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Synthesis of Al-Sc, Al-Zr, and Al-Sc-Zr alloys via SLM from elemental powder blends

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Multiple blends of aluminum and transition metal powders are solidified via selective laser melting (SLM) to create precipitation-strengthened alloys. Previous work has demonstrated the ability to manufacture Ni-base and Ti-Al-Nb oxide-dispersion strengthened (ODS) parts via AM for energy applications (i.e. gas and steam turbines). Al-(Sc,Zr) powders are blended from elemental powders, and then line scans are performed on the powder blends during in-situ x-ray diffraction and imaging at the Advanced Photon Source (APS) at Argonne National Laboratory to create consolidated samples. High-speed x-ray imaging is used to study the behavior and interaction of the particles in the melt pool, the size and shape of the melt pool and keyhole (vapor plume), and any pore formation events across a wide range of powder compositions and process parameters, from conduction to keyhole mode. Results correlating process parameters and keyhole dimensions are compared to existing models for SLM line scans. Complementary in-situ, pre-melting, and post-melting x-ray diffraction are used to study phase evolution in elemental Al-(Sc,Zr) powder blends during SLM to quantify homogenization, second-phase formation, and phase evolution upon multi-pass melting. Additionally, metallography is performed to study microstructural changes induced by varying powder compositions and process parameters. Current work at PSI, in collaboration with Prof. Helena van Swygenhoven's group, focuses on manufacturing dense, bulk samples from the elemental Al-(Sc,Zr) powder blends and studying the phase evolution via in-situ diffraction. These bulk samples will be compared to their counterparts manufactured from prealloyed powders.

Position

Phd

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