

Plasma Synthesis and Scanning Electron Microscopy of Nanomaterials

Dylan Jacobs | Mentor: Dr. Benjamin Greenberg

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Objectives:

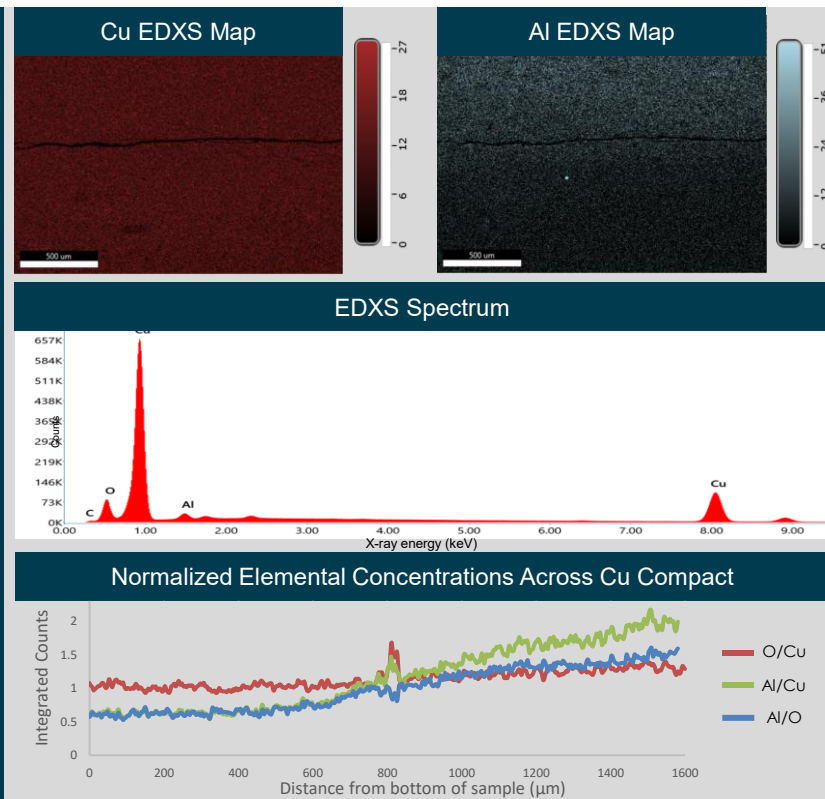
1. Characterize porous nickel (Ni) & copper (Cu) nanoparticle compacts (NPCs) coated with Al_2O_3 .
2. Determine Al_2O_3 ALD coating uniformity in NPCs.
3. Develop **inductively coupled plasma (ICP)** reactor to synthesize nanoparticles.

Methods:

1. Coat Ni & Cu NPCs with Al_2O_3 using **through-ALD**.
2. Image the compact cross-section's micro-structure using **scanning electron microscopy (SEM)**.
3. Analyze elemental composition using **energy dispersive x-ray spectroscopy (EDXS)**.

Contributions:

1. Performed SEM & analyzed micrographs & EDXS elemental maps to determine how ALD coating concentrations varied across NPCs.
2. Designed ALD experiments to determine how compact density & precursor dose parameters affect ALD coating uniformity.
3. Built vacuum & cooling systems for ICP reactor, conducted Ar/ H_2 plasma experiments.
4. Minimized reflected power in ICP system by tuning RF matching network using Smith chart.
5. Mitigated RF electromagnetic interference in ICP system.



Internship value:

- Learned to operate scanning electron microscope & analyze SEM/EDXS data.
- Introduced me to inductively coupled plasma physics & plasma-enhanced chemical vapor deposition (PECVD).
- Presented results & collaborated with scientists & engineers to improve my technical communication abilities.

Conclusions:

- ALD coating concentration depends heavily on substrate compact density.
- Through-ALD procedure reduces dose time by 50% and achieves uniform conformal coatings in NPCs.

Next steps:

- Demonstrate ability to vary Al_2O_3 coating depth profile by tuning ALD parameters.
- Achieve uniform ALD on a variety of substrates.

Applications:

- Through-ALD to achieve high-interfacial-area **nanocomposites**.
- **Thermoelectric nanocomposites** with low thermal conductivity & electrical conductivity.

