Properties of TiAl6V4 alloy parts produced by selective laser melting – parameter influence

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Abstract

Additive layer manufacturing and, in particular, selective laser melting (SLM) are very powerful tools to generate geometrically complex structures of high performance materials. However, a homogeneous, completely dense material is difficult to achieve since no mechanical pressure is involved like, for example, in forging processes. The consolidation of SLM parts is achieved solely by temperature, gravity and capillary forces. Non-optimal scan parameters may cause instabilities in the melt pool during the process, which lead to the formation of inner defects such as unmolten particles, spherical entrapped gas bubbles, lack of fusion etc. (Fig.1).

Manufacturing defects cannot be avoided completely and, therefore, they should be kept to a minimum at the stage of the powder-layer consolidation. This requires a careful process optimization procedure to obtain a high quality material [1]. For this reason more than 60 test samples were produced by SLM from TiAl6V4 powder varying different scan parameters: laser power, scanning rate, hatch distance and laser focus. Porosity was analyzed quantitatively as a function of the scan parameters using two- and three-dimensional materiallography. It is shown that the porosity can be reduced by with well optimized process parameters significantly. The quality of the external surfaces is also strongly affected by the local heat transfer conditions, which are influenced by laser energy: efficient process parameters lead to significant decrease in surface roughness and less surface defects. The roughness of the horizontal surfaces was measured and comprehensively analyzed. The process optimization allows a sizable reduction of roughness reduction and the number of external defects.

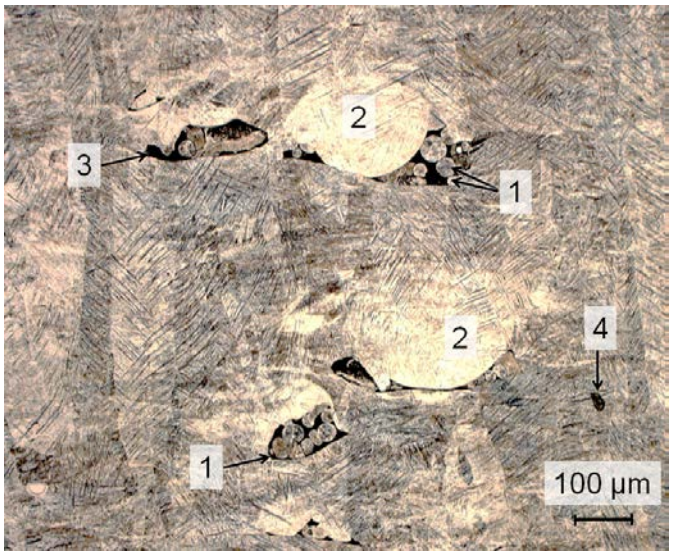

Fig. 1. Non-processed particles (1), balling behavior (2), lack of fusion (3) and pores (4) as a result of non-optimal laser scan parameter by SLM. Etched cross section, laser scanning microscopy.

[1] G. Kasperovich, J. Hausmann, "Improvement of fatigue resistance and ductility of selective laser molten TiAl6V4", *Journal of Materials Processing Technology,* 2015, vol. 220, pp. 202-214.
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