# Correlative SIMS techniques for semiconductor materials and applications

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The semiconductor landscape is rapidly evolving, driven by increasing demands for device performance, sustainability, and continued miniaturization. Beyond conventional silicon-based technologies, materials such as graphene and transition metal dichalcogenides (TMDs) are gaining increasing relevance for future device concepts. Their reduced dimensionality and sensitivity to interfaces, contamination, and processing conditions pose significant challenges for characterization. These systems require analytical approaches capable of providing high spatial resolution, excellent surface sensitivity, and unambiguous chemical identification.

Secondary Ion Mass Spectrometry (SIMS) is well suited to address these demands. Time-of-Flight (ToF) SIMS enables high-resolution chemical imaging and depth profiling, while high mass-resolving approaches such as Orbitrap$^{TM}$-SIMS provide enhanced mass accuracy and improved capability to resolve complex chemical signatures [1]. In addition, the integration of in-situ Scanning Probe Microscopy (SPM) offers complementary structural, electrical and topographical information, enabling for example a direct correlation between chemical and morphological features [2].

In this contribution, correlative SIMS approaches for the investigation of semiconductor-relevant material systems will be presented. Emphasis will be placed on the combination of conventional ToF-SIMS for high-resolution imaging and depth profiling, Orbitrap$^{TM}$-SIMS for advanced and unambiguous chemical identification, and in-situ SPM for nanoscale structural and electrical characterization.

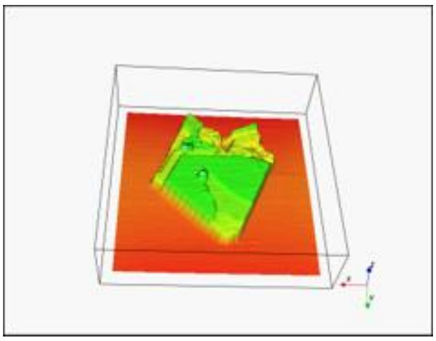

*Figure 1. 3D correlation of the in-situ SPM topography information and the chemical mapping from ToF-SIMS acquired on a mechanically exfoliated $MoS_2$ flake.*

[1] A. Franquet, V. Spampinato, S. Kayser, W. Vandervorst and P. van der Heide, Vacuum 202, 2022, 111182.
[2] V. Spampinato, M. Dialameh, A. Franquet, C. Fleischmann, T. Conard, P. van der Heide, and W. Vandervorst, Analytical Chemistry 92(16), 2020, 11413-11419.