SIMS are wide-ranging. SIMS may be optimised for a wide range of conditions and a diverse range of semiconductor materials, for example GaAs, HgCdTe, Si and wide bandgap materials such as GaN and SiC. High sensitivity analysis methods can be applied to tasks such as:

- → Dopant and impurity detection
- → Calibration of growth rate and stoichiometry
- → Interface characteristion
- → Diffusion and implantation profiles
- → Surface and interface contaminant detection
- → Elemental mapping of devices

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CAPABILITIES:

- Depth resolution of 2-5nm with sputter rates down to a few nm/hour
- Profiling to a depth of 8µm
- Excellent detection sensitivity with wide dynamic range
- Complete coverage of the periodic table
- Quantification with appropriate standards
- Imaging with 2-5µm spatial resolution

Typically, fabrication of III.V or II.VI semiconductor heterostructures takes place using various layer deposition and/or modification techniques. The quality and performance of the device depends upon accurate calibration and quality control of the various techniques.

SIMS depth profiling is ideally suited for device and heterostructure analysis. With provision of appropriate standards, absolute concentrations of sample impurity and dopant may be obtained. Depth calibrations may be made in conjunction with a device such as a stylus profilometer. Single layers as thin as 2nm may be profiled and complex devices may be profiled to a maximum depth of about 8µm in a single pass. The availability of the MCs+ technique further enhances the data yield from SIMS analysis. Data for up to ten species may be acquired concurrently during analysis.

SEMICONDUCTOR CASE STUDIES

EXAMPLE 1: Growth Calibration

Upon commissioning a new Cl dopant source on a MBE, calibration of the source was necessary to achieve an optimal doping profile. ZnSe was grown on GaAs with Cl doping.

The Cl source was progressively pulsed off and on during growth, for differing periods. SIMS provided information about the growth rate of the whole structure, together with a profile of Cl in the doped layers. Note also the Cl pulse when the source shutter is first opened, shown by a small peak at the edge of a doped layer.

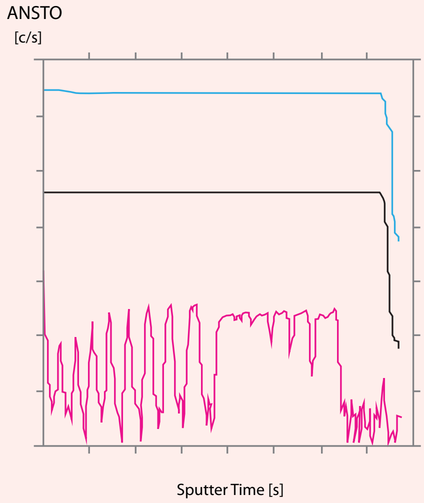
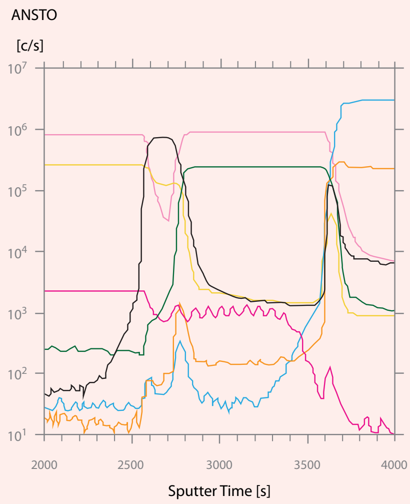


Image courtesy of ANSTO

EXAMPLE 2: Device Structure and Impurity Profile

Here, a multilayer device has been depth profiled from the surface through to the GaAs substrate. Several layers consisting of various combinations of Be, Zn, Se, and Te were grown. Iodine was used as a dopant during growth in the ZnSe layer. Source pulsing during growth produced the characteristic zig-zag pattern. With its excellent depth resolution and dynamic profiling capability, SIMS enables the analysis of critical interface regions for sharpness. Furthermore, with wide dynamic range detection SIMS provides concurrent monitoring of both bulk and impurity species.



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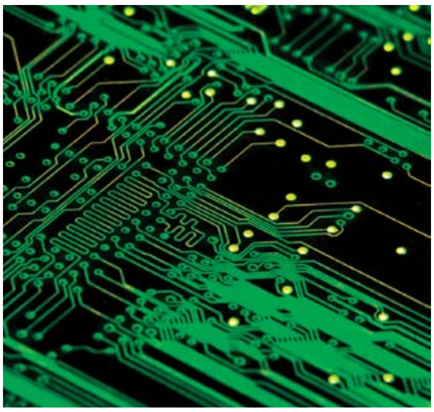

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