Selective Laser Melting Of NiTi Alloys

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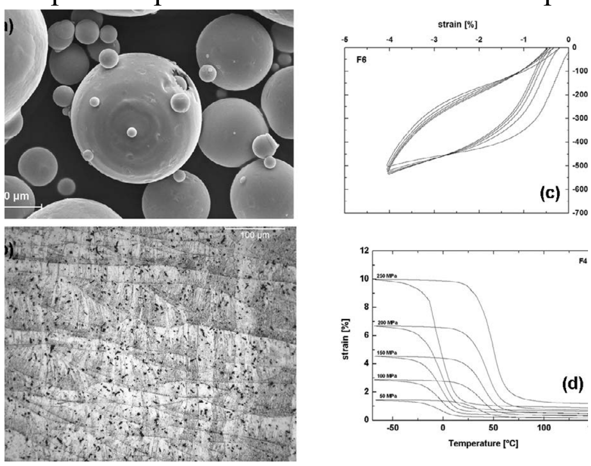
Near-equiatomic NiTi is known for the ability to gain high deformations when subject to a thermal cycle under load (shape memory effect) or during a loading/unloading cycle at constant temperature (pseudoelasticity). The resulting mechanical work may be exploited in practical applications as actuators and sensors. Lightness, compactness, noiseless and thermo-mechanical cyclic stability are the leading characteristics of NiTi-based devices. However, the poor workability by means of conventional processing techniques limits the use of NiTi. The high ductility and the high degree of work hardening of NiTi alloys during cutting lead to difficult processing and poor workpiece quality. Therefore, in most applications the NiTi component is designed out from the same semifinished product (sheet, strip, wire, tube, bar) and its final geometry is simple and it is often in the form of wire, spring or tape [1].

Selective laser melting (SLM) is an additive production process that uses a laser beam source to selectively melt metal micrometric powder, layer by layer and following a 3D CAD model. It allows producing three dimensional objects of even complex geometry, limiting the use of tools and overcoming the problems related to traditional technologies. As a first consequence, the possibility to produce near-net-shape components has expanded the field of applications of NiTi.

In this work, on the base of previous results [2], an optimized set of process parameters was selected to deepen the variation of the microstructure, the phase transformation temperatures and the mechanical response of NiTi parts produced by SLM, starting from a 55.2wt% Ni NiTi powder. After the production process, it was detected the depletion of Ni in the as-built parts which caused an overall increasing of the phase transformation temperatures. All NiTi families present a shape memory response at room temperature. It is shown that the resulting material may exhibit distinct damping and strain recovery responses correlated with the used SLM parameters. Moreover, differences in thermal and mechanical behavior were also observed between samples with same process parameters highlighting the effect on of phase transformation temperature of part growing direction and position on the building platform.



Sem image of the NiTi micrometric powder (a), optical microscope observation of the NiTi as-build part (b), stress-strain (c) and strain recovery (d) responses.

References:

[1] Y.Kaynak, H.Tobe, R.D. Noebe, H.E. Karaca, S. Jawahir, The effects of machining on the microstructure and transformation behavior of NiTi Alloy, Scripta Materialia 74, (2014) 60-63.

[2] J.M. Walker, C. Haberland, M.T. Andani, H. E. Karaca, D. Dean, M. Elahinia, Process development and characterization of additively manufactured nickel-titanium shape memory parts, J. Intell. Mater. Struct. (2016) DOI: 10.1177/1045389X16635848.

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