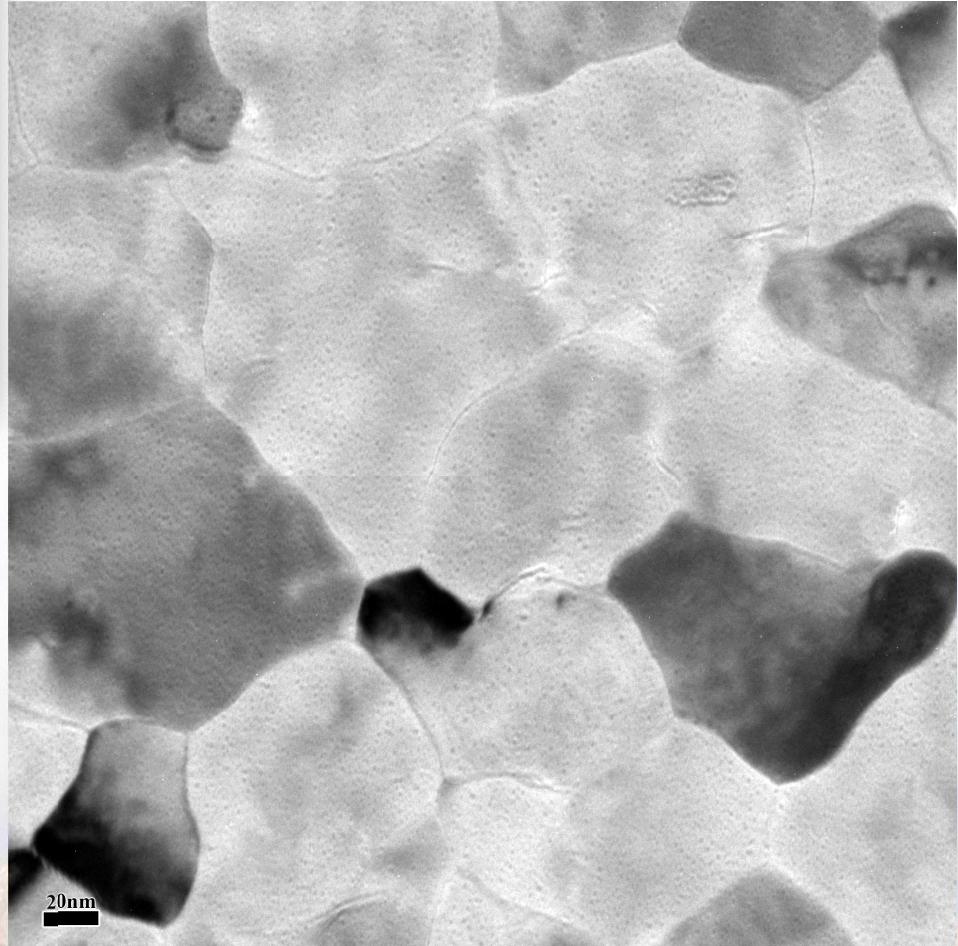


Scott Coon  
Department 01111

# 2015 STAR Summer Internship

SAND2015-6234PE

## Sandia National Laboratories





# STAR Internship-Summer 2015

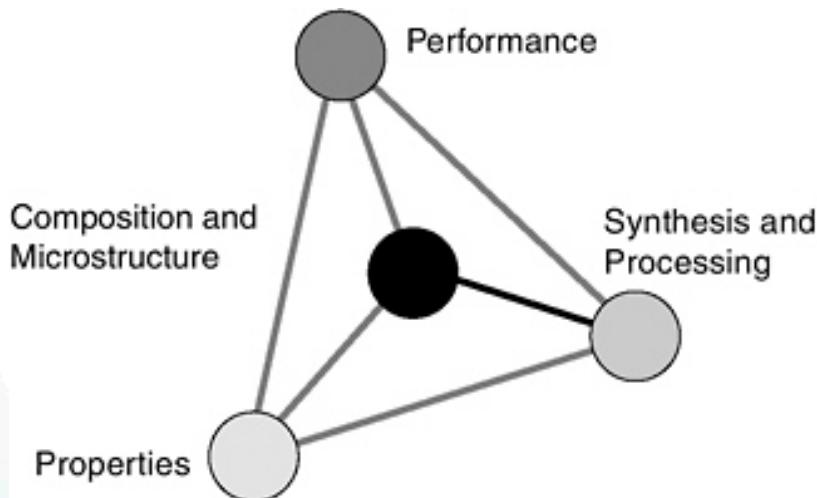
- **East Mountain High School**
  - Senior
- **Where I interned this summer**
  - Ion Beam Laboratory (IBL) Building 720
  - Physics
  - Materials Science/Engineering



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# What is Materials Science?

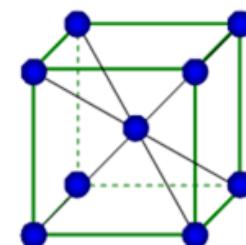
- “Investigating the relationships that exist between the structures and properties of materials.” (Callister)



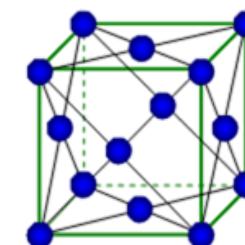
Via: [www.nap.edu](http://www.nap.edu)

Crystal lattice examples

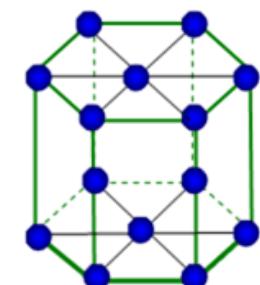
[www.substech.com](http://www.substech.com)



Cubic body centered (bcc)  
Fe, V, Nb, Cr



Cubic face centered (fcc)  
Al, Ni, Ag, Cu, Au



Hexagonal  
Ti, Zn, Mg, Cd

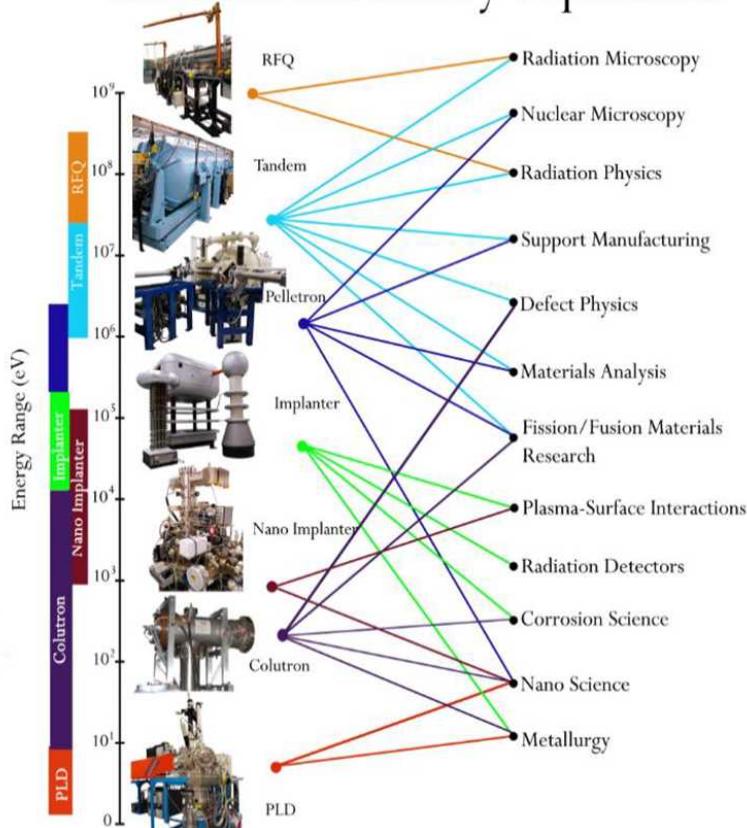
- Incorporates multiple scientific disciplines
- Crystal structures determine many material properties (strength, hardness, etc)
- Relationships between structure, processing, property, and performance
- Characterizing Materials



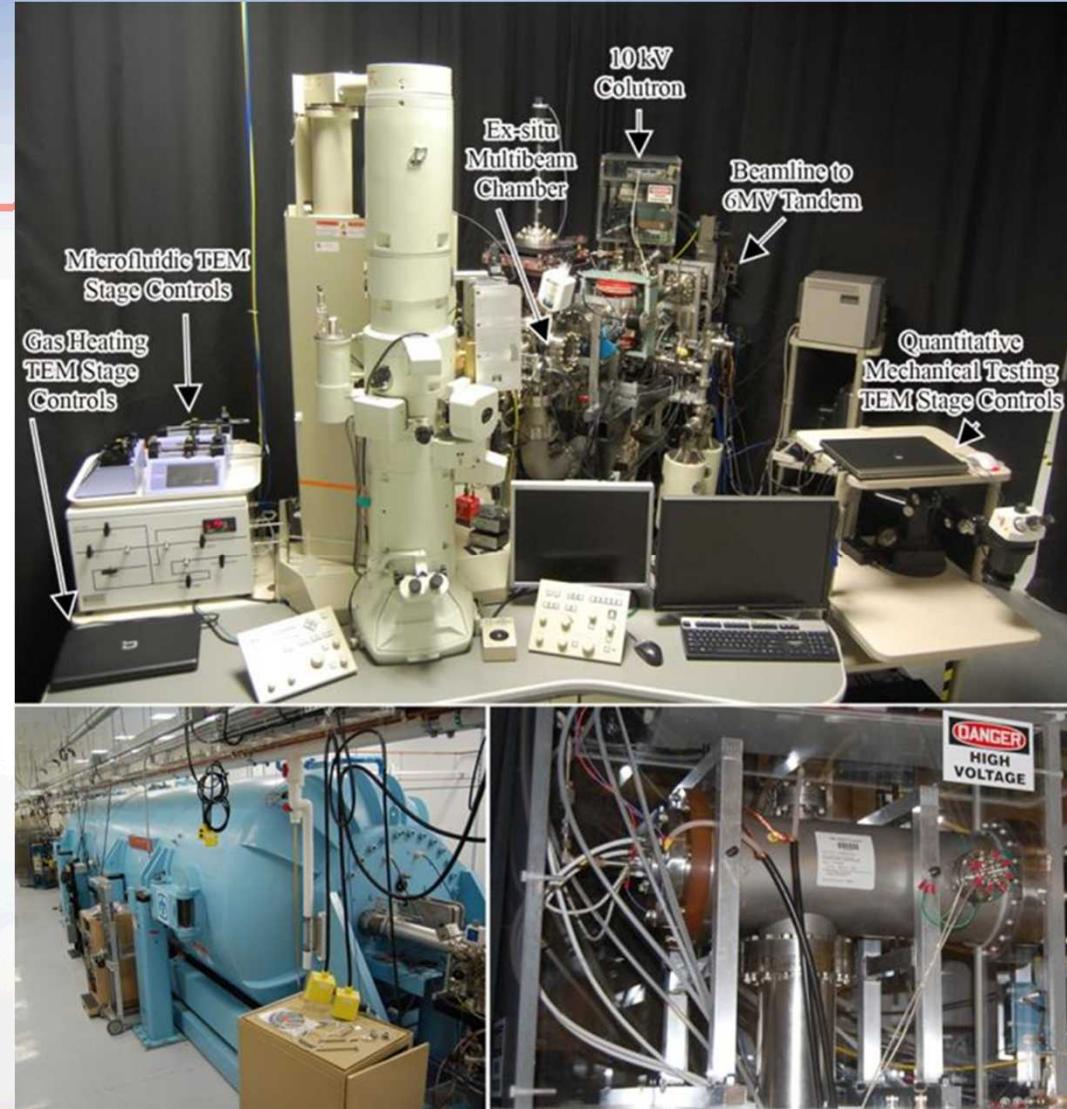
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# Capabilities of the Ion Beam Laboratory

## Ion Beam Laboratory Capabilities



The IBL also contains an *in situ* ion irradiation transmission electron microscope (I<sup>3</sup>TEM). One of two in US, twelve in the world.



Top: The *in situ* TEM is able to view samples as they are influenced by radiation in real time.

Bottom Left: The 6 MV Tandem Accelerator.

Bottom Right: The 10 KV Colutron Accelerator

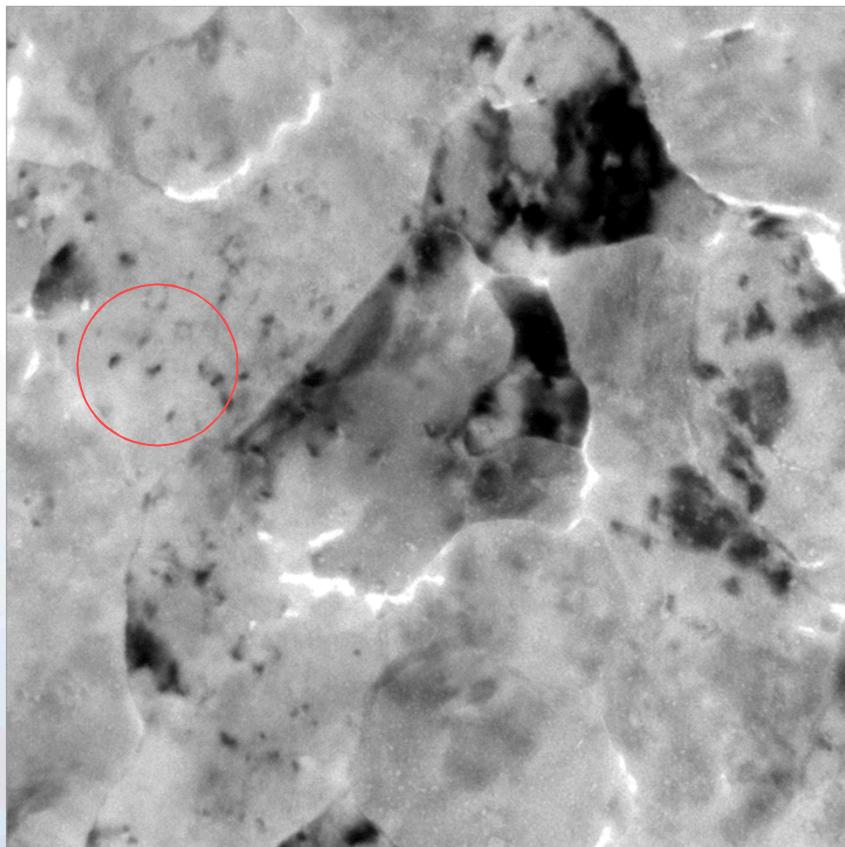


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# Radiation-Solid Interactions

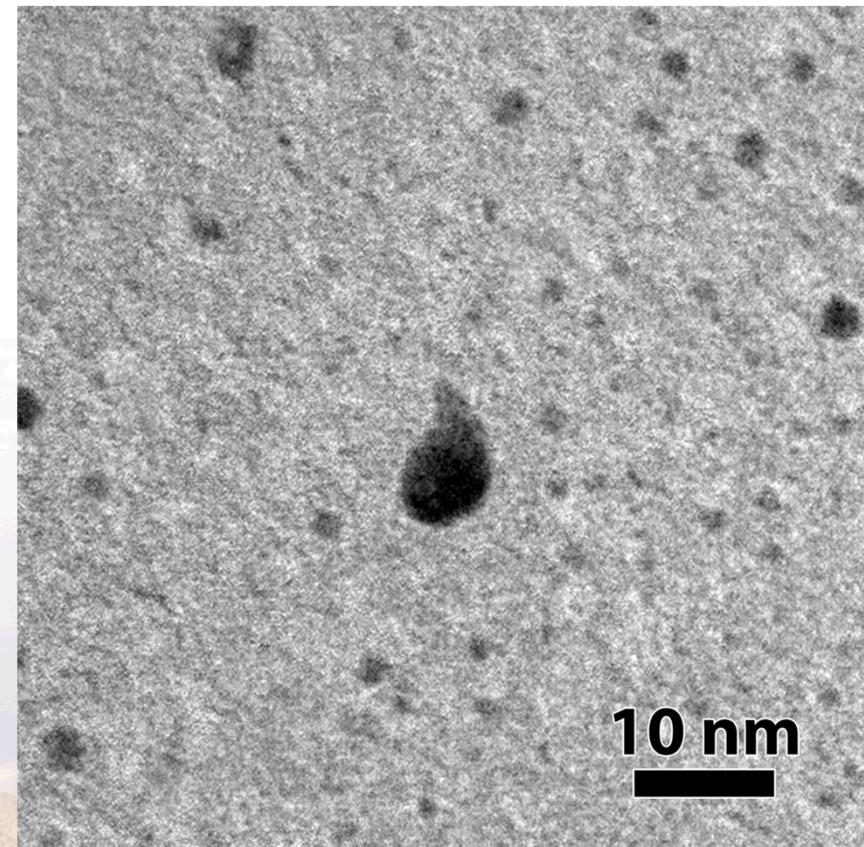
Radiation interacting with tungsten forms defects in the tungsten

The void defects caused by radiation are clearly visible in this TEM image.



Radiation-solid interactions at the IBL

Gold nanoparticle broken apart under single self-ion bombardment



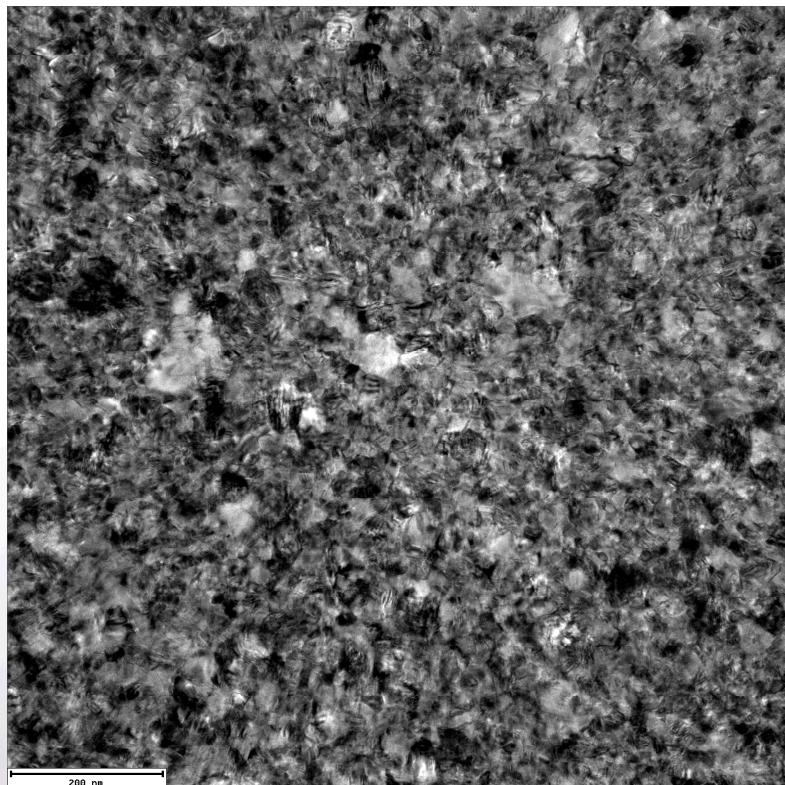
Bufford, D. C. and K. Hattar (2014). "Physical response of gold nanoparticles to single self-ion bombardment." *Journal of Materials Research* **29**(20): 2387-2397.



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# Preliminary Projects

- **Strengthening Research Skills**
  - Literature Review
- **Learning Image Analysis & Editing**
  - Grain Size Analysis
  - Defect Sizes and Densities in Materials
- **Learning to Code**
  - Python
- **Sample Preparation**
  - Palladium, Aluminum, Copper, Iron, Tungsten
  - Thin Film samples (nanometer-sized)
  - Prepared using “float off” technique
  - Viewing samples in TEM



Evaporation-deposited Palladium Sample as seen in the TEM

**Main Project: *In Situ* Tungsten Experiments**  
**Question:** How does Tungsten react to extreme environments?



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# Tungsten Project

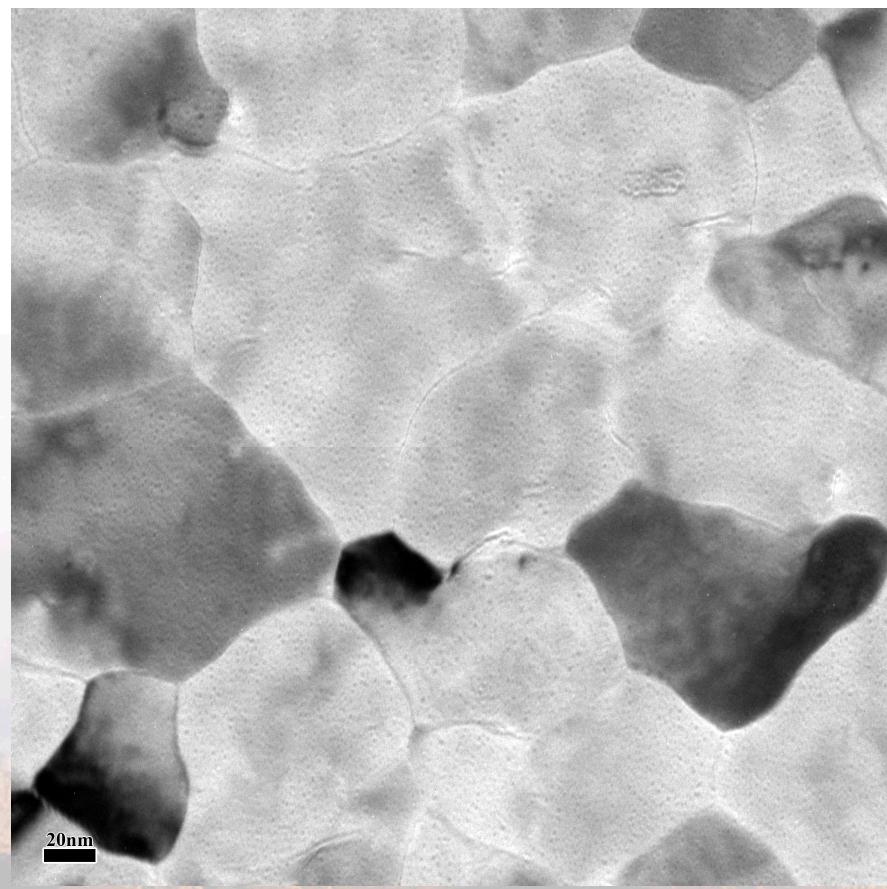
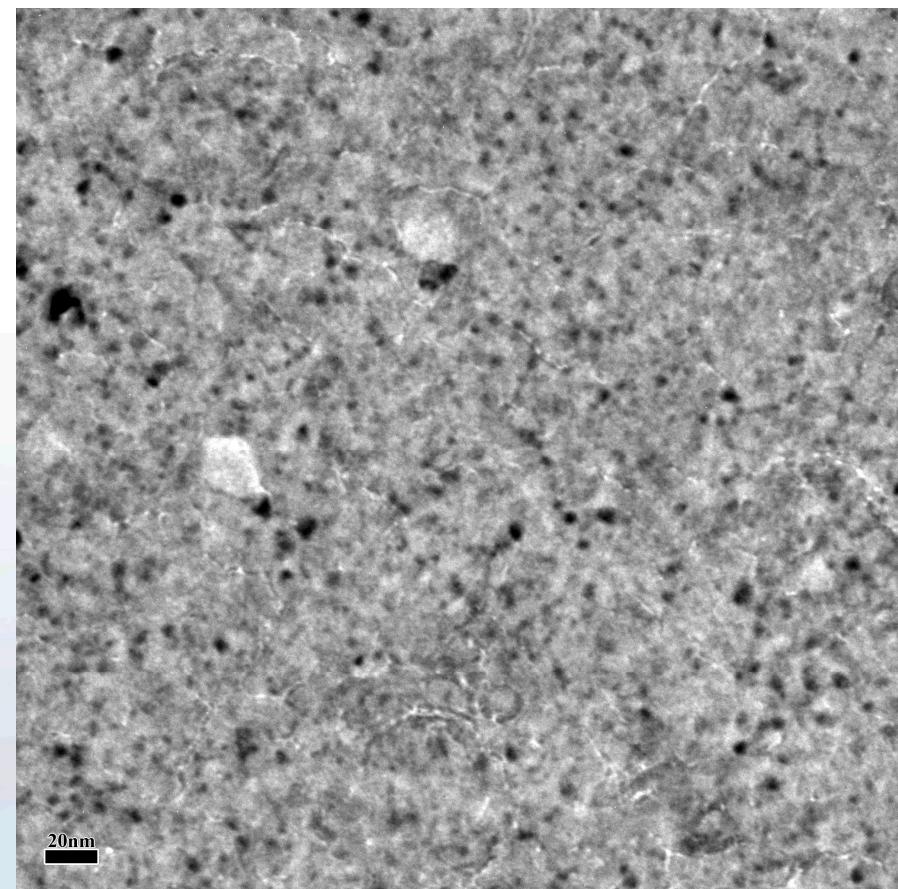
## Annealed (Heated) Samples

Pure tungsten before and after heating to 1000° C

Grain Size: 14 nm

➡ Grain Growth ➡

Grain size: 67 nm



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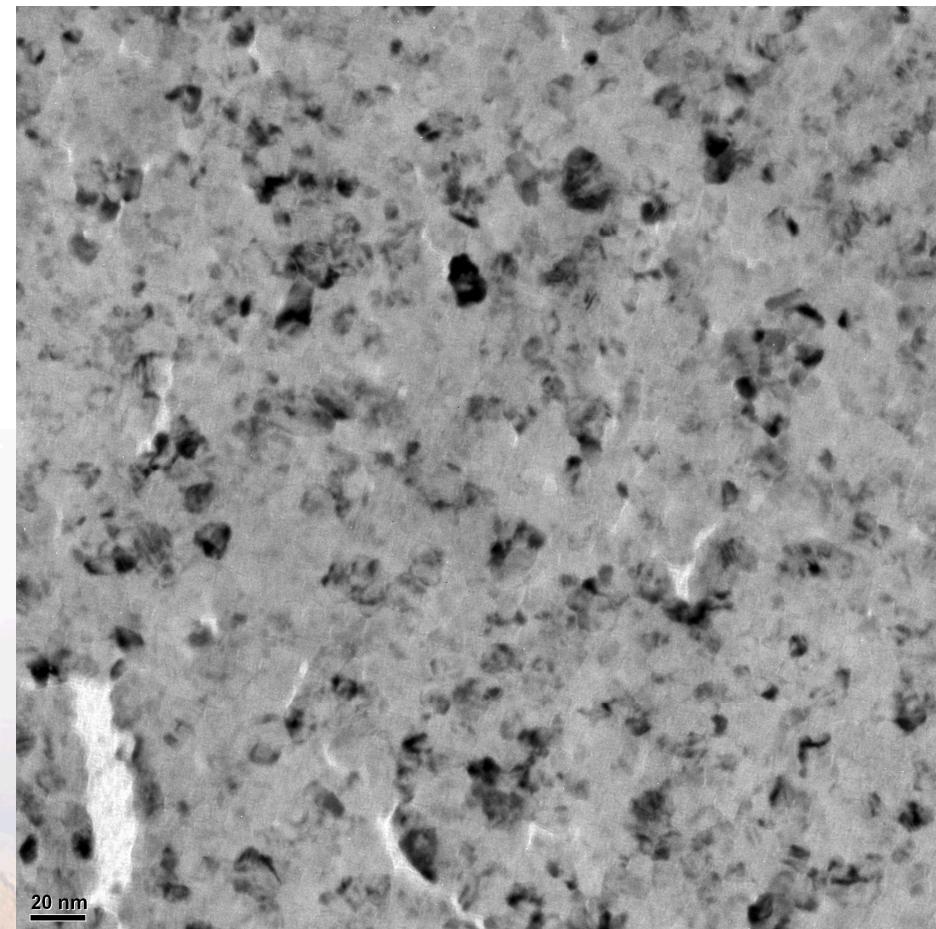
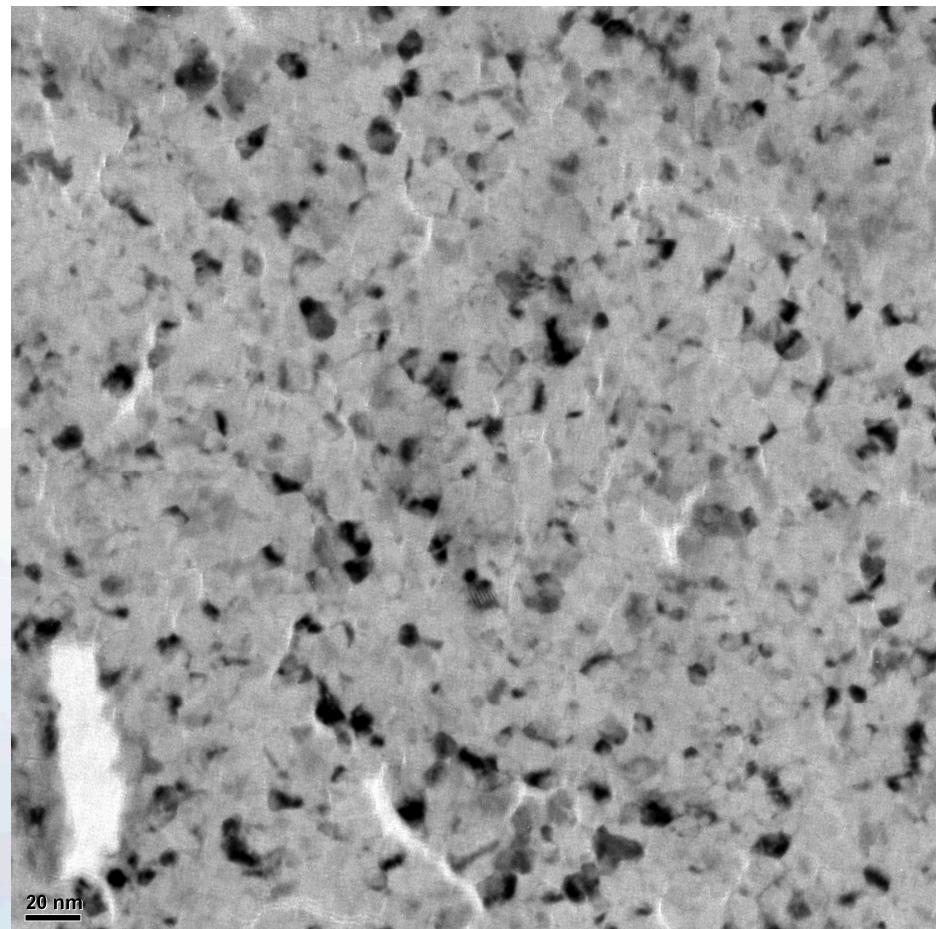
# Alloyed Tungsten

Tungsten-Titanium before and after annealing

Grain Size: 10 nm

→ Grain Growth →

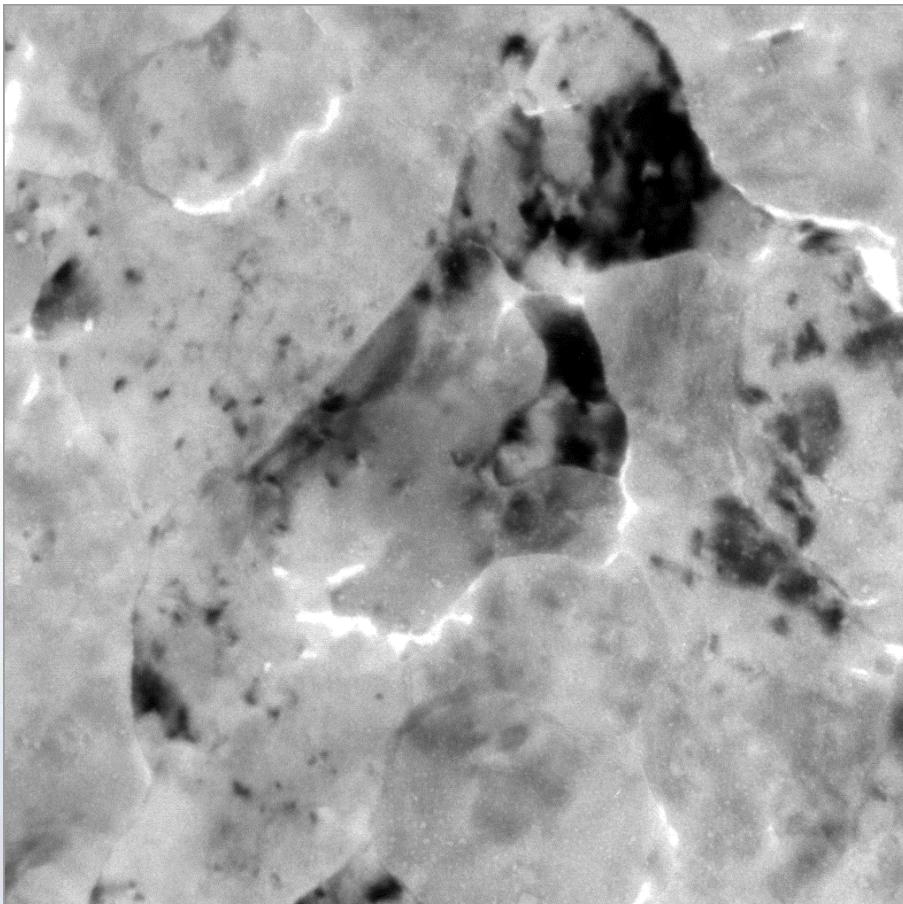
Grain Size: 12 nm



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# Irradiation and Results

## Pure, irradiated tungsten

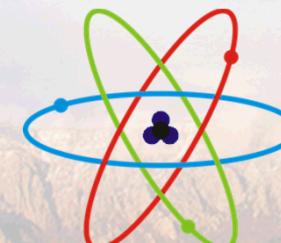


## Results

- Pure tungsten has high tolerance for heat
- Alloying tungsten with titanium provides an increase in tolerance for heat
- Good heat tolerance means more uses in extreme environments

## Future Work

- Radiation experiments
- Testing in advanced, next-generation nuclear reactors



- After annealing the samples were irradiated with 3 MeV  $W^{4+}$  (self-ion irradiated)

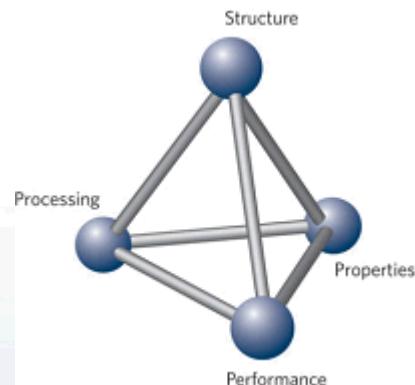


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# Conclusion

What this internship provided me:

- Extended scientific knowledge
- Increased technological skills
- Real-world research experience
- Preparation for college



## Future

- Attending 27<sup>th</sup> Annual Rio Grande Symposium on Advanced Materials (RGSAM)
  - Presenting poster on Tungsten project



What this internship did not provide me:

- The words that make up the acronym “STAR”

Acknowledgements: Khalid Hattar, Jon Custer, Daniel Bufford, Brittany Muntifering, Olivia Donaldson, Mackenzie Steckbeck, Cajar Gong, Sarah Blair, Justin Davis, J. Trelewicz, Tyler Kaub, Greg Thompson