Design of a high-strength austenitic TRIP steel for additive manufacturing

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Materials Science and Engineering

PSED Cluster
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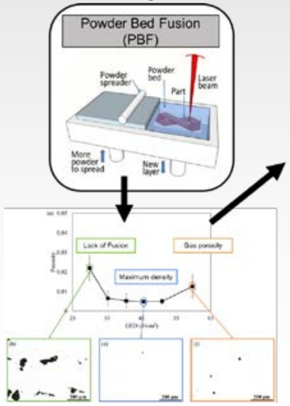
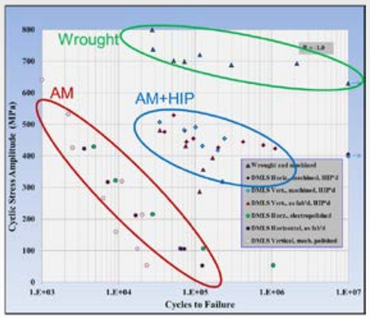
Motivation

- Additive manufacturing (AM) introduces porosity during printing
- Porosity can significantly decrease material toughness, fatigue performance
- Porosity impossible to fully remove, costly and time consuming to re
- **Goal: develop printable stainless steel that will tolerate as-built porosity while maintaining useful strength for structural applications**

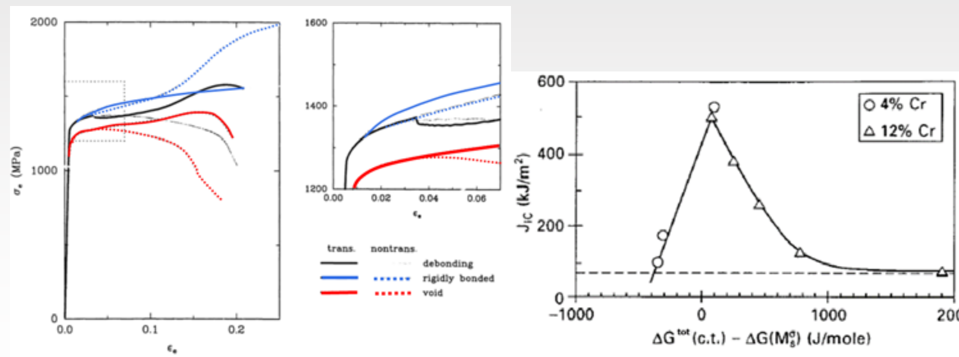




Stress-life rotating bending fatigue data of Wrought & DMLS processed Ti6Al4V

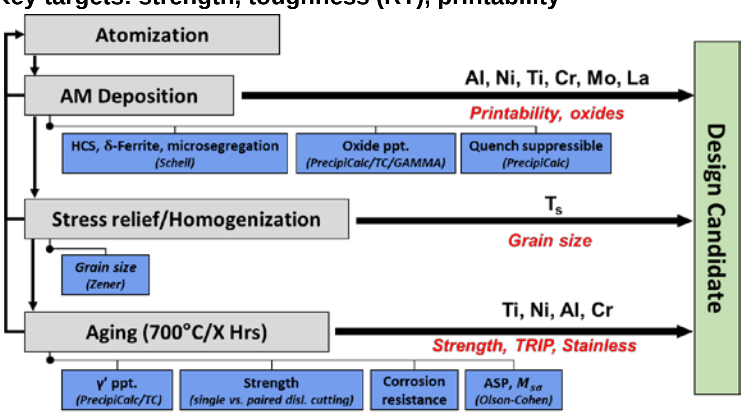
Opportunity

- TRansformation Induced Plasticity (TRIP) effect: phase change due to stress/strain
- Improved resistance to microvoid-induced strain softening around voids/particles
- Optimal toughness achieved with maximum TRIP (M_S^σ temperature for crack tip)
- **Design steel to utilize TRIP effect with optimal efficiency near use-temperature**



Design approach

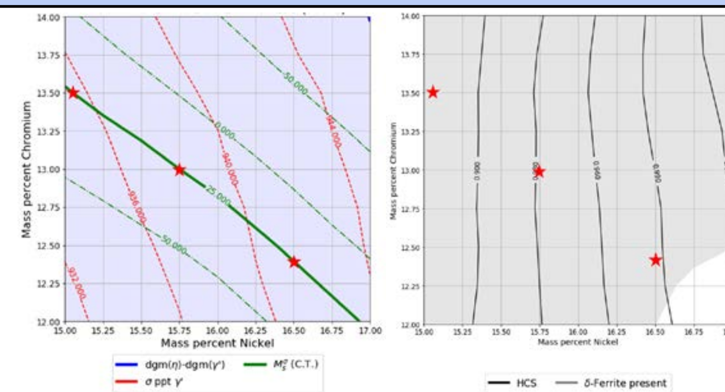
- Multi-model "flow-block" framework representative of material processing path
- Targets major parameters inherent to each processing step
- **Key targets: strength, toughness (RT), printability**



Outcomes

- Parametric multivariable satisfactory design approach
- Final composition "windows" indicate multi-property relationships
- **Final design concepts meet all strength, toughness, and printability goals**

Provides insight for future stainless AM steel protype development



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