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Advanced physico-chemical characterization of complex systems for microelectronics: innovative SIMS-based approaches

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The imperative to downsize in emerging technology generations requires the development of tailored and innovative characterization techniques and approaches, as conventional methodologies appear inadequate.

SIMS has been extensively applied to the measurement of the distribution of elements and molecules in depth profiling, spatial imaging, and volumetric imaging. However, the lateral resolution typically achievable is often incompatible with the intricate features found in cutting-edge devices, and more challenges arise from potential interface effects, roughness, or topography changes during SIMS experiments. Moreover, maintaining molecular information, especially for organic and polymeric systems, demands exceptionally high mass resolving power for the unequivocal and precise molecular peak assignment.

Recent advancements in SIMS instrumentation aim to improve the technique. Examples include introducing OrbitrapTM mass analyzers in lab-based SIMS platforms to boost mass resolving power [1] and developing combined Scanning Probe Microscopy-SIMS platforms for simultaneous topographical and chemical composition information [2-3].

This presentation highlights examples of physico-chemical characterization of materials used in the microelectronics field, demonstrating how the latest advancements in SIMS provide precise and comprehensive information. Additionally, a more universal approach involving ensemble measurements across multiple small features is discussed (self-focusing SIMS), showcasing how self-focused cluster ions can confine the information to specific areas of interest without sacrificing sensitivity due to localized analysis regions [4-5].

[1] V. Spampinato et al., Analytical Chemistry, 2022, 10.1021/acs.analchem.1c04012
[2] V. Spampinato et al., Analytical Chemistry, 2020, 10.1021/acs.analchem.0c02406
[3] V. Spampinato et al., Advanced Materials Interfaces, 2023, 10.1002/admi.202202016
[4] A. Franquet et al., Vacuum, 2022, 10.1016/j.vacuum.2022.111182
[5] V. Spampinato et al., Applied Surface Science, 2019, 10.1016/j.apsusc.2019.01.107