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RESULTS ANALYSIS OF Ti6Al4V TITANIUM ALLOY TESTS IN STATIC LOAD CONDITION

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INTRODUCTION

The technology of 3D printing in metal is gaining popularity due to the possibility to product the elements of any geometry, which is difficult or impossible to obtain with the methods used so far. One of the most commonly used additive methods is Direct Metal Laser Sintering (DMLS). The printing process precedes the 3D model creation on the basis of which the element is manufactured. In the DMLS method, powdered metal is evenly distributed on a mobile working platform, on which a laser beam heats the metal particles causing them to sinter in places consistent with the numerical model.

Due to its mechanical properties and resistance to high temperatures, Ti6Al4V alloy is used in aviation for: turbine engine components, discs, rings, blades, aviation fittings and rocket engine coatings. In medicine, the specified alloy is used to manufacture joint endoprostheses, elements for anastomosis of bone fragments, in dental prosthetics, cardiac surgery, and interventional cardiology. The use of titanium in medicine results from its biocompatibility with human tissue, as well as its low mass and corrosion resistance (Fig. 1).

The aim of the paper is to present the tests results under static load condition of Ti6Al4V material produced by the DMLS additive method.

APPLICATION

Fig. 1. Implants made in DMLS technology (*www.eos.info*)

TEST SPECIMEN

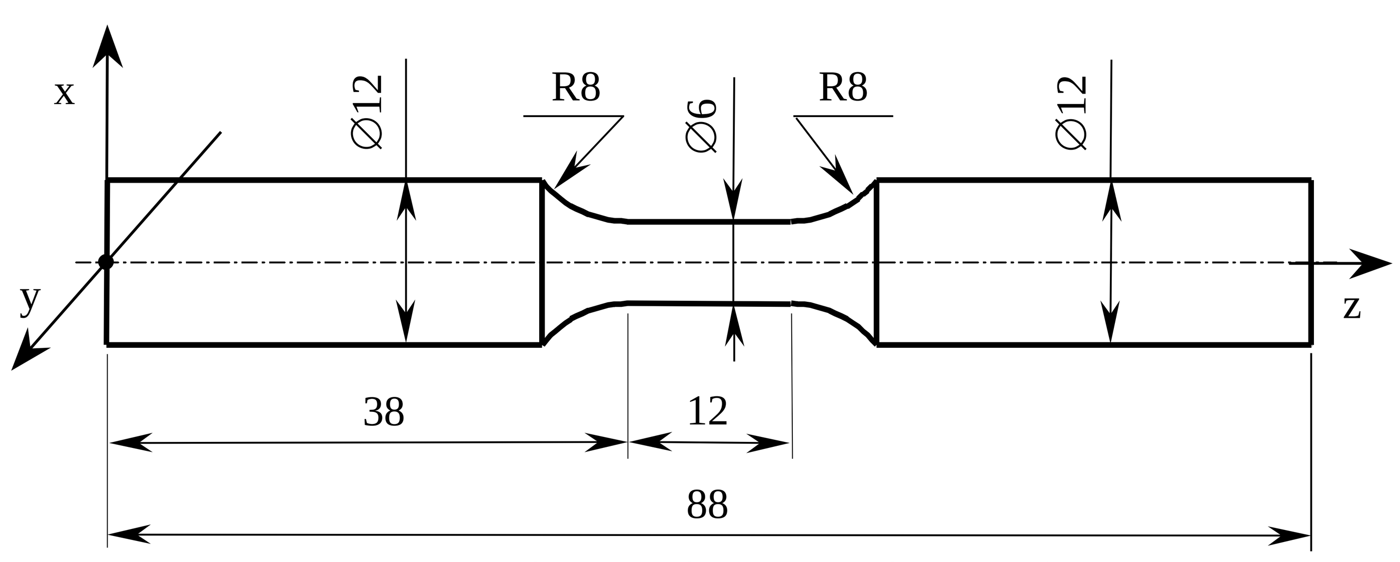

Fig. 2. Geometric features of a specimen for strength tests according to PN-74/H-04327

GEOMETRIC FEATURES MEASUREMENT

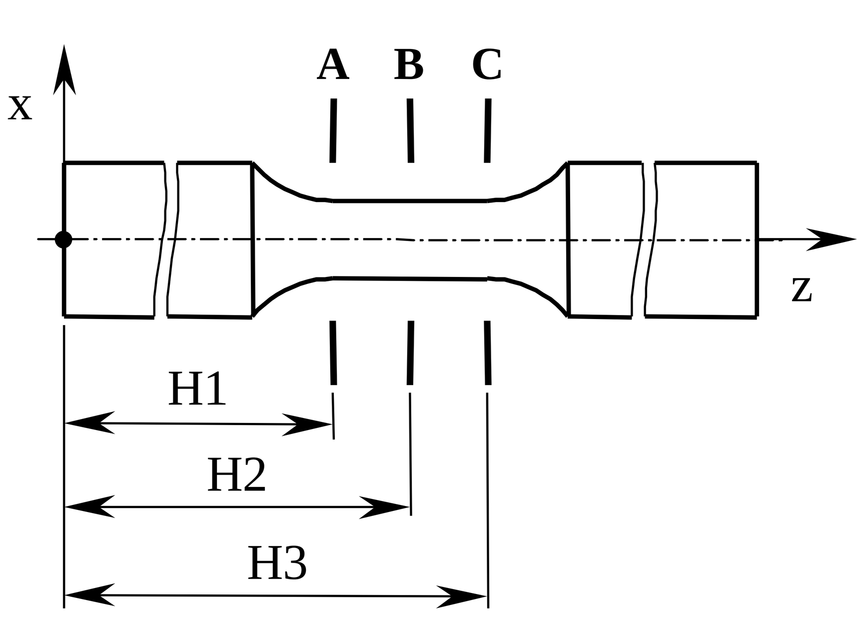

Fig. 3. Test specimen with diameters and roundness measuring points marked

Table. 1. The roundness and diameter deviation measurement results of the sample measuring part

	Specimen measuring part parameters	
	Diameter	Roundness deviation
	mm	mm
Average value	5.949	0.019
Standard deviation	0.004	0.004
Minimum value	5.942	0.013
Maximum value	5.958	0.027

STRENGTH TEST RESULTS

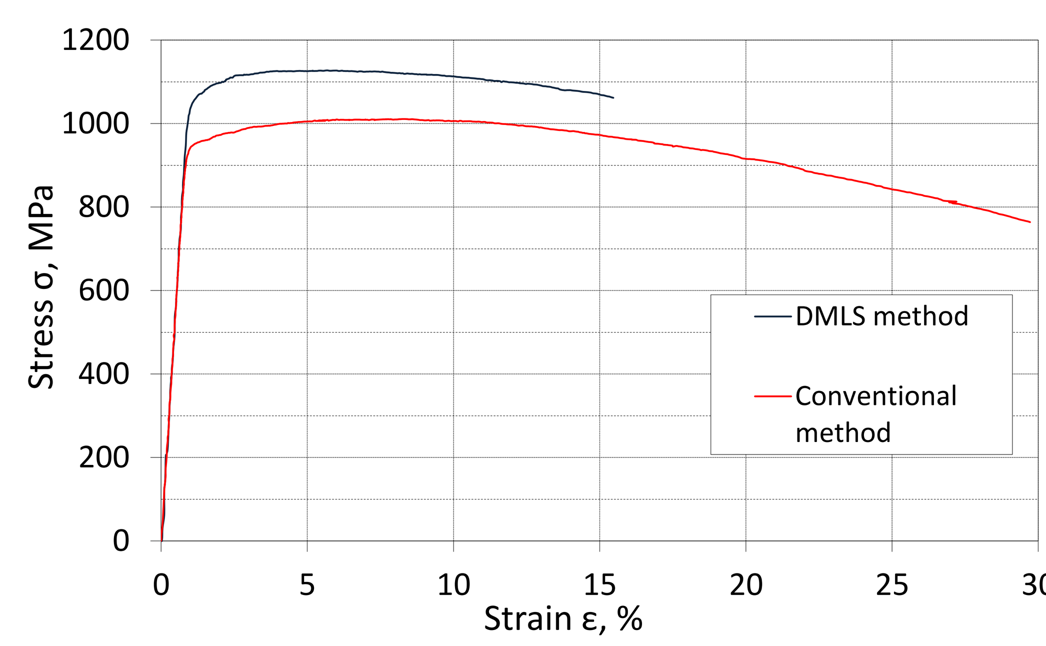

Fig. 4. Stress – strain chart of Ti6Al4V titanium alloy

Table. 2. Average values of static strength parameters under tensile loads

Material production method	Static parameters of Ti6Al4V			
	S_u	$S_{y0.2}$	A	E
	MPa	MPa	%	MPa
DMLS	1127	1052	15.5	114510
Drawn bar	1010	947	29.7	113060

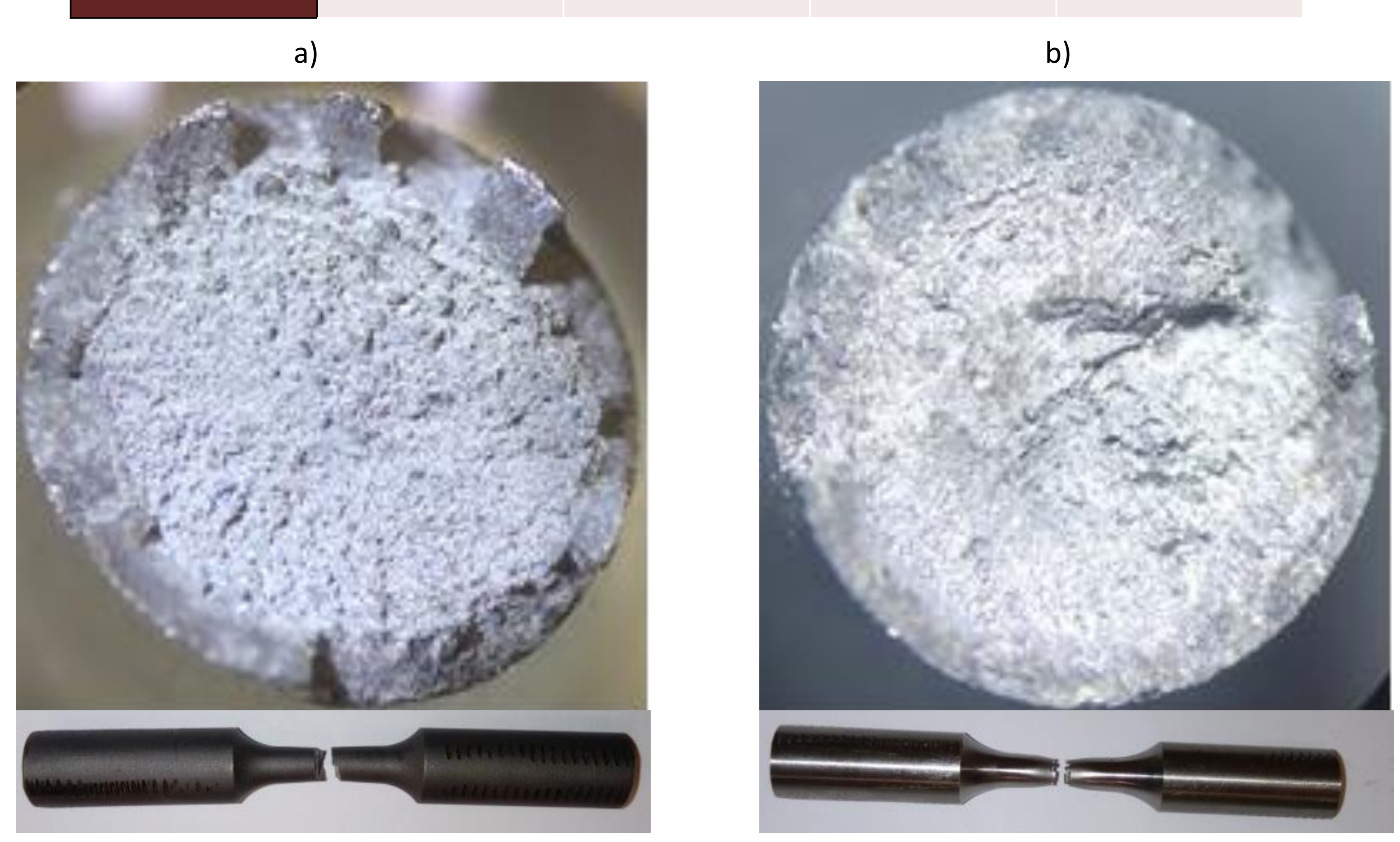

Fig. 5. Microscopic photos of fractures of samples after rupture: a - additive DMLS technology, b - from a drawn bar with a diameter of 12 mm (turned samples)

CONCLUSION

Analyzing the samples fractures after breaking, it can be seen that in the specimen made of drawn bar in the measuring part, a visible narrowing at the fracture is occurred. The narrowing is not visible on the sample made using DMLS technology. Figure 5 shows microscopic images of broken samples fractures. In the case of a printed sample (Fig. 5a), the form of damage corresponds to a brittle crack that has initiated from the outer surface on different layers. After damage to the outer section, further damage to the sample occurred along the sintered layers. The form of damage to the sample made of a drawn bar (Fig. 5b) corresponds to breakthroughs for elastic-plastic materials.

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