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New Product Announcement – Invizo 6000, New Applications, New Performance

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Atom probe tomography (APT) has been an important technique for metallurgical research for more than 50 years, but only recently has there been substantial adoption in the semiconductor industry [1–3]. Maintaining this trend requires continuing advances in the areas of hardware (and software) related to APT. The field-of-view (FOV) / mass-spectral-quality tradeoff [4] along with laser wavelength [5,6] are two such areas of advancement. It is highly desirable for an atom probe to have a combination of a wide field of view and high mass resolving power (MRP), but historically, these two metrics are inherently at odds with each other, from a design perspective. Some efforts to overcome this difficulty employ reflectron energy compensating based solutions [7], while others use a straight flight path design [8,9]. In this work, we present the new CAMECA Invizo 6000™ atom probe and introduce the primary benefits.

The Invizo 6000™ design provides substantially increased data volumes and improved specimen yield. It uses a patented design [9] based on Einzel lenses and laser beam delivery optics to enable dual sided specimen illumination with a deep UV (257.5 nm) wavelength (spot size of <2 µm). The results of these technological advancements include: 1) an ultra-wide FOV (in some cases capturing the entire specimen volume) while maintaining high MRP, 2) more uniform heat diffusion resulting in more uniform field evaporation, and 3) more uniform heat deposition and reduced evaporation field (stress) differences between different phases which produce more uniform specimen shapes. The benefits of the Invizo 6000 include simplified specimen preparation with a higher chance to capture the region of the interest (due to the wide FOV), better concentration statistics (due to the wide FOV), improved yield for some materials systems (due to the wide FOV and DUV), improved MRP uniformity (due to dual beam illumination) and more accurate data reconstruction (due to dual beam illumination and DUV).

The wide FOV of the Invizo 6000 is illustrated in Figure 1a, which shows a field desorption map of an aluminum specimen with a FOV ~110º. This will vary with specimen geometry, but typical values range from 90-110º For comparison, a typical LEAP 5000 FOV is ~60º. In addition to providing more data and the associated benefits, this type of field of view enables the ability to caption larger features in their entirety, as illustrated in Figure 1b, which shows a V-defect in a GaN-based quantum well structure. The presence of significant oxygen atoms detected at the edges of the specimen (in XY) indicates that, in this case, the entire specimen volume is being collected.

While exposure to a single focused-laser-beam can lead to non-hemispherical (asymmetrical) shape (particularly when very high laser energy is utilized), the Invizo 6000 features a unique laser pulsing system which irradiates the specimen from two sides in a thermally coincident manner [4]. Figure 2ab shows a comparison of a representative specimen shape (silicon) from one-beam and two-beam laser conditions. The local curvature (tip radius) variation along the tip surface for each of the specimens is quantified in Fig. 2c. and shows a decrease of ~5X (standard deviation as a percentage of the mean).

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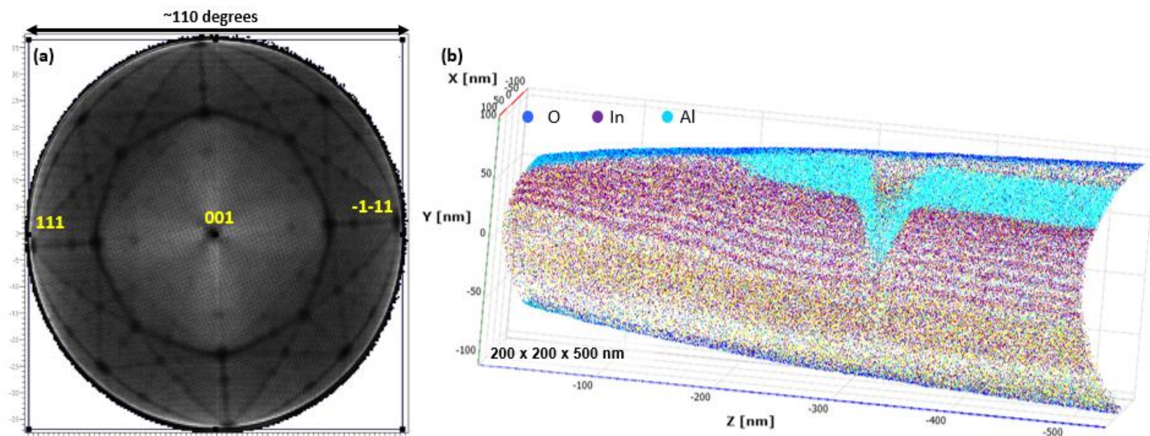

Figure 1. (a) Invizo 6000 field desorption map of an aluminum specimen with an angular field of view ~110º (units are detector dimensions in mm) and (b) full field of view of a V-defect in a GaN-based quantum well structure with the native oxide (dark blue) at the outer edges of the specimen visible in the acquired data volume.

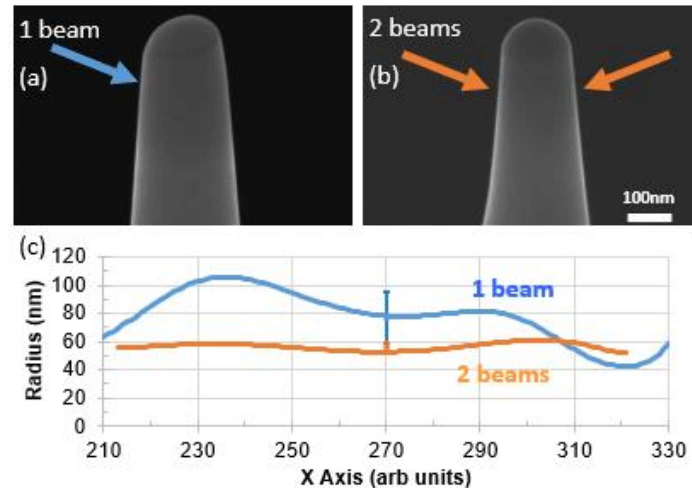

Figure 2. Representative specimen shapes from the Invizo 6000 for (a) one-beam and (b) two-beam laser conditions. In (c) the single point average radii are (77 ± 18) nm and (56 ± 2.6) nm for the one- and two-beam conditions, respectively.

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