Post-processing heat treatment of additive manufactured NiTi alloys with Ti-rich composition

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The functional characteristics inherent to NiTi shape memory alloys arise from the reversibility of the shape memory transformation mechanism: a solid-state displacive transformation, referred to as the martensitic transformation (MT). A high-temperature parent phase, known as austenite, transforms to a low-temperature product phase, referred to as martensite. The nature of the underlying mechanism, nucleation and growth of twinned martensite, is highly sensitive to metallurgical conditions, including composition, thermal history, and post-processing parameters. These metallurgical factors can introduce localized variations in composition and strain/stress fields. Laser directed energy deposition (LDED) additive manufacturing (AM) is an emerging technology, offering a means to finely tailor the shape memory properties and overall performance of the alloy. In this study, we subjected a NiTi alloy of higher Ti composition, referred to as Ti-rich NiTi, to post-processing heat treatments including solutionizing and aging. We then investigated the influence of these heat treatment conditions on the thermally induced martensitic transformation and superelasticity using differential scanning calorimetry and mechanical testing system, respectively. Our aim is to establish correlations between the shape-memory behavior and the resultant microstructures arising from the heat treatment process.