Effects of Cutting on Niobium

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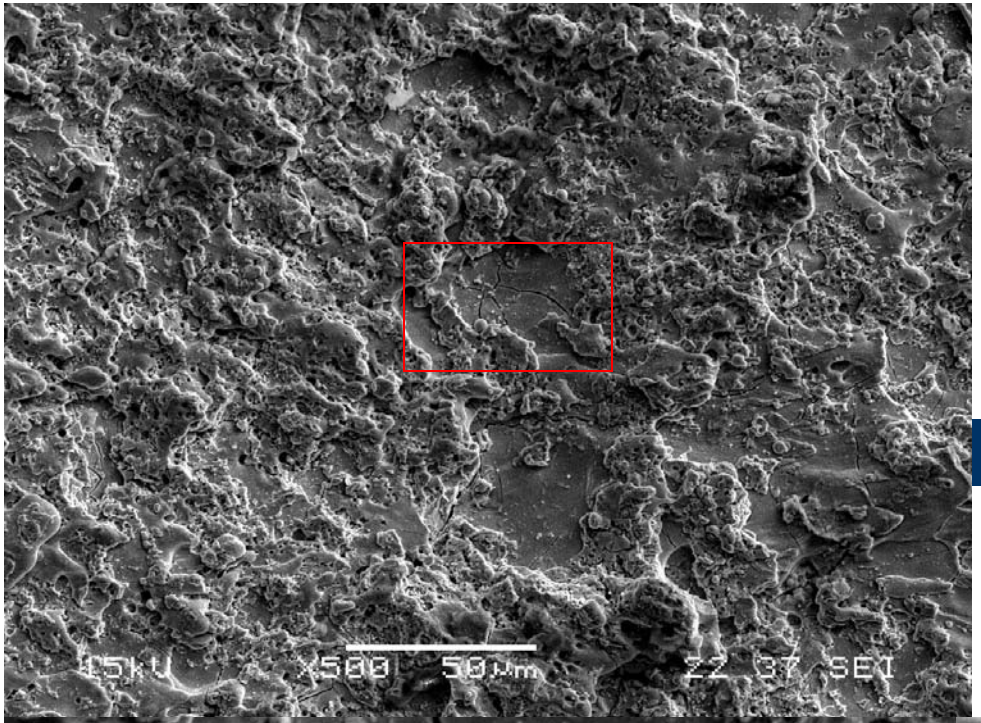
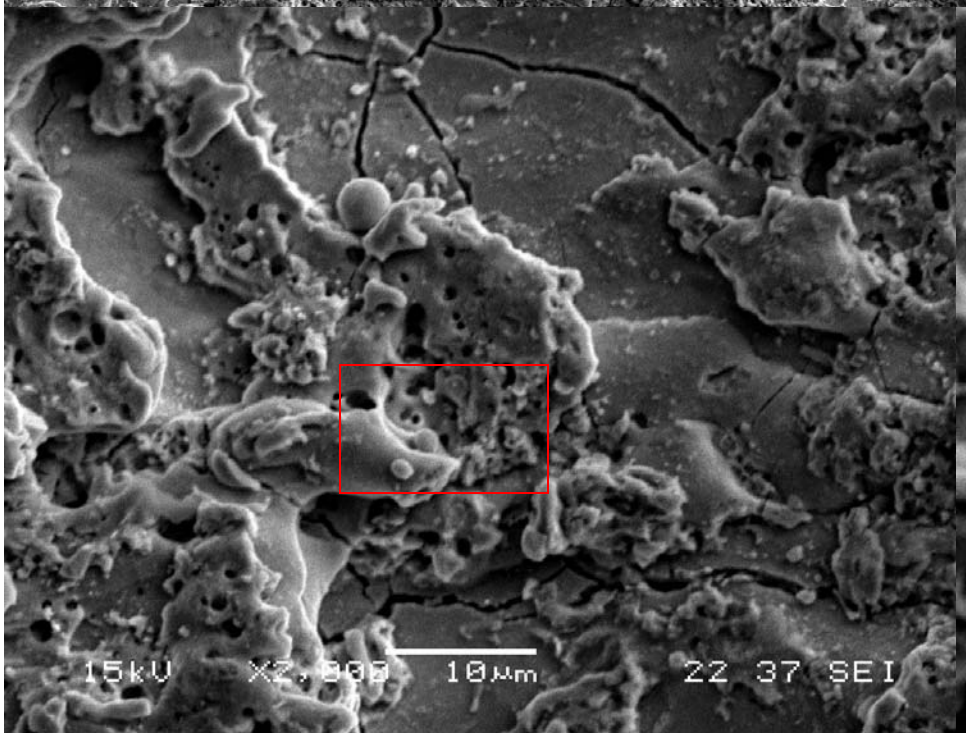
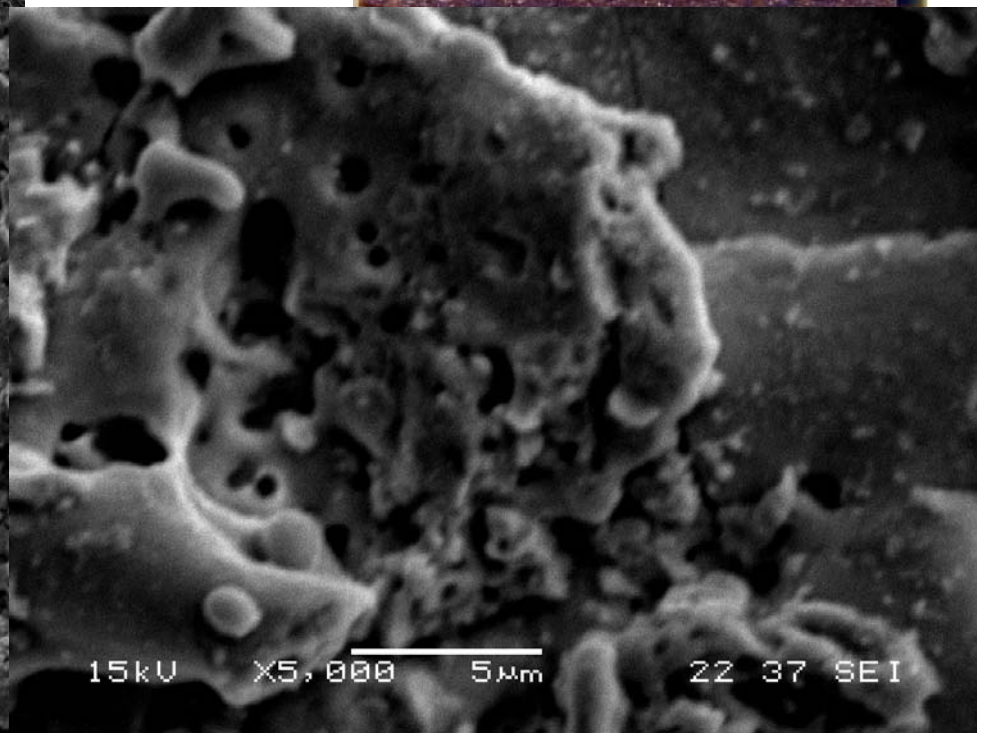
Cutting Study

- The Techniques Used to Cut Niobium can Introduce Different Contaminants into the Niobium and Affect the Surface Morphology.
- It is Important to Know these Effects so that the Proper Amount of the Damaged Layer can be Removed by Chemical & Mechanical Polishing.
- Cutting Techniques to Examine
  - Band Saw
  - Diamond Saw
  - EDM Wire
  - Water Cutting
  - Mill
  - Sheer Cut
- Samples All Prepared Analysis Underway

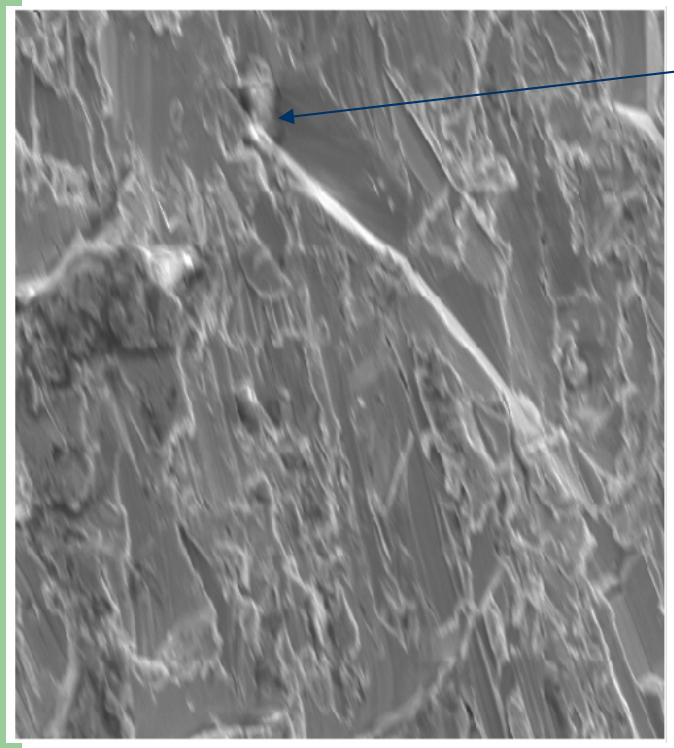
Images of EDM Wire Cut Sample at Various Magnifications







Energy Dispersive Spectroscopy of Garnet Water Jet Cut Niobium



Embedded
Garnet Particle

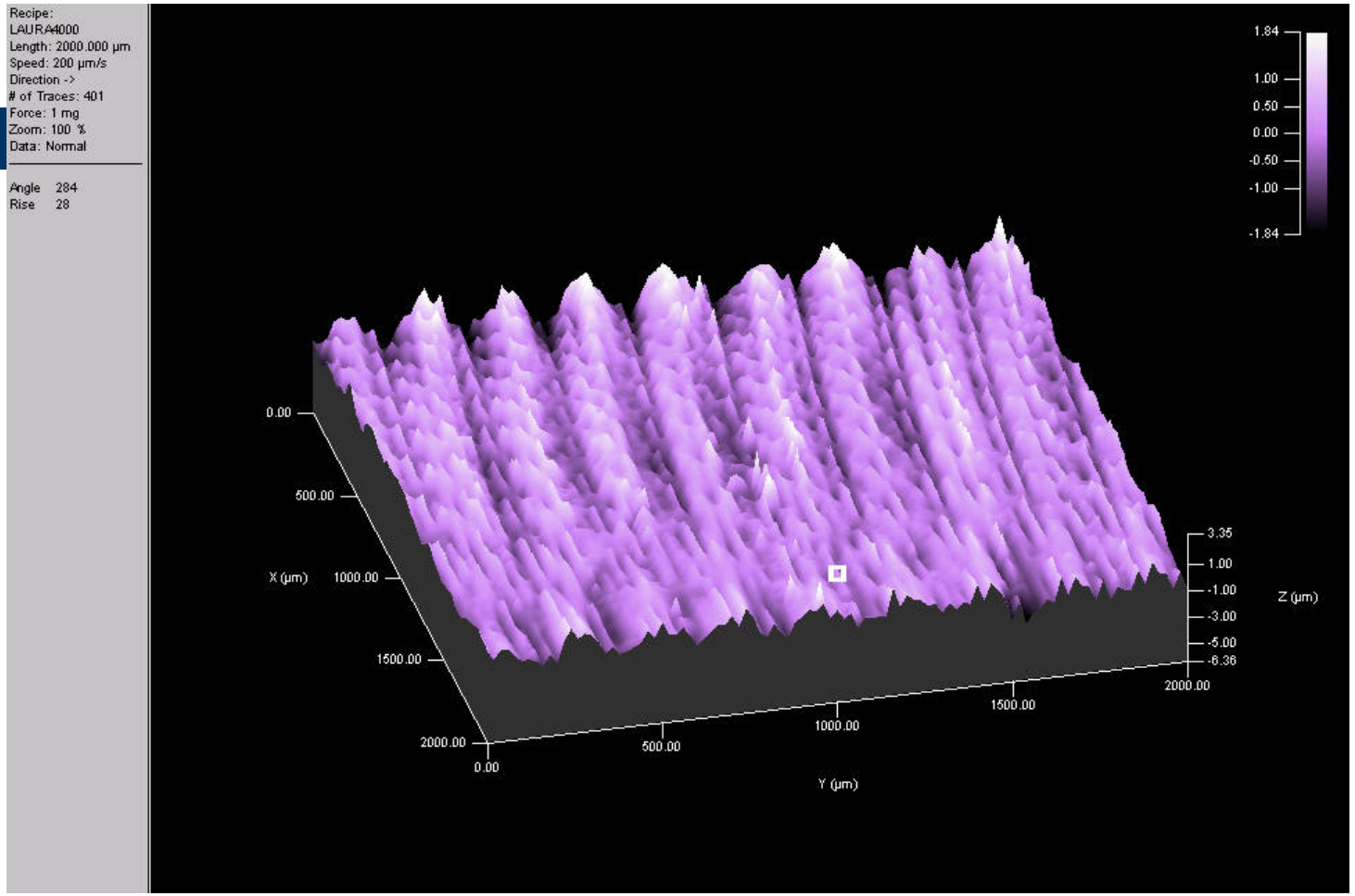
Element	Weight%	Atomic%
O	30.79	70.08
Al	1.25	1.69
Si	1.53	1.98
Fe	0.83	0.54
Nb	65.60	25.71
Totals	100.00	

Average Elemental Surface Composition of Top 2-3 microns

EDS Results in wt%

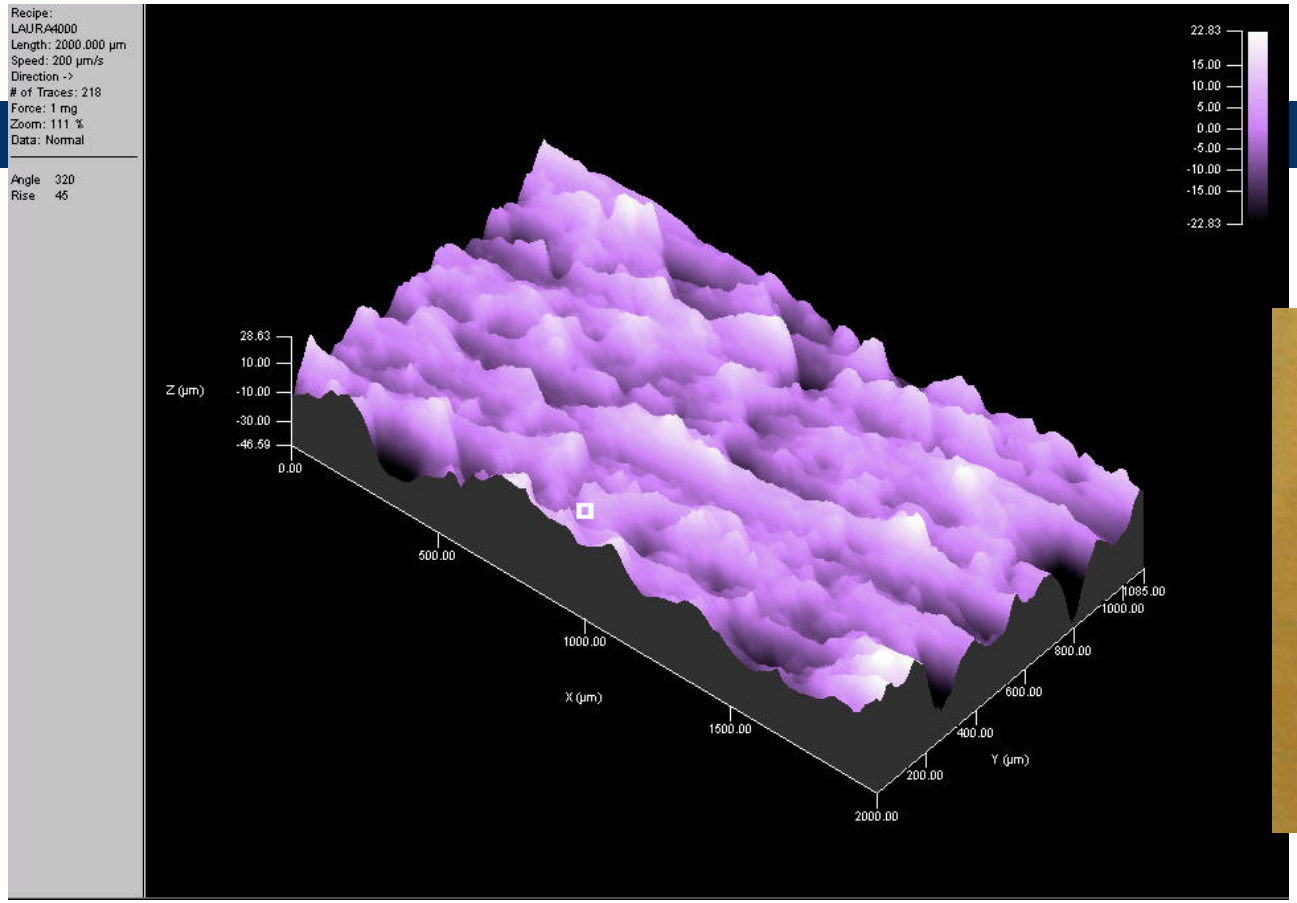
	Nb	O	Al	Tl	C	Zn	Na	Cu	Si	Fe
Mill	95	5								
Diamond Saw	92	5		3						
EDM Wire	51	20			5	9	1	14		
Water Jet	77	18	1						2	2
Band Saw	79	15		3					3	
Shear	94	6								

Surface Structure - Mill



- Average Surface Roughness 0.53 Microns

Surface Structure – Band Saw



- Average Surface Roughness 7.6 microns

Surface Roughnes

Technique	RMS Deviation, μm	Artith. Mean Deviation, μm	Area Scanned mm^2
Mill	**0.6**	0.5	8
Diamond Saw	**2.4**	1.8	4
EDM Wire	**3.1**	2.5	6
Water Jet	**7.8**	6.32	4
Band Saw	**16.9**	14.1	2
Shear			

Residual Resistivity Ratio

Technique	RRR	± Δ	
Mill	414	20	
EDM Wire	381	20	
Water Jet	395	20	
Diamond Saw	374	20	
Band Saw	334	20	
Shear	308	40	

H ?

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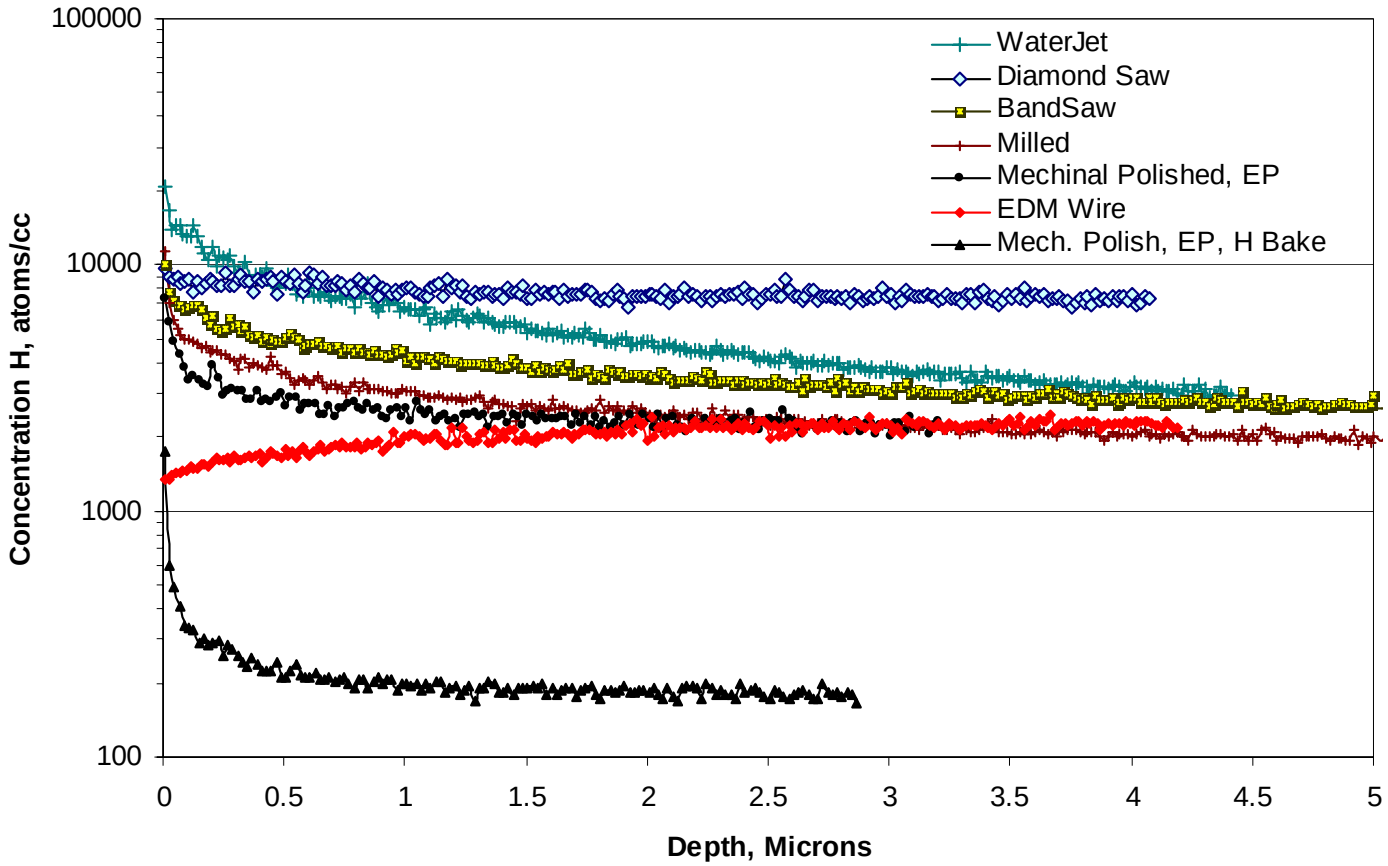
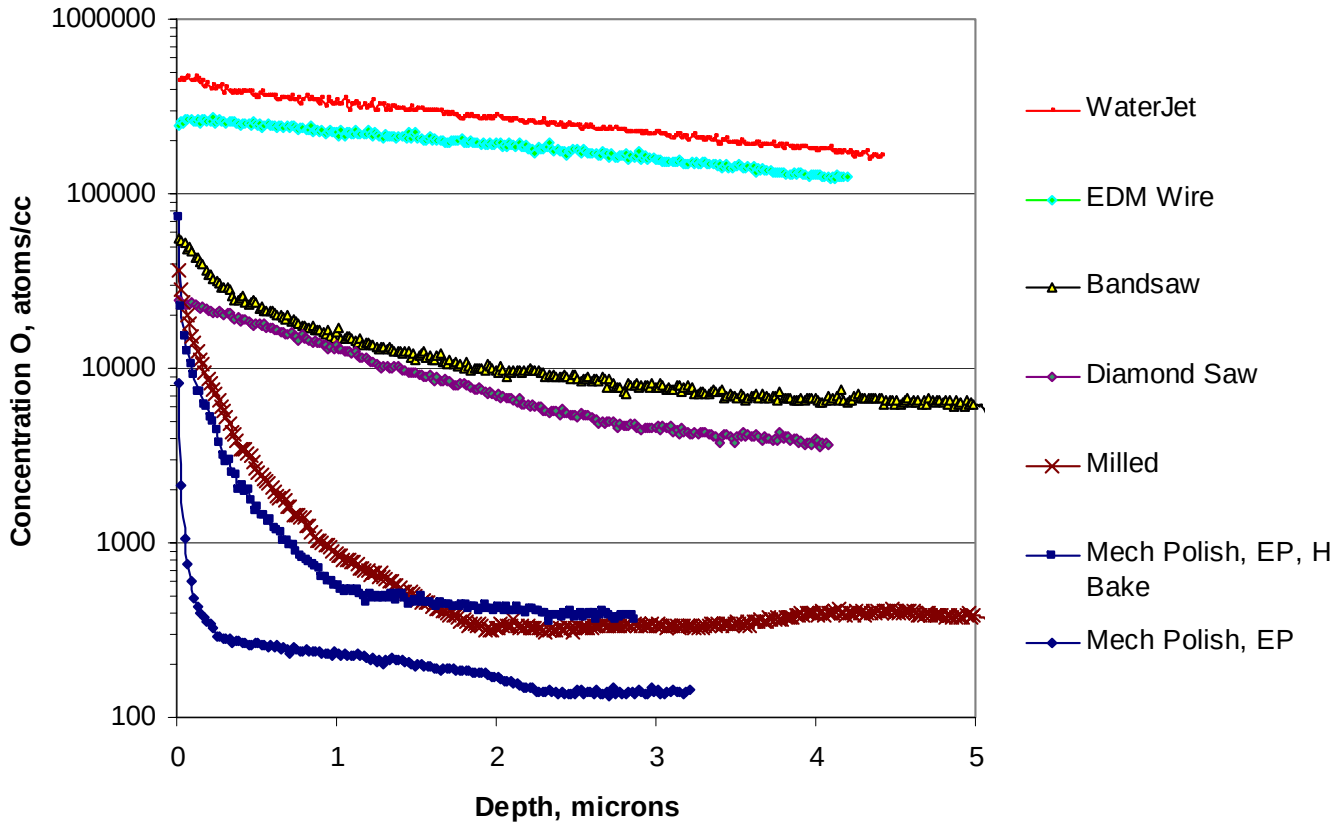
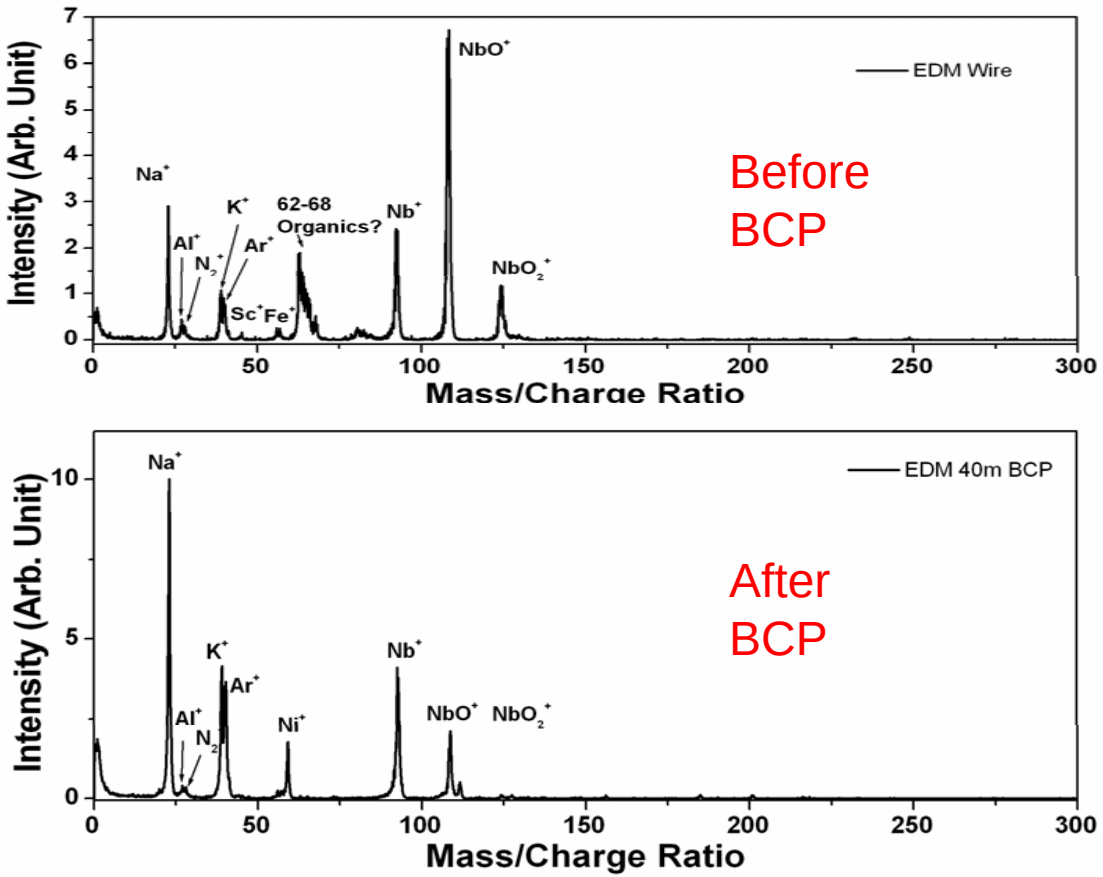
SIMS Hydrogen Depth Profile



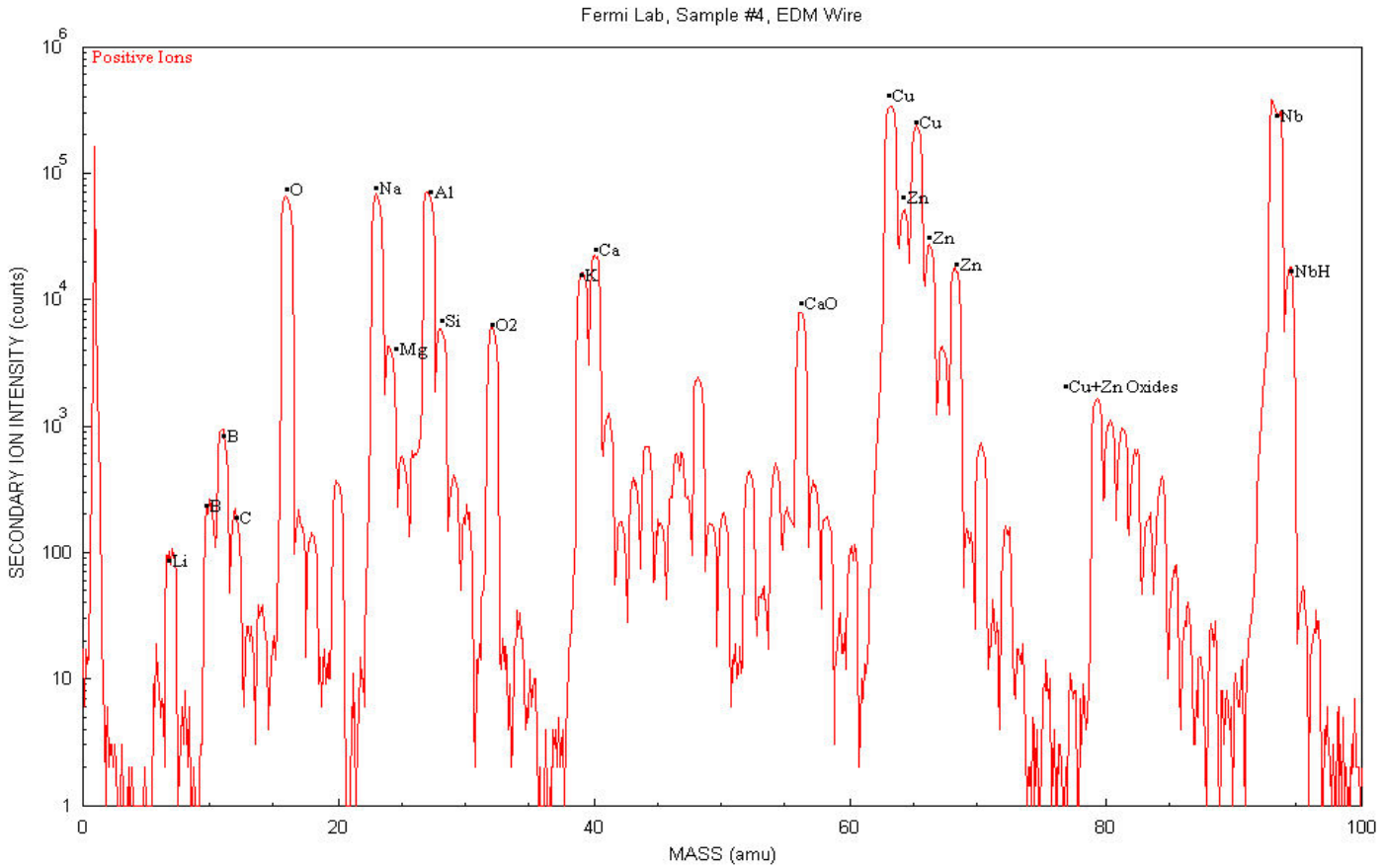
SIMS Oxygen Depth Profile



Secondary Ion Mass Spectroscopy – EDM Wire



EDM Wire SIMS Positive Ion Scan



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Conclusion

- All techniques alter the first 3-5 microns of surface
- RRR are stable => only slight pollution (H)
- Milling produce very clean surface (H, O), comparable to EP processed surfaces.
- Further results are awaited to determine how much should be etched after each process