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Effect of heat treatment on microstructure, corrosion, and shape memory characteristics of laser deposited NiTi alloy

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ABSTRACT

The aim of this work is to study the effect of heat treatment on the microstructure, phase transformations, shape memory characteristics and corrosion behaviour of laser deposited equiatomic NiTi alloy. Dense samples of NiTi alloy were fabricated using Engineered Net Shaping (LENS^{TM}) with two different laser energy densities by varying the scan speed and laser power. These samples were annealed for 30 min at 500 °C and 1000 °C in flowing argon, followed by furnace-cooling to room temperature. The resulting microstructures and properties were compared with the corresponding as-deposited samples. Microstructural analysis after heat treatment showed needle-shape martensite in the samples processed at lower laser energy density of 20 J/m^2, and lenticular or plate-like martensite in the samples processed at 80 J/m^2. The XRD results revealed relatively high concentration of martensite (B19') in heat-treated NiTi alloy compared to as-processed samples. Furthermore, the heat treatment decreased the forward and reverse transformation temperatures of NiTi alloy from 80 – 95 °C to 20 – 40 °C, presumably due to annihilation of thermally induced defects. Interestingly, the samples annealed at 500 °C showed a measurable increase of 1-2% in the shape memory recovery, from the net recovery of 8% exhibited by the as-processed NiTi alloy. The corrosion resistance of laser-processed NiTi alloy decreased upon annealing.

Keywords: Laser processing, Laser engineered net shaping, NiTi alloy, Shape memory effect, Heat treatment, Corrosion.