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**Title:** Sigma Characterization Capabilities

**Author(s):** Bloom, Rose Anne

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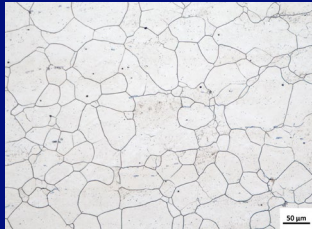


# Sigma Characterization Capabilities

Presented by Rose Bloom

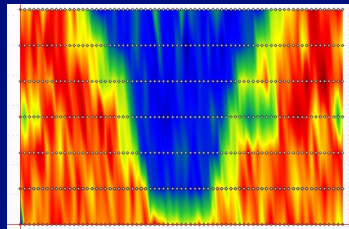
April 11, 2023

# Outline



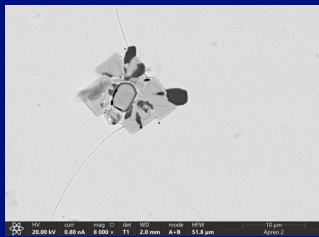
**Optical  
Imaging**

- Various scopes
- Various analytical software



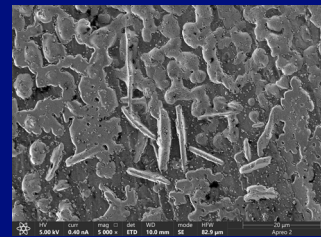
**Hardness  
Testing**

- Vickers/Knoop
- Rockwell



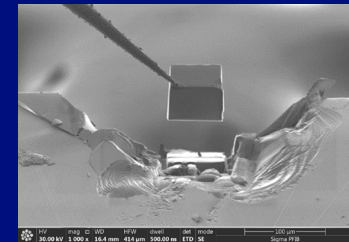
**Miscellany**

- LIBS
- XRF
- Profilometry
- Adhesion Testing
- Eddy Current



**SEM**

- EDS/WDS
- EBSD
- TKD

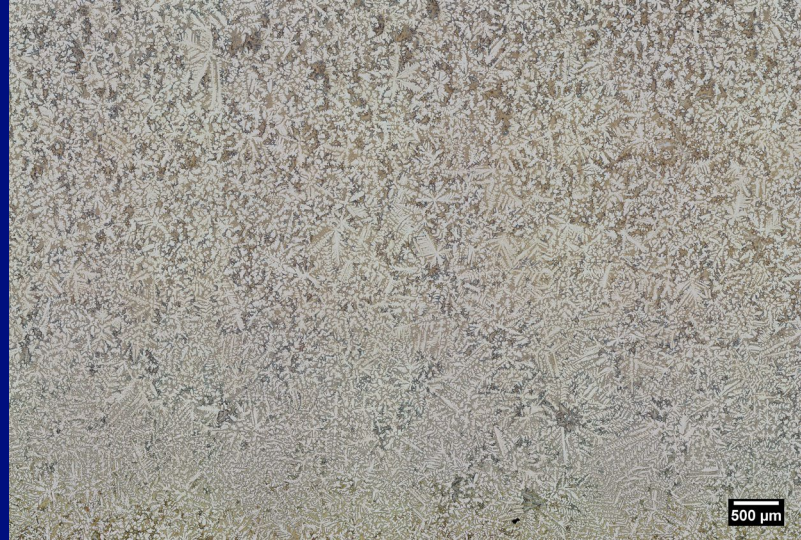
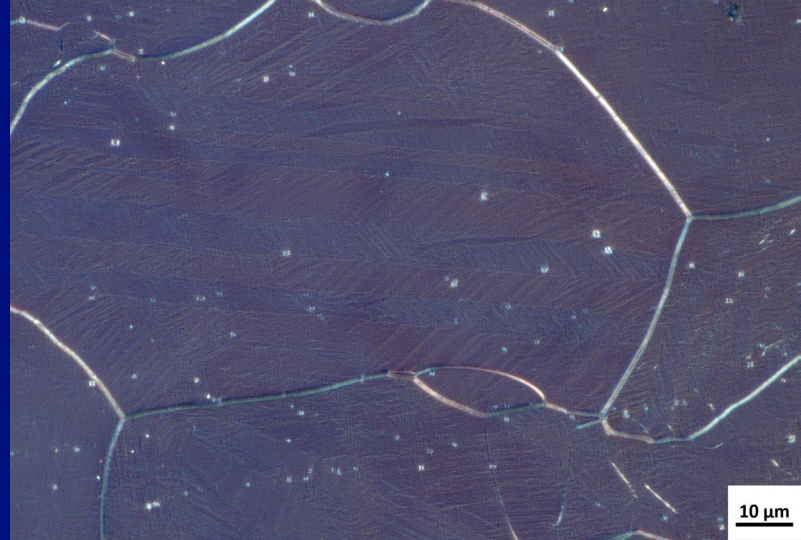


**pFIB**

- Micromachining
- TEM prep

# Optical Imaging and Analysis

- Zeiss Axio Observer
- Zeiss Discovery V 2.0 Stereoscope
- Keyence VHX 7000
- U/Th preparation lab
- Beryllium preparation lab
- “Cold” preparation lab

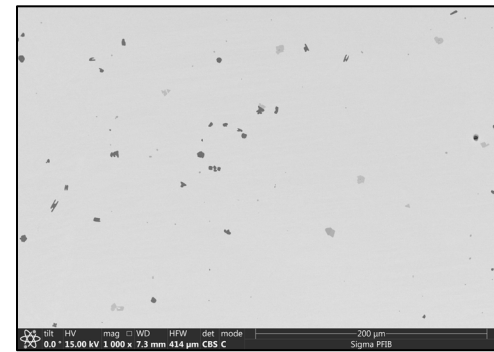


$U_6$  martensite (top)  
 $U_6$  dendrites (bottom)

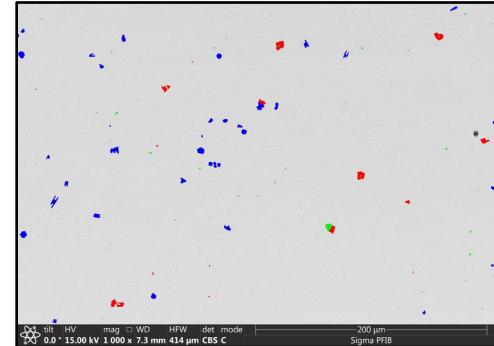
# Imaging and Analysis

- Particle Size
- Phase Area Percentage
- Coating Thickness
- Grain Size
- Dendritic Arm Spacing
- Porosity
- Inclusions
- Fiber Length/Width Nodularity

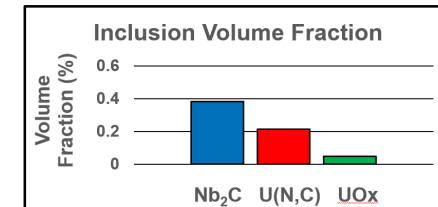
- Clemex
- MIPAR
- ImageJ
- MAMA



BSE image showing inclusions in direct cast DU



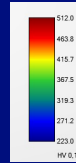
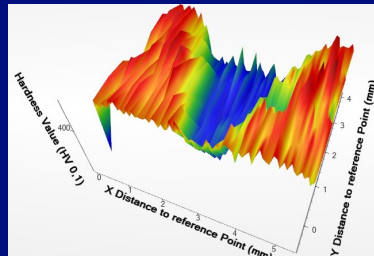
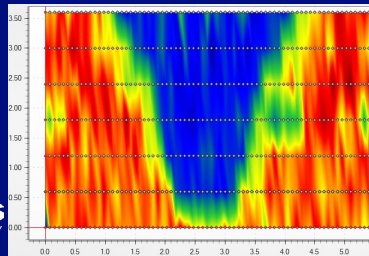
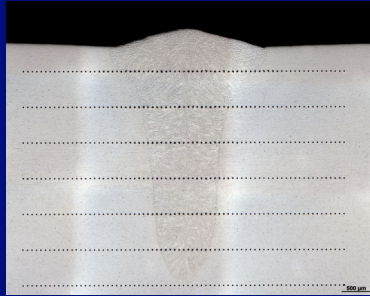
Inclusions segregated by morphology and assumed chemistry





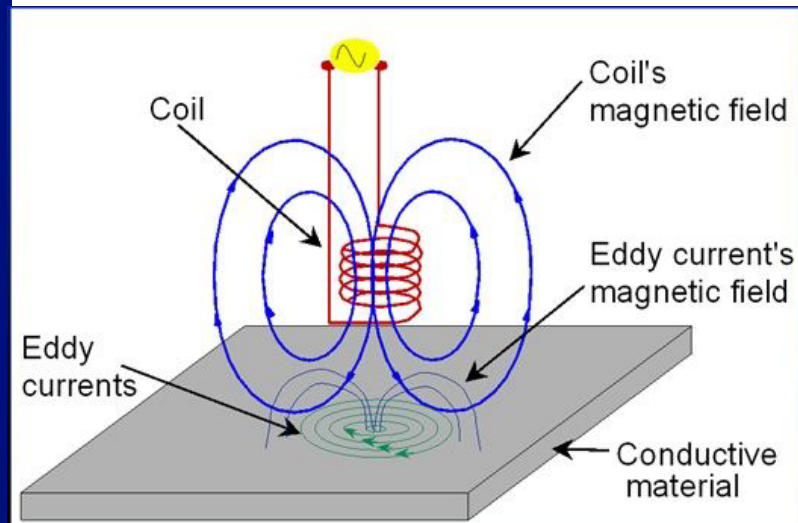
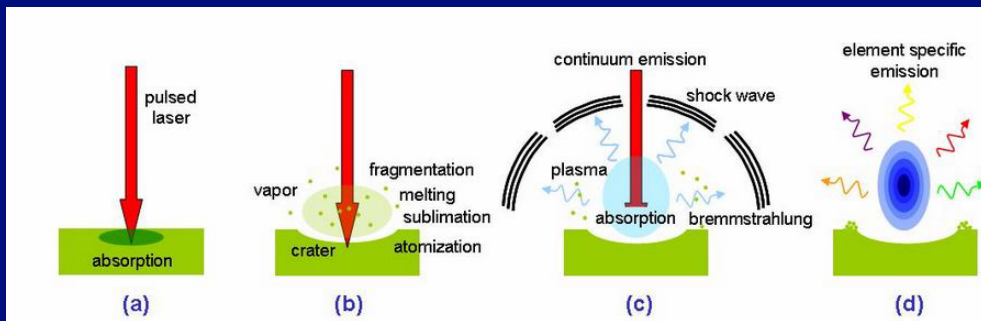
# Hardness Testing and Adhesion Testing

- Struers DuraScan
- Struers DuraMin
- Struers Rockwell Hardness Tester
- 4000 Plus Bondtester



# Miscellany

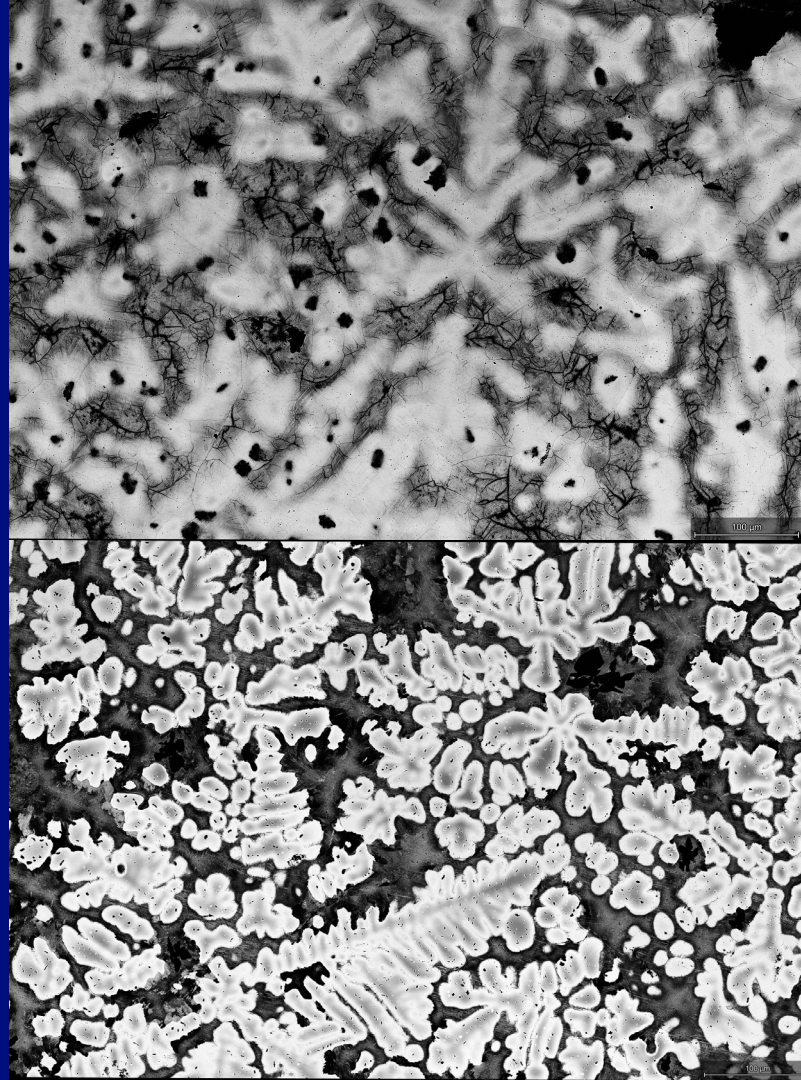
- EA 300 LIBS on Keyence VHX 7000
- Thermo Niton Analyzer XRF
- Keyence VR-5000 Profilometer
- Eddy Current





# SEM EDS WDS EBSD

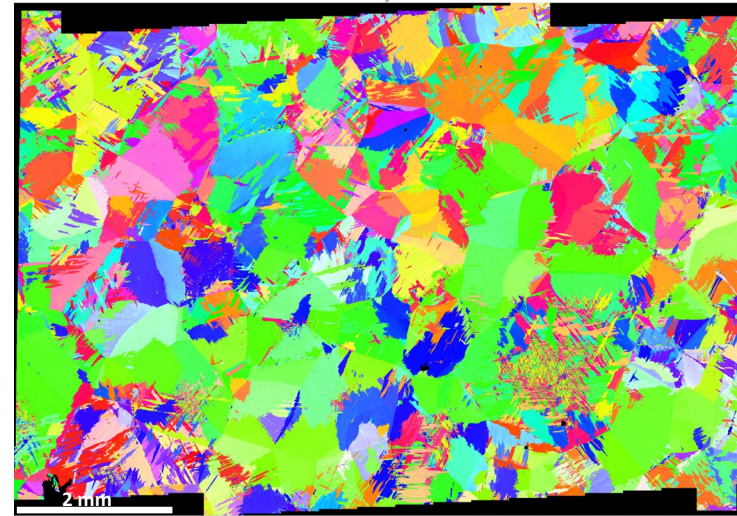
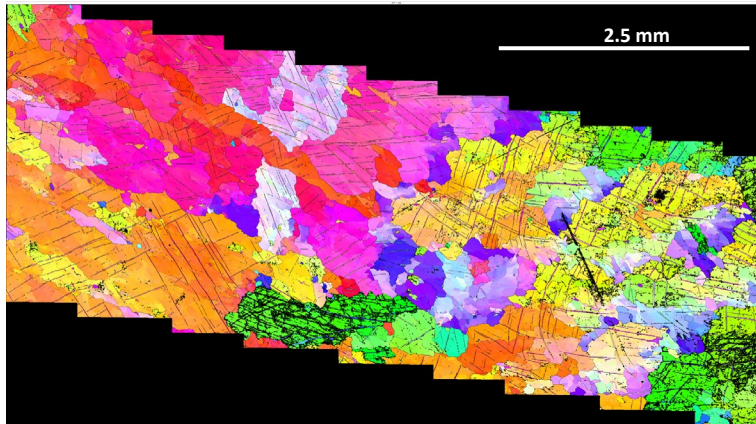
- FEI Apreo 2
  - Quantax X Flash EDS
  - Quantax X Sense WDS
  - Quantax e-Flash HD EBSD with on axis TKD capabilities
- FEI Xe G4 Helios pFIB
  - Oxford EDS Ultimax
  - Symmetry 2 EBSD detector



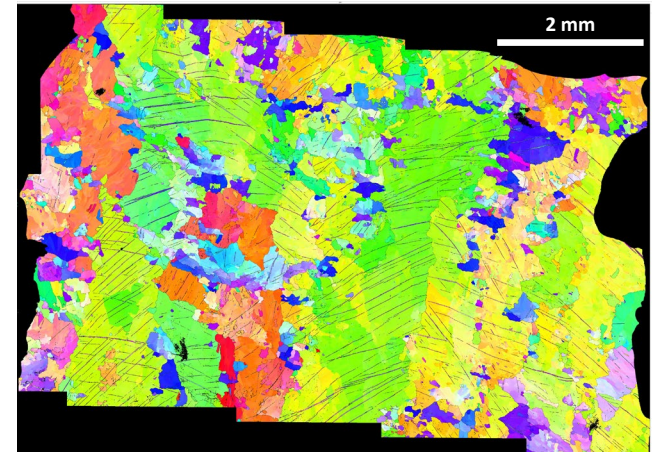
BSE of  $U_6$  dendrites (top and bottom)

# EBSD

- Oxford Symmetry S2 Large area EBSD
- Bruker Quantax e-Flash HD EBSD with on axis TKD capabilities



Formed Ti64 EBSD

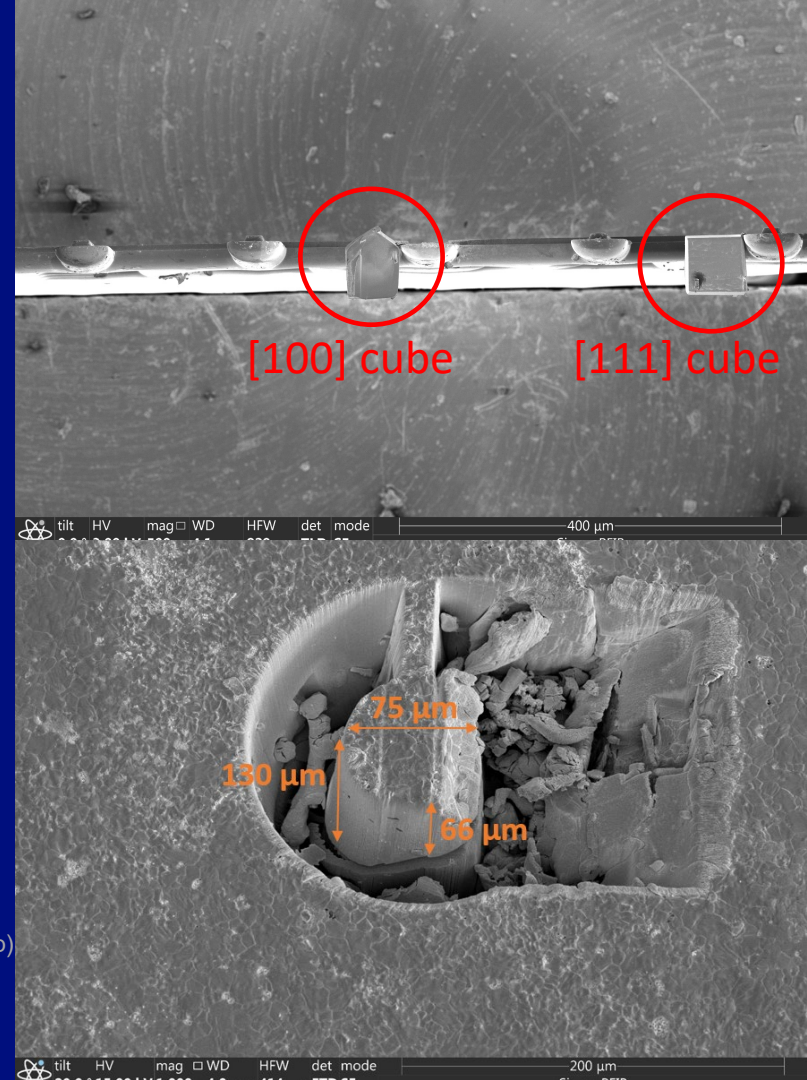


EBAM EBSD



# FIB/pFIB

- FEI G4 Xe pFIB



Single crystal  $\text{UO}_2$  cubes(top)  
LEU oxide cylinder (bottom)

## Bonus Characterization in Sigma

- ICPMS
- Bruker D2 Phaser tabletop XRD
- Mechanical Testing
- Quantitative XRF
- Auger
- AFM
- Gleeble
- XPS...potential
- MicroCT...potential
- Ultrasonic...potential

