

Basic Characterisation of 17-4PH structure manufactured by Selective Laser Melting

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INTRODUCTION

The aim of this study was to produce different samples made out of stainless steel 17-4PH to compare SLM (with and without post heat treatment) with conventionally manufacturing (wrought material with heat treatment). The properties investigated in this work are strength, hardness, notch impact energy and surface quality as a function of the sample orientation with respect to the building direction.

EXPERIMENTAL AND RESULTS

The investigated material is the high-alloyed stainless steel 17-4 PH (1.4542, X5CrNiCuNb 16-4). The alloying elements (> 1wt%) of this steel are shown in Table 1.

C	Si	Mn	Cr	Ni	Cu	Nb
0,04	0,25	0,40	15,40	4,40	3,30	0,30

Table 1: Chemical analysis of the 17-4PH in wt% according EN10088

The heat treatment (HT) of the SLM material (650°C, 1 h) and the heat treatment of the wrought material (solution annealing @ 1050°C for 1 h, quenched with air, artificial aging @ 550°C for 4 hours) are shown in Figure 1.

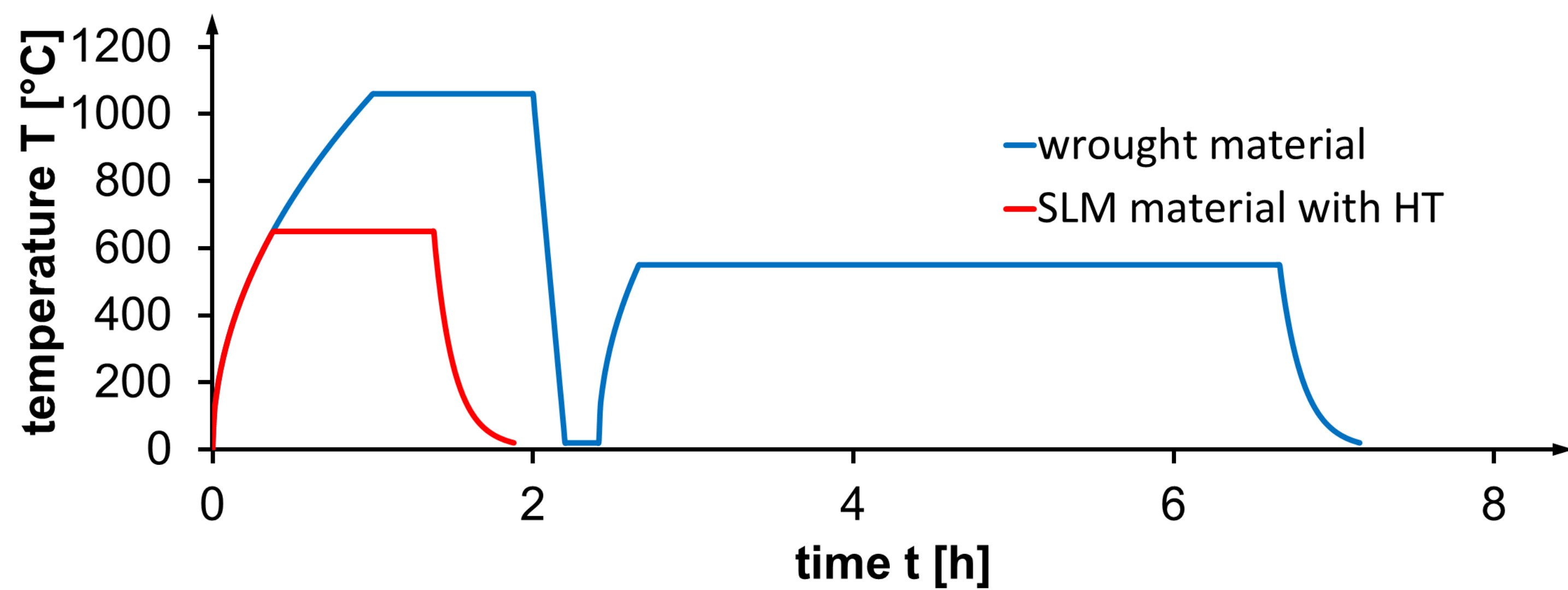


Figure 1: Heat treatment (HT) of the wrought material and of the laser melted material

Figure 2 shows the building volume inside the SLM machine, filled with samples for the tensile test, the charpy V-notch test, the hardness test and the surface investigation. The built direction is the z coordinate.

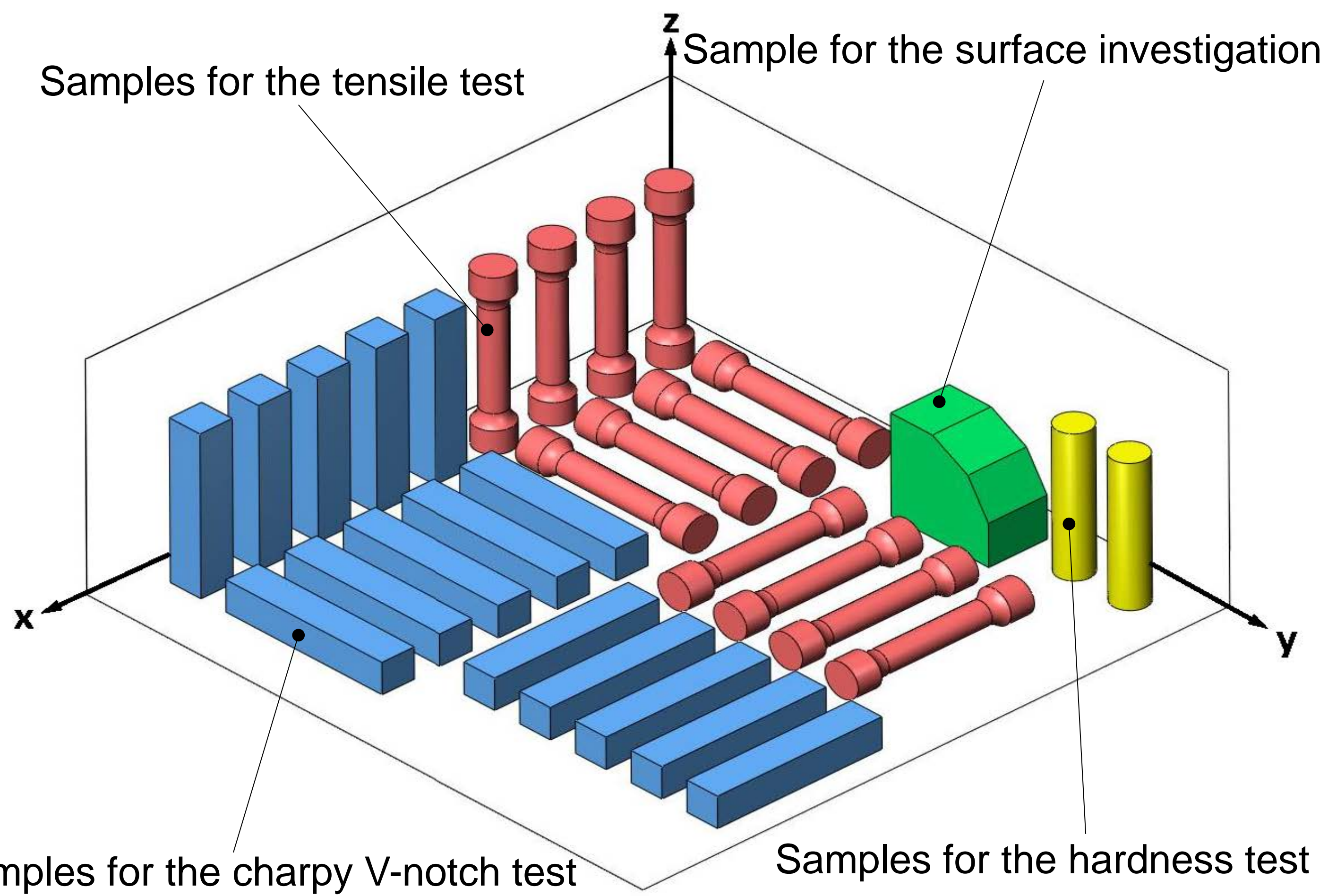


Figure 2: Building volume of the SLM machine filled with the samples.

In Table 2 the results of the charpy V-notch test are presented. There are lower values of the SLM material after the heat treatment compared to the as-manufactured condition.

notch plane	SLM material without heat treatment			SLM material with heat treatment			wrought material
	yz	xz	xy	yz	xz	xy	
notch impact energy Av [J]	142±2	140±2	161±5	80±2	82±4	89±2	72±2

Table 2: Results of the charpy V-notch test.

The yield strength of the wrought material is about two times larger than the yield strength of the SLM material shown in Figure 3. The heat treatment has no

CONCLUSION

Considering mechanical properties, a clear anisotropy is observed in the as-manufactured state. The post heat treatment cannot significantly reduce the anisotropy. Therefore the part orientation inside the SLM machine and the post heat treatment are essential for the engineering and the manufacturing of SLM parts.

significant influence on isotropy. There are big differences between the building direction and the other directions.

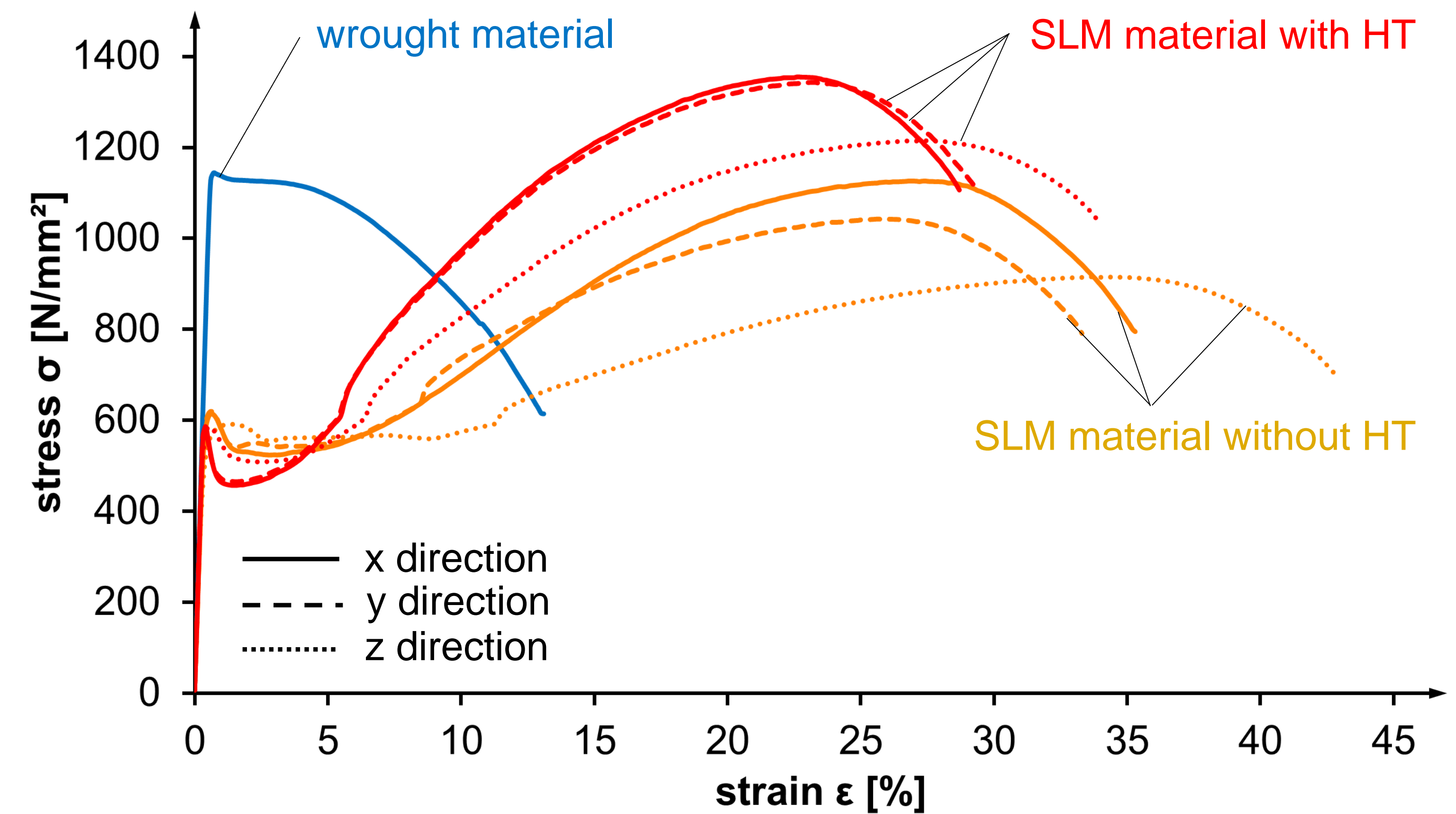


Figure 3: Results of the tensile test.

The Results of the hardness test are shown in a hardness mapping in figure 4. The hardness of the wrought material is much higher than that of the SLM material. Due to heat treatment the hardness of the SLM parts increases.

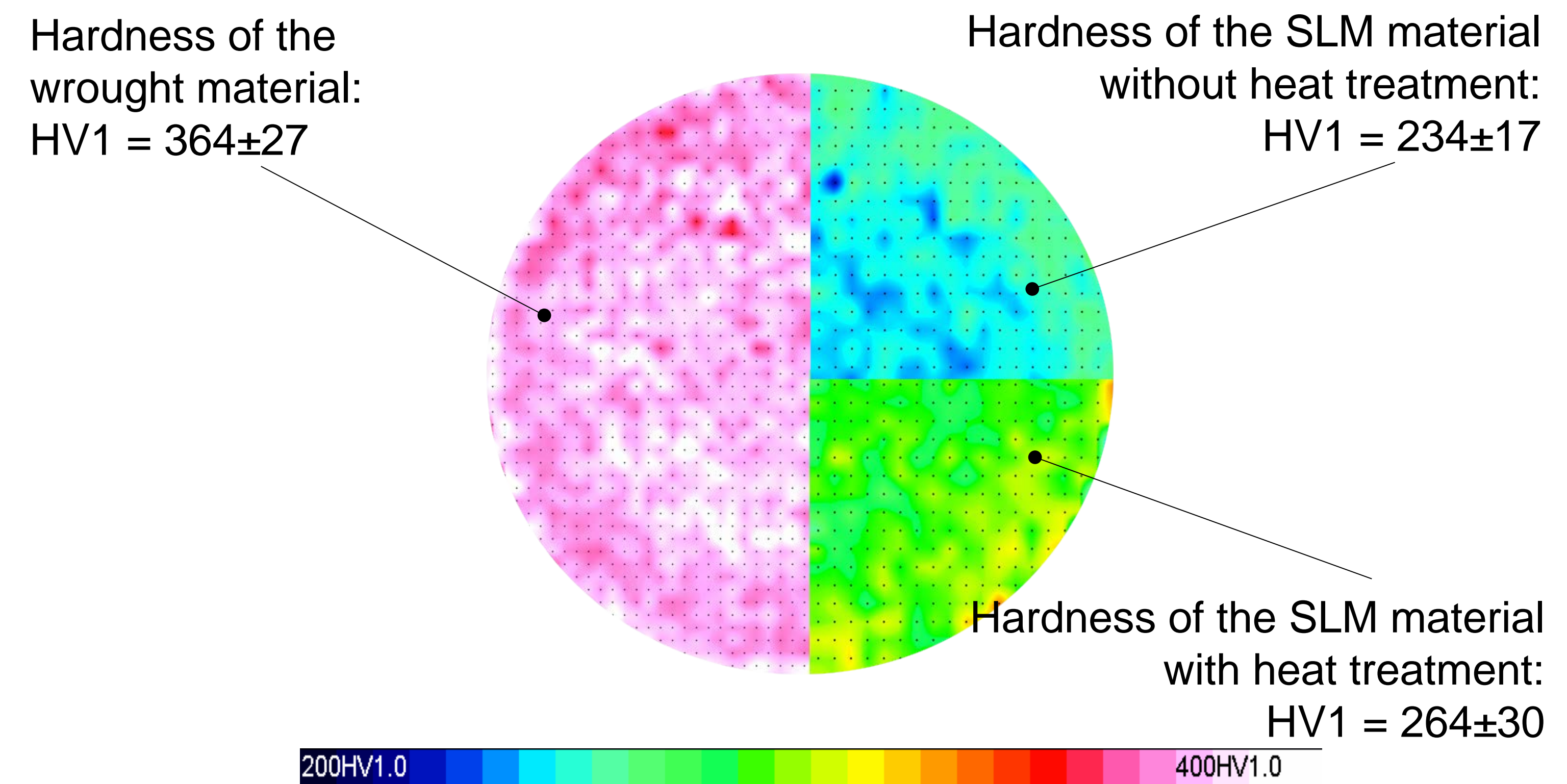


Figure 4: Results of the hardness test.

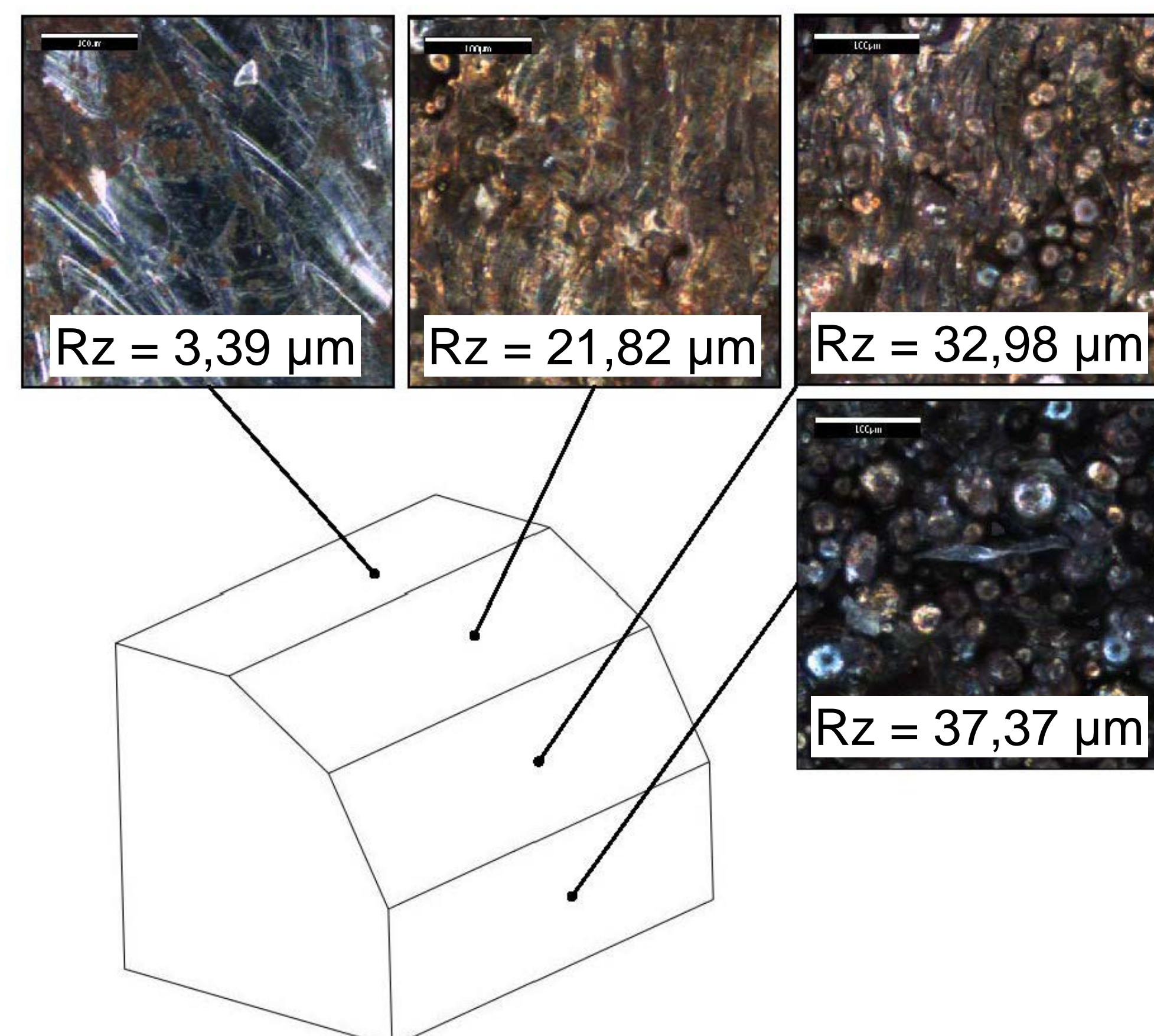


Figure 5: Results of the surface investigation.

Figure 5 shows the surface investigation of the SLM parts. Due to the manufacturing process different surface qualities appear on different orientated levels. Vertical surfaces are rougher than horizontal oriented surfaces.