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Study of Phase-Transformation Behavior in Additive Manufacturing of Nitinol Shape Memory Alloys by In Situ TEM Heating

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Reversible martensitic transformation, a diffusionless solid-solid phase transition, gives NiTi (Nitinol) alloys shape memory effect (SME) and superelasticity with several-percent recoverable strains. Because of these attractive properties, NiTi alloys are widely applied in actuators, sensors, and dampers. With the recent advent of laser powder bed fusion (L-PBF) additive manufacturing (AM), NiTi with complex geometry can be fabricated by the near-net-shape manufacturing. Since L-PBF processes involve rapid heating/cooling rates, steep thermal gradients and complex histories, locality in NiTi parts exhibits heterogeneity, which dramatically affects their functional properties. Therefore, an in-depth understanding of the correlation between thermal process parameters and structural variations is essential for material design.

Thus, to capture the connections between phase transformation and the local inhomogeneity, TEM samples from different locations in the melt pool area were prepared and placed on a MEMS-based microheater for *in-situ* heating transmission electron microscopy (TEM) experiments. A higher phase transformation resistance was shown at the melt pool boundaries, due to the fine cellular structure and high-density of dislocations. Our results indicate the ability to apply *in-situ* TEM heating experiments to study microstructural transformations for further optimizing process parameters in (additive) manufacturing.