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Cryogenic Powder Metallurgy and Multi-Scale Metal Manufacturing Science

S&T Campaign: Materials Research
Manufacturing Science

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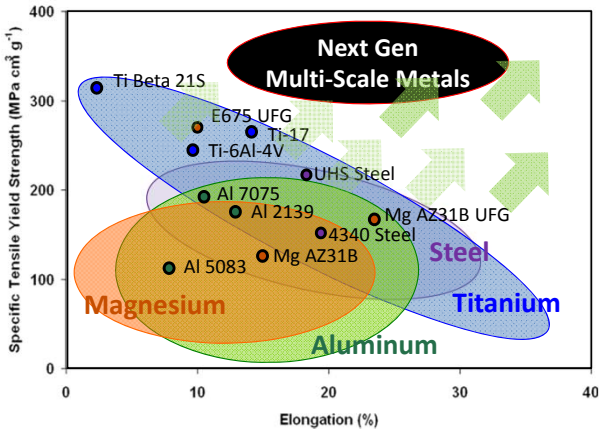
Research Objective

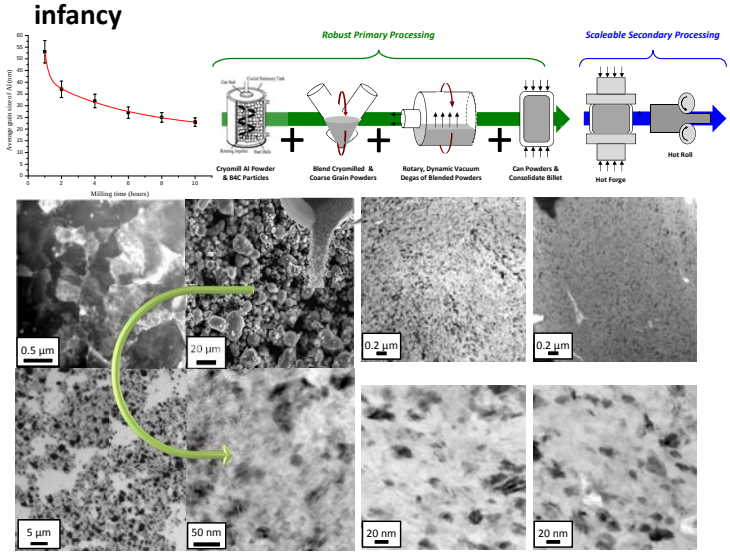
- Establish strengthening and ductilization mechanisms at nano- and ultrafine-scales
- Advance computational multi-scale microstructure design and process optimization by cryogenic nanostructuring and grain stabilization
- Innovate integrated multi-scale metallic process science and advance lighter, stronger, tougher metallic material systems manufacturing



Design Space of Next Generation Lighter Stronger and Tougher Metals

Challenges

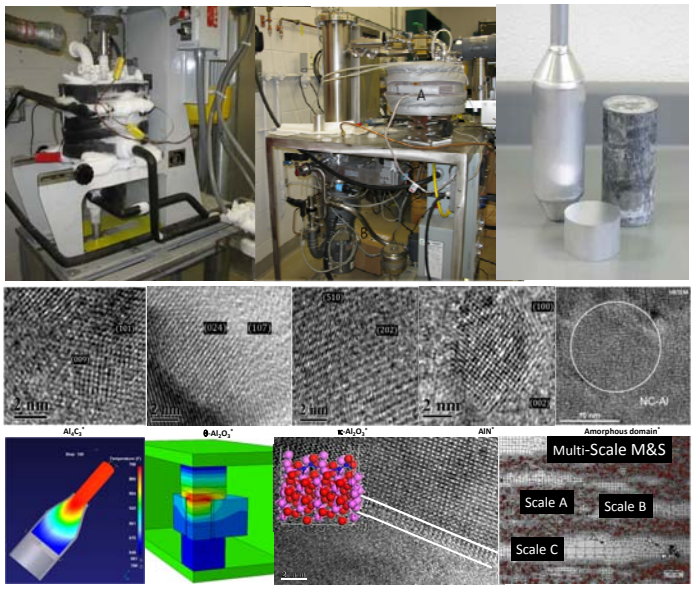
- Strengthening mechanism at bulk sub-nanoscale has never been experimentally realized nor validated
- Fundamentals in ductilization metallurgy are lacking
- Integrated multi-scale process of nanostructuring, primary & secondary processing, and fabrication is in its infancy



Cryogenic Integrated Powder Metallurgy

ARL Facilities and Capabilities Available to Support Collaborative Research

- Cryogenic powder metallurgy laboratory
- Integrated material-process modeling & simulation
- Multi-scale material modeling
- Thermo-physiomechanical process simulation
- Analytical and structural characterization



Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Thermo-mechanical process innovation
- Ductilization metallurgy experiment and computation
- Cryogenic dispersoid and mass transport mechanisms
- Experimental and computational micro and hybrid alloy powder atomization and synthesis
- Thermodynamic and kinetics in cryogen-induced lattice and surface diffusion

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2. Hofmeister, C., et al., *Composition and structure of nitrogen-containing dispersoids in trimodal aluminum metal-matrix composites.* Journal of Materials Science, 2010. 45: p. 4871-6 .
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