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Shape memory alloys (SMAs) are widely used in several applications, such as actuators, sensors and dampers, due to their attractive property of shape alloy effects (SME). SME is a capability of SMAs to regain the original shape after loading deformation by heating through the reversible martensitic transformation to nullify the strain. According to the stress-strain curve for the SMAs, the applied strain and the working temperature are used to determine the stress of the SMA and its phase. Controlling the structural transformation window by varying the different components or manufacturing can be used to achieve better performance in SMAs. As a result, an in-depth understanding of the correlation between the structural variation and the applied temperature can provide insights to improve SMAs material designs.

To capture this microstructural variation on heating in real-time, in situ heating experiments in transmission electron microscopy (TEM) are used to study the SME in laser powder bed fusion (L-PBF)-NiTi alloys. In the present study, TEM samples from different areas of melt pool were prepared by focused ion beam (FIB) and placed on the MEMS-based microheaters for in-situ TEM heating experiments to study the phase transformation with increasing temperature.

In LPBF, since the laser processing introduces the inhomogeneous heating profile at each point, this creates the melt pool with non-uniform composition distribution perpendicular to the build direction. To explore the influences of the inhomogeneous distribution on the phase transformation window, the reversible martensitic transformation has been investigated on different positions of the melt pool in in-situ TEM heating experiments. Studying microstructural transformation in heating experiments provides essential insights to further optimize process parameters in (additive) manufacturing.