A Review of Nitinol Shape Memory Alloy Processed by Selective Laser Melting

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Abstract. Nitinol (nickel-titanium or Ni-Ti) is regarded as the most utilised shape memory alloy. It has potential applications in the medical, aerospace, automotive and heat engine sectors due to its good superelasticity, shape memory effect, low stiffness, damping, biocompatibility, and corrosion resistance. A variety of conventional manufacturing methods exist for producing Nitinol. However, various material characteristics including impurity proneness, compositional sensitivity, high reactivity and ductility, results in poor manufacturability and inferior product quality. It is also very difficult to fabricate complex optimized shapes using these techniques. These issues can be resolved by the modern additive manufacturing (AM) methods which can produce net or near-net shape parts with highly precise and complex Nitinol structures. Selective Laser Melting (SLM) and Laser Engineered Net Shape (LENS) are the two AM methods which were found to be able to process Nitinol effectively. SLM has the benefit of having an inert atmosphere which protects chemically reactive Nitinol powders to a higher degree. In this paper, the most recent publications related to the SLM processing of Nitinol are reviewed to identify the various influential factors involved and process-related issues. The various process parameters used by different researchers are reported in this paper. It is reported that high thermal gradients caused by rapid melting and solidification, will affect the transformation temperatures and shape memory properties. Optimisation of several operating parameters including laser power, energy density, beam focus, hatch spacing, etc. were found to be critical in fabricating highly dense Nitinol. Processing parameters and related thermal cooling gradient are also crucial for obtaining the correct phase structure for shape memory capabilities.