Investigate microstructural evolution in metal additive manufacturing processes using dynamic in-situ SEM.

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Given the high cooling rates and temperature variations in Plasma Arc Additive Manufacturing (PLAAM) the final microstructure in AM components is often anisotropic, characterized by site-specific directional variations or the development of metastable phases, therefore significantly affecting local and overall properties of the final product. Furthermore, previously deposited layers are subjected to additional cyclic heat inputs during the manufacturing process, which can lead to the diffusion of elements, phase transitions, or changes in grain morphology.

In the present work, in-situ SEM methods are being developed to understand the complex spatial-temporal thermal transients that AM components are exposed to during fabrication. The focus is on developing the microscopy techniques needed to simulate such a temperature profile on a sample of sufficient size in relation to a typical grain size in AM components. COMSOL simulations are used to predict the temperature distribution in bulk samples on the utilized MEMS-SEM microheaters. Electron Backscatter Diffraction (EBSD) and SEM imaging during a cyclic heating experiment are used to follow the dynamic changes in the microstructure. This research will allow conclusions to be drawn about the feasibility of using SEM-based heating studies to develop a fundamental understanding of microstructure formation during PLAAM processes.