Study on properties of AISI 316L produced by Laser Powder Bed Fusion for high energy physics applications

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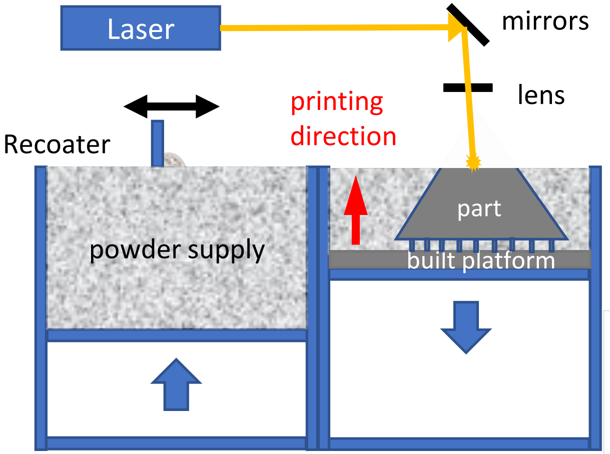
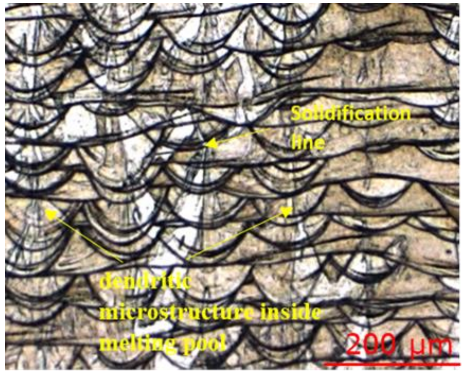
Nowadays additive manufacturing is catching on and spreading across various fields at an astonishing rate. High energy physics, where materials are often exposed to special environmental conditions, is also starting to use this technology. The aim of this paper is to compare traditional and 3D printed stainless steel AISI 316L products with an eye turned to the specific high energy applications. The manufactured samples are subjected to different heat treatments, including vacuum firing, which is usually adopted for ultra-vacuum applications. Experimental tests are carried out on a set of samples to analyse the material composition and to assess properties such as mechanical performance in cryogenic application, high radiation resistance and ultra-vacuum compatibility. Such analysis of the material behaviour allows weakness and strength of the technology to be identified, compared to traditional AISI 316L.



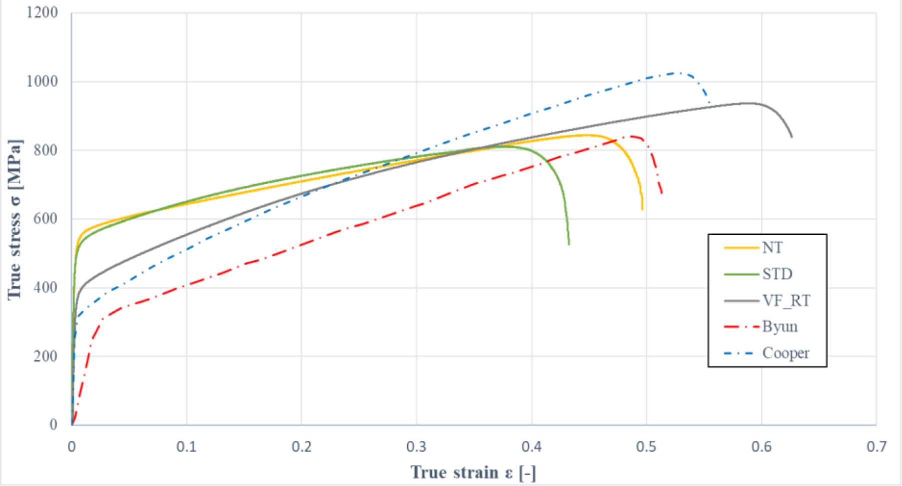
Selective laser melting working principle: recoater spreads a metallic powder bed on built platform, laser selectively melts powder part is build layer by layer (bottom to top)..



Different heat treatments:

- no difference in ferrite content
- no difference in the magnetic permeability

	Ferrite content check (Ferriscope FMP30)	Magnetic permeability (Magnetoscope 1.069)
NT	0.14±0.02 %	1.004 ± 0.004
STD	0.15±0.02 %	1.004 ± 0.004
VF	0.1±0.02 %	1.004 ± 0.004



Comparison of true stress strain curves at RT: AISI 316L AM parts subjected to different heat treatment vs. bulk parts.

NT (no heat treatment);

STD (standard h.t.): 180°C/h to 550°C; stable 6h; cool dow;

VF (vacuum firing h.t.): 200°C/h to 950°C; stable 2h; cool down