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Benefits of a Full Field of View in Atom Probe Tomography

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The analytical performance of atom probe tomography is determined by, among other things, the field of view (FOV) and mass resolving power (MRP). The FOV sets the analyzable length scale while the MRP influences the quantification of the mass spectrum. It is highly desirable for both to be as large as possible, but historically, these two metrics are inherently at odds with each other. From a design perspective, the challenge is due to (in part) the high spread in flight-time variations (different flight paths) across the FOV of a large detector. Some efforts to overcome this difficulty employ reflectron energy compensating based solutions [1] while others use a straight flight path design [2, 3]. This work presents some recent examples of data collected with the new CAMECA Invizo 6000™ showing the benefits of this innovative new system [3] to provide unprecedented FOV with high MRP.

The benefits of the large field of view are manifested in several ways. First, there is a clear benefit in the sample preparation process. In standard commercial APT systems, regions of interest (ROI's) can be just a few nanometers in size and must be placed within the central 50-60% of a specimen that is typically between 50-100 nm in size. The full FOV design of the Invizo increases the analyzable portion of the specimen to ~90% or more (depending on the details of the specimen geometry) as demonstrated in Figure 1. This means less time is required on a FIB-SEM to produce the required number of specimens with the ROI contained within the target area.

Another benefit is in the ability to more directly match electron microscopy images typically acquired during specimen preparation to the acquired data to enable a more accurate reconstruction. As shown in Figure 2, a feature clearly identified on the extreme edge of the specimen can be correlated to a silver-based feature at the edge of the FOV allowing the reconstruction length scale to be calibrated, including the position of a change in the shank angle partway through the particle.

A third benefit is through the additional analyzable volume for samples with the ROI distributed throughout the acquired volume. A clear example of this is in the case of precipitate analysis, as shown in Figure 3. For equivalent depths, the Invizo 6000 contains ~2X the volume compared to a LEAP and thus would have 2X the precipitates. This provides better statistics for understanding the shape, orientation, and composition of the precipitates in each data set.

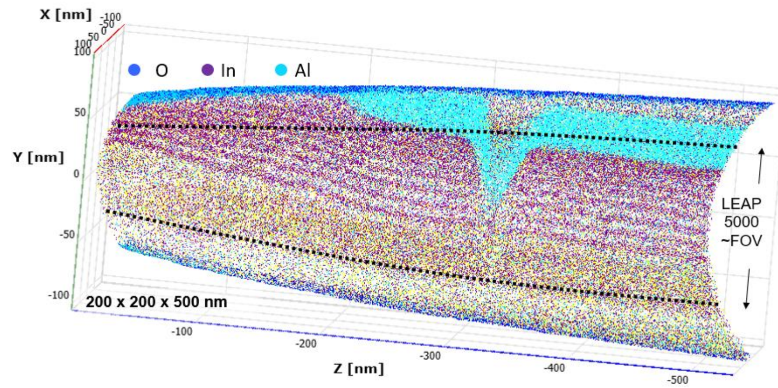

Figure 1. A GaN LED device with a V defect. Native oxide at the edges show the full FOV of the specimen was captured in this case allowing both the top and bottom of the V defect to be analyzed within a single data set. The dashed lines indicate the approximate FOV for a LEAP 5000.

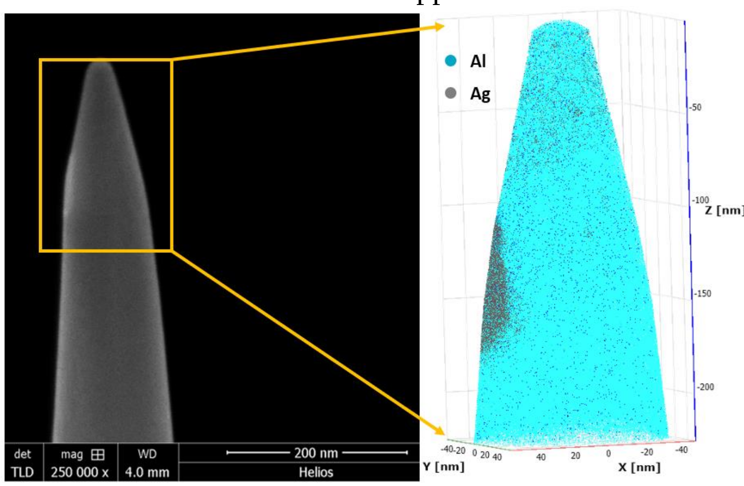

Figure 2. An AlAg alloy showing a large Ag-based precipitate at the specimen edge in the electron microscopy image which can then be matched to the atom probe data for reconstruction calibration.

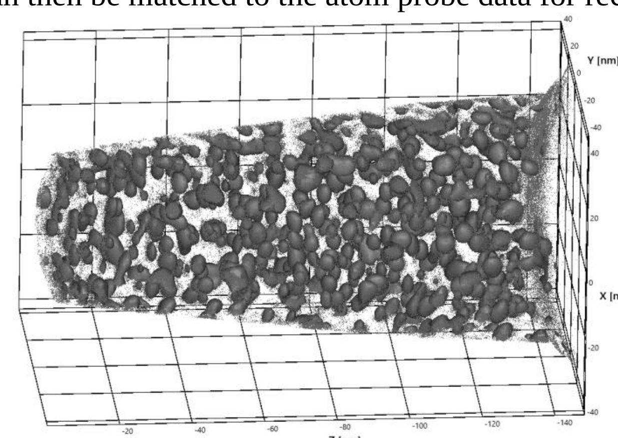

Figure 3. An AlAg dataset containing more than 250 precipitates acquired with the Invizo 6000. An equivalent LEAP 5000 FOV would contain approximately half as many precipitates.

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