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An Electrostatic Reconstruction Wizard

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INTRODUCTION

Standard atom probe tomography (APT) reconstructions assume a spherical apex shape typically in conjunction with an analytical projection law to recreate spatial positions for detected ion events. [1, 2] To provide the flexibility required to improved reconstructions of APT data collected from aspherical specimen apex shapes we have been developing reconstruction tools based on a system of programmable arrays of point charges. [3,4] We present several techniques for specifying apex shapes being developed as part of the new electrostatic reconstruction module of the APSuite™/IVAS Reconstruction Wizard.

BACKGROUND

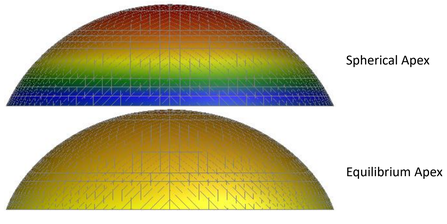
In the absence of a spherical apex assumption, we must supply apex shapes for the reconstruction to use. Among others, we support:

- An isotropic equilibrium apex
- An equilibrium apex subject to laser heating
- A sequence of shapes for flattening horizontal planar landmarks

While imaging data is desirable even for these modes in setting shank geometries, they are all automatic and do not use imaging data.

ISOTROPIC EQUILIBRIUM

- Starting from an approximately spherical apex we iteratively solve for apex fields and make shape adjustments to force an apex with uniform electric field strength over the apex surface.
- This reproduces the apex blunting that is expected from earlier work.[5]



Apex field variation reduced from ~6 V/nm to 0.5 V/nm.

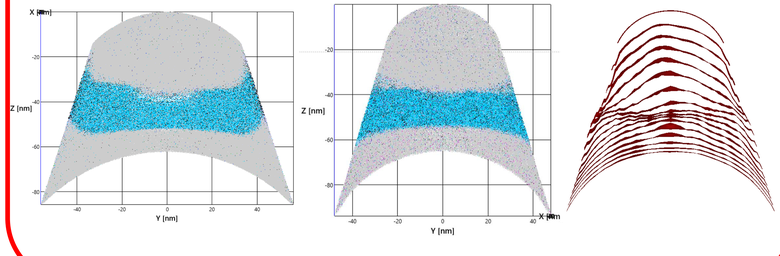
ADAPTIVE LANDMARK RECONSTRUCTION

Using the Invizo instrument to obtain full field-of-view data and assume planarity of a feature, we can generate a sequence of apex shapes that will correct curvatures in the APT reconstruction.

- This is done by:
  - Performing an initial electrostatic reconstruction using a series of isotropic apex shapes
  - Finding a best-fit plane through the middle of a layer
  - Making adjustments to the initial apex shapes that correct deviations.
  - We then perform a final reconstruction using this sequence of modified shapes and the resulting electric fields that result from them.

Below we show an oxide layer in Si reconstructed with a) standard fixed shank recon and b) Adaptive Landmark recon with c) the generated apex shape sequence.

A) B) C)



LASER HEATING CORRECTION

APT evaporation with laser pulsing with a single beam can result in apex shapes with different curvatures towards or away from the beam direction. [6]

- Typically, the side facing the laser is warmer and evaporates more readily allowing a larger radius of curvature to form, resulting in:
  - Reduced magnification causing higher hit density in the detector event histogram, and the resulting reconstruction
  - Spatial variation in charge-state ratios indicating lower electric field in the warmer areas. [7]

By changing the target fields to have a linear field gradient across the apex we can relax the apex shape to reflect the laser affect, creating a more uniform density in the reconstruction.

A) B) C)

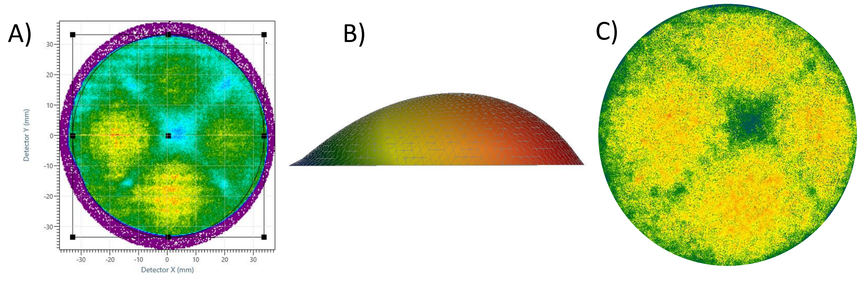


Fig A) Detector Event Histogram from laser pulsed Si; B) A heating corrected apex shape; C) The resulting reconstruction showing improved uniformity.

CONCLUSIONS

CAMECA is developing a suite of non-spherical reconstruction tools. We present three techniques for semi-automatically generating non-spherical apex shapes. These include an isotropic equilibrium apex, an equilibrium apex subject to laser heating, and with the full-field-of-view Invizo data we can compute a sequence of apex shapes that flatten horizontal layers.

With these techniques we can create artifacts in APT reconstructions caused by assuming a constant spherical apex shape.

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