CAMECA
SCIENCE & METROLOGY SOLUTIONS
AMETEK

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FINDINGS FROM THE UNIVERSITY OF SYDNEY: ATOM PROBE OF ALLOYS AND STEELS ON THE INVIZO 6000, LEAP4000X SI, AND LEAP3000 SI

Q&A SESSION

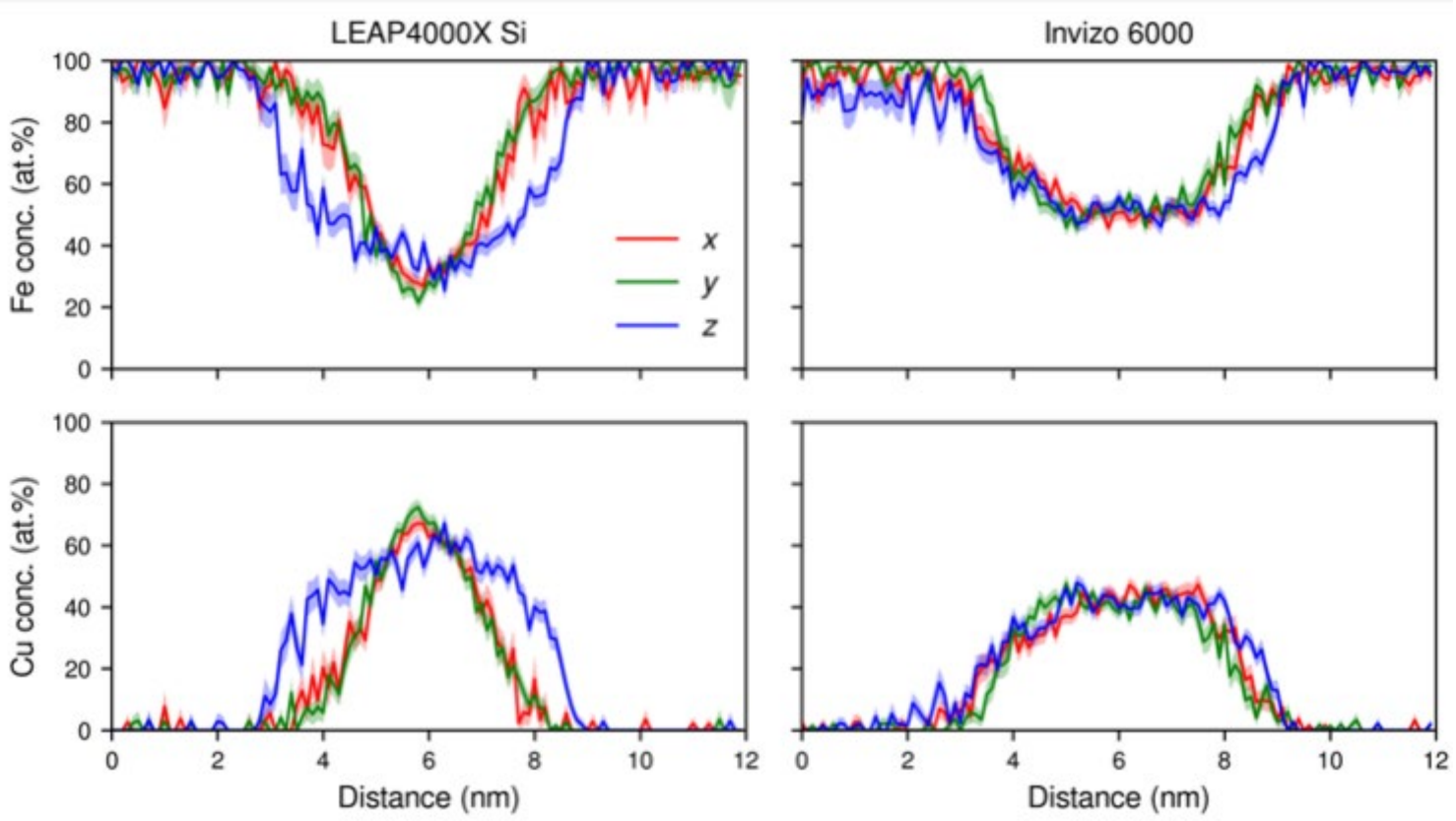
- Question: What is the diameter of the counter electrode? is it still ~50 micron like the conical LEAP electrodes or larger like the EIKOS (500 micron?). if so does this have any substantial effect on the required DC voltage to increase the field strength?
- Answer: "It is very similar in diameter to the EIKOS counter electrode. Yes, you will see in this presentation the lower electrostatic k-factor when moving from one instrument to another. The electrode is not integrated onto the specimen puck like EIKOS - there is final alignment in the instrument that is completed with machine vision. As you saw - about 25% difference in k-Factor - something that needs to be considered when doing reconstruction."

- Question: Since only single tips can be used, he may get into it, but how are samples for INVISO typically prepared? As opposed to commonly using FIB liftout for LEAP. Only bulk tips through electropolishing or similar?
- Answer: "FIB LO to wire 'blanks' instead of a microtip is a regular practice for Invizo, EIKOS, and older 3DAP and TAP instruments. It takes about 30% longer to make the specimens from a FIB wedge LiftOut."

- Question: Why not compare 5000 with 6000?
- Answer: "They never had a 5000 at Sydney, just a 3000/4000/Invizo - hence these comparisons. The laser system for a 4000 is similar to a 5000."

- Question: Please remind me- what is the spot size in the Invizo?
- Answer: "The Invizo 6000 beam size is a bit larger than the LEAP 6000 or the LEAP 5000."

- Question: How does the Fe-Cu profile change in the analysis direction as compared to the lateral dimensions, this might indicate if the blurring is a result of the laser or reduced resolution?
- Answer: "Narrow ROIs and used for 1D concentration profiles along similarly-sized and shaped Cu precipitates show the Fe and Cu concentration profiles from the precipitate composition in the core of the Invizo precipitate is less than that of the LEAP4000X Si. Unfortunately I couldn't find a nice near-spherical precipitate in my 3000 or 4000 data so the size of the precipitate in xy and z are different. Perhaps the real precipitate that the Invizo evaporated was not spherical either."



- Question: So that is around ~ 2 um FWHM?
- Answer: "The evaporation response on aluminum is less than 1 micron for the Invizo, typically the LEAP systems will have a spot size of less than 0.5 microns - of course that depends on the specimen material and geometry.”

- Question: Are distortions on edges are induced by the extra lenses?
- Answer: "The distortions at the edge are indeed from the strong image compression at the edge that enables seeing the whole FOV for some sample geometries (larger shank angles for example). Advanced reconstruction techniques are being applied cooperatively between CAMECA and U Sydney to address these topics."

- Question: Didn’t catch this but were all the data presented acquired in laser mode? Running a tip in voltage mode might also help with understanding whether the laser blurs the concentration profiles of small precipitates?
- Answer: "Yes, all the data are in LP mode. With the strong lensing, VP mode for the Invizo is possible, but at degraded mass resolving power.”

- Question: With dual laser beam, is the stated pulse energy per beam or total combined?
- Answer: "The laser stated in ACC is the power for each beam individually, so if set for 50pJ, each beam delivers 50 pJ towards both sides of the specimen apex at the same time (thermally coincident).”

- Question: icf seems to be x y dependent?
- Answer: "Yes, the strong lensing at the edge of the dataset is not easily addressed with standard reconstruction protocols, we hope to be able to address this with adaptive reconstruction.”

- Question: Why do you use so much energy, 5x higher, a?
- Answer: "The interaction of the different wavelengths of the lasers and the exact focus condition results in different laser powers used when trying to match field conditions as seen by the charge state ratio of the major elements - similarly, the change from green lasers (3000X) to UV lasers (4000/5000X) required using different energies.”

- Question: Are there adjustments being made by Cameca to remove the effects of the mesh in the reconstructions?
- Answer: "No specific efforts. It is a similar problem as in a reflectron system, if you have a homogenous specimen, you can see some of the density variations due to the grid on the ACC detector view (Detector space mm on the detector). They do exist in the reconstruction (real space nm) as well, but they get smoothed out in time as the specimen erodes and the voltage changes, therefore mapping spots of detector space to different real space coordinates."

- Question: Would the mesh posing in front of the tip reduce detection efficiency?
- Answer: "Yes, the Advanced Delay Line Detector has about 80% efficiency, primarily limited by the MCP open area - with the mesh, we collect and identify about 62% of the atoms that leave the tip as ions and hit the detector.”

- Question: How about multi hit ondetector?
- Answer: "The multi-hit characteristics of Invizo is similar to our other straight flight path systems (e.g. 5000 XS) - if you run at higher rates, you may get more multiple events and risk more loss of identification due to pile up. If you evaporate a material with one species preferentially evaporating (e.g. high - 1% - B dopant in Si) you will also see this effect - same as in other atom probe systems."