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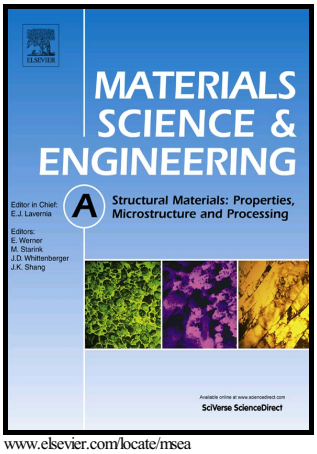

www.elsevier.com/locate/msea

PII: S0921-5093(18)30431-3
DOI: https://doi.org/10.1016/j.msea.2018.03.072
Reference: MSA36265

To appear in: *Materials Science & Engineering A*

Received date: 24 January 2018
Revised date: 16 March 2018
Accepted date: 17 March 2018

Cite this article as: Narges Shayesteh Moghaddam, Sayed Ehsan Saghaian, Amirhesam Amerinatanzi, Hamdy Ibrahim, Peizhen Li, Guher P. Toker, Haluk E. Karaca and Mohammad Elahinia, Anisotropic tensile and actuation properties of NiTi fabricated with selective laser melting, *Materials Science & Engineering A,* https://doi.org/10.1016/j.msea.2018.03.072

Anisotropic tensile and actuation properties of NiTi fabricated with selective laser melting

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Abstract:

This study evaluates the anisotropic tensile properties of $Ni_{50.1}Ti_{49.9}$ (in at. %) components fabricated using an additive manufacturing (AM) process of selective laser melting (SLM). Dog-bone shaped tensile specimens were fabricated in three orthogonal building orientations (i.e., horizontal, edge, and vertical) with two different scanning strategies (i.e., alternating x/y and alternating in ±45° to the x-axis). Next, the samples were subjected to tensile testing until failure, shape memory effect tests and thermal cycling under constant tensile stresses up to 500 MPa. Their failure surfaces were analyzed for possible microstructural defects. It was revealed that the build orientation and scanning strategy affect the texture/microstructure, and hence the failure stress, ductility, shape memory effect, and functional stability. Samples fabricated in the horizontal orientation with alternating x/y scanning strategy had the highest ultimate tensile strength (606 MPa) and elongation (6.8 %) with the strain recovery of 3.54% after 4 shape memory effect cycles. At stress levels less than or equal to 200 MPa, these samples had the actuation strain greater than 3.8% without accumulation of noticeable residual strain. It was observed that the scanning strategy of alternating in ±45° result in degraded mechanical and shape memory response, particularly in horizontal and edge samples.

Keywords: Shape Memory Alloy; NiTi; Additive Manufacturing; Selective Laser Melting; Tensile Properties; Processing Direction.