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► To cite this version:

Jean-Paul Barnes, Claire Guyot, Pierre Hirchenhahn, Tony Maindron, Olivier Renault, et al.. The importance of sample preparation in time-of-flight secondary ion mass spectrometry analysis for semiconductor applications. SISS-22 -The Scientific International Symposium on SIMS and Related Techniques Based on Ion-Solid Interactions, Jun 2023, Kanazawa, Japan. cea-04170890

HAL Id: cea-04170890

<https://cea.hal.science/cea-04170890>

Submitted on 25 Jul 2023

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The Importance of Sample Preparation in Time-of-Flight Secondary Ion Mass Spectrometry Analysis for Semiconductor Applications

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Recent global events have highlighted our dependence on semiconductor technology and energy supply. From smartphones and cars, through critical infrastructures for healthcare, energy, mobility, communications and industrial automation, semiconductor technology and a reliable energy supply are central to the modern digital economy. Worldwide demand for computer chips is expected to double by the end of the decade, making semiconductors of significant geostrategic importance. Leading economies around the world have launched initiatives to enforce their position to ensure access to critical technology. In addition, a significant reduction in environmental impact is essential leading to the development of new technology and the use of materials that have a reduced environmental footprint or come from a sustainable or biological source. Advanced characterization plays an important role in such developments and amongst the many techniques that are used, Time-of-flight Secondary Ion Mass Spectrometry (TOF-SIMS) is particularly well suited to many of the challenges that are faced. For example, the ability to depth profile both organic and inorganic materials enables TOF-SIMS to provide unique insights in organic light emitting diode (OLED) technology [1]. The inherent 3-D nature of the technique provided by the scanned primary ion beam and successive sputter cycles can be very powerful in investigating complex 3-D structures and is not always fully exploited. The integration of a dedicated Ga FIB beam also provides the possibility to investigate much larger, porous or air sensitive structures that are not feasible using a top-down depth-profiling approach. This talk will deal with the importance of sample preparation in obtaining reliable information about complex semiconductor samples. We will show firstly how the use of a bevel crater formed using argon cluster sputtering combined with tandem mass spectrometry and photoemission techniques can be used to investigate the degradation in OLED samples. Secondly we will discuss how the use of the Ga FIB beam can be used to cross-section different types of interconnect structures for 3D integration of different technologies on the same chip and even to perform 3D FIB-TOF-SIMS tomography by successive FIB cuts and imaging steps [2]. The importance of sample preparation strategies to enable correlative analysis will also be addressed.

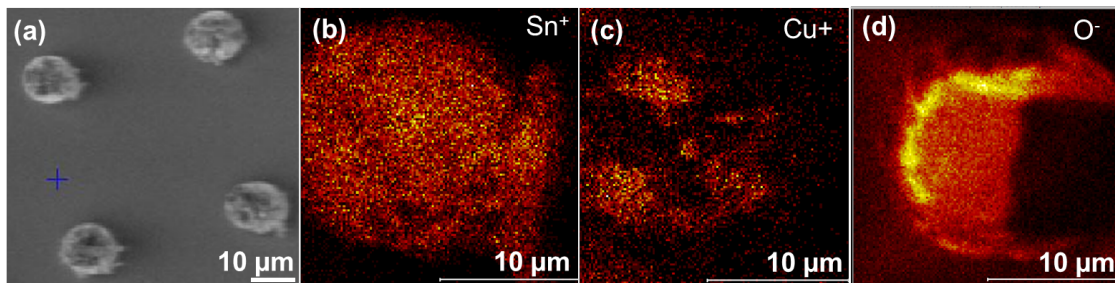


Figure 1. (a) Ion beam generated secondary electron image of an array of copper pillars, image of (b) Sn^+ and (c) Cu^+ secondary ions highlighting compositional variations at the surface. (d) O^- secondary ion image after in-situ FIB cut to evaluate pillar oxidation.

Part of this work, carried out on the Platform for Nanocharacterisation (PFNC), was supported by the “Recherches Technologiques de Base” program of the French National Research Agency (ANR).

References

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- [2] A. Priebe *et al.* *Ultramicroscopy*, vol. 173, 2017.