Design of Refractory Alloys for Processing by Additive Manufacturing and for Service at Extremely High Temperatures

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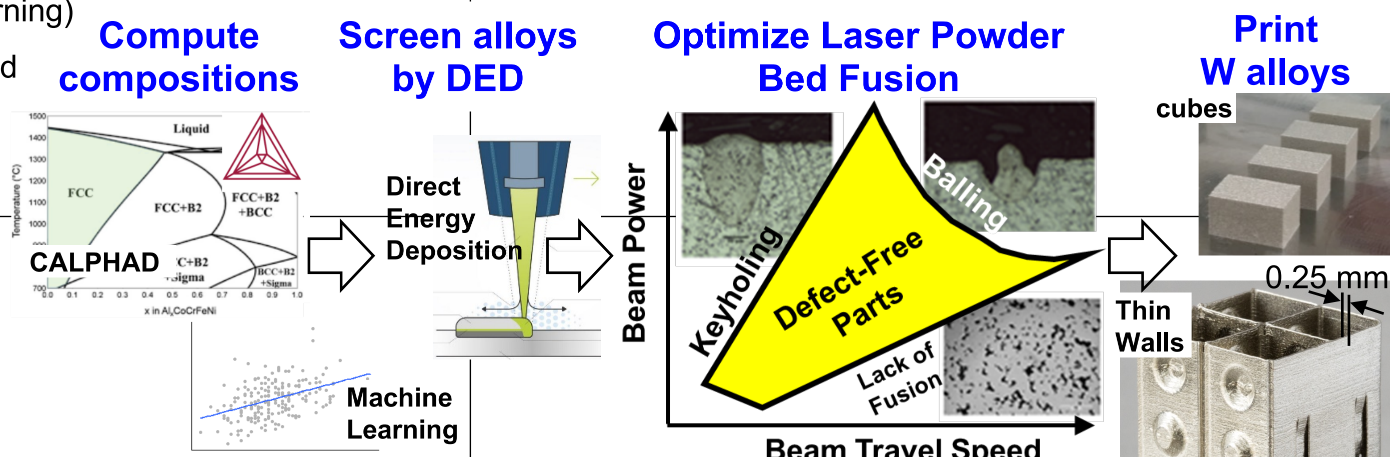
Research Objectives

- Addressing Topic 6, enable additive manufacturing of tungsten-base alloys
- Identify rhenium, tantalum, or other alloy additions that can produce W-alloys with high strength at 2000°C and ductility
- Define laser powder bed fusion process variables for minimal porosity and cracking in bulk and thin-wall structures
- Current TRL: 2, alloying tungsten improves ductility and strength in conventional processing, effects in additive processing are not clear. End TRL:3, will show defect-free parts can be printed from tungsten alloys and meet properties



Approach

- Screen alloys by CALPHAD & machine learning for property estimates). Use Trumpf TruLaser Cell 3000 Direct Energy Deposition to make bar specimens. Perform high T bend tests – screen composition by processability and mech. behavior.
- Make single tracks, multi-track pads, and 3D cubes in an EOS M-290 LPBF to connect process variables, melt pool geometry, and microstructure
- Optimize LPBF parameters to produce thin-wall structures
- Demonstrate 2000 °C mechanical properties with tensile tests.

Potential Impact

- Tungsten-base alloys can have high temperature properties, but porosity and cracking occurs after additive manufacturing
- AM enables flexibility in metal component design, but the alloys must be able to be processed by AM methods
- This work will enable additive manufacturing of thin wall tungsten-base alloy components for high temperature service in NASA applications