Multi-Modal Characterization on NanoFab with SIMS - Recent Results from an Analytical Standard and a Metal Sample

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Gas field ion source (GFIS) technology has been used to create helium and neon beams for use in several characterization and nanofabrication applications [1]. GFIS technology presents several advantages, including small probe sizes and high precision beams that deliver dramatic surface detail at 0.5 nm spatial resolution, unique contrast mechanisms, and high precision nanofabrication. While these advantages yield impressive results, there are no analytical capabilities that can match these achievements.

There are many analytical techniques available that are suitable for ion beam sources. One particularly attractive technique is secondary ion mass spectrometry (SIMS). The qualitative SIMS technique has excellent sensitivity, the ability to differentiate between isotopes, and has high dynamic range. A dedicated SIMS instrument was recently developed for ZEISS Orion NanoFab, leveraging the NanoFab's 2 nm neon beam, enabling analysis of regions limited only by the lateral distribution of the surface sputtered atoms [2, 3]. By combining the advantage of high resolution imaging capabilities of the instrument with elemental and isotopic maps of the SIMS, multi-modal, correlative data sets can be generated.

Here, we will show SIMS elemental maps acquired with ZEISS ORION NanoFab with lateral resolutions of less than 20 nm. The well-established BAM-L200 certified reference [4] is used to characterize the detector's ability to identify Al and Ga in the alternating GaAs and AlGaAs layered sample, as seen in Fig 1a and 1b, and shown as a composite colorized image in Fig 1c. When imaged at high magnification, the finest line pairs with a half pitch of 9 nm are easily observed.

In addition to measuring the detector's ability to resolve small structures, we also present SIMS images from a metal sample. Here, the challenge was to identify (1) the composition of iron rich needles; (2) the Cu to Al ratio in the dendrites and in the theta phase; and (3) gradients in the Cu to Al ratio from the center to the periphery of the dendrites. Initial results, presented in Figure 2, show Al-rich dendrites surrounded by a copper-rich theta-phase ($CuAl_2$).

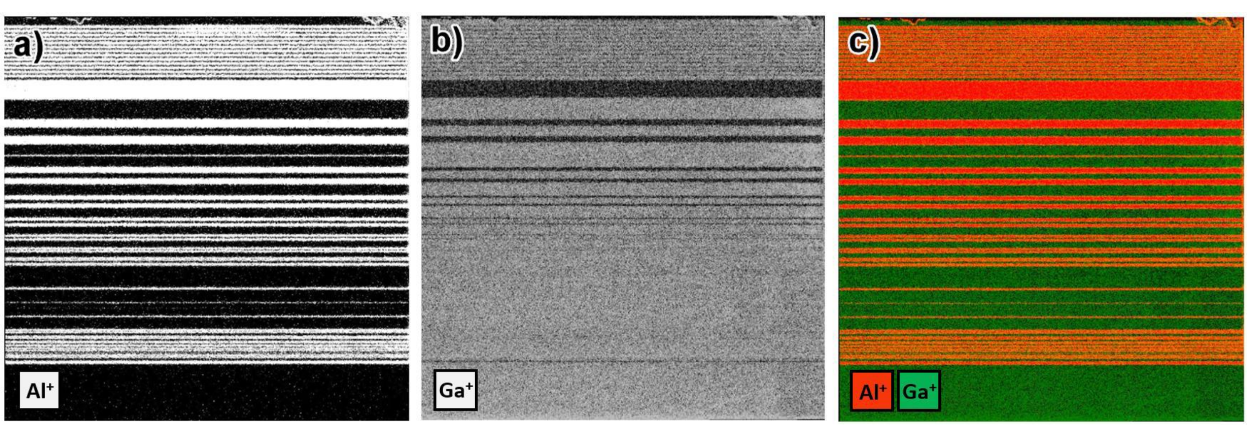

Figure 1: Zeiss ORION NanoFab SIMS generated elemental mapping images of the BAM-L200 standard. The images in (a) and (b) show the images acquired with detection set for aluminum and gallium. Image (c) is a composite image with the two elements colorized as shown.

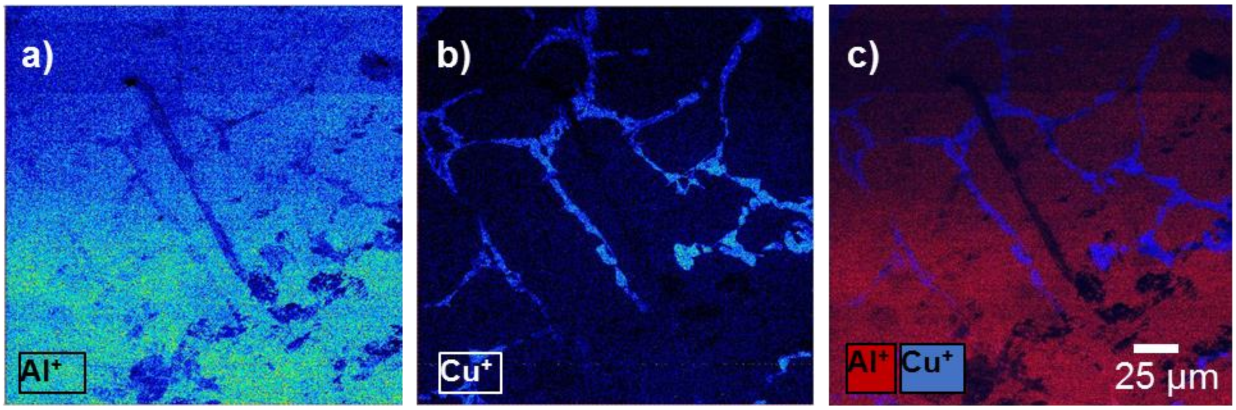

Figure 2: ZEISS ORION NanoFab SIMS generated elemental mapping distribution of Al (a) and Cu (b) on CuAl alloy sample. Image (c) represents a composite image. Field of view is 225um.

References:
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