General:

ZTP10 & ZTP25 is a near alpha titanium matrix nanocomposite (nTMC) designed specifically for additive manufacturing (AM). ZTP10 & ZTP25 belong to the ZTi-Powder® family. The alloy matrix is a Ti64 alloy doped by yttria and zirconia ceramic powders in addition to some minor additives. It possesses very high mechanical properties at room and high temperature compared to forged and AMed Ti64. The unique chemical composition and processing of ZTP10 & ZTP25 allows a very high corrosion resistance at high temperature and experiments showed a very stable microstructure at 850 °C. In addition, in-house heat resistance coatings could be applied over ZTP10 & ZTP25 parts to sustain the harsh environments of aerospace applications. Other application fields were also identified for ZTP10 & ZTP25 especially in the biomedical's such as medical implants.

Materials structure:

ZTP10 & ZTP25 processing parameters were first developed on a powder bed fusion machine (PBF). Using this alloy, bulk parts were firstly made and later parts with different complex geometries were produced. The microstructure of the as- built state of ZTP10 & ZTP25 parts consists of fine lamellae α grains in addition to minor traces of beta phase precipitates depending on chemical composition. ZTP10 & ZTP25 was also processed through post heat treatments such as hot isostatic pressure (HIP) to obtain a full density and high fatigue resistance. Research papers were issued in high impact factor journals stating the work on ZTP10 & ZTP25.

ZTP [1]

Physical and Chemical Properties				
Mass density [2]	~ 4.45 g/cm³			
Component density [3]	> 98.5 %			
Melting point	1690~1772 °C			
Chemical composition [Mass fraction in %][4]		Element	ZTP10.	ZTP25.
		Ti	Balance	Balance
		Al	6.79	7.20
		V	3.98	4.14
		Y	0.01	0.09
		Zr	0.27	1.66
		O	0.19	0.6
		Fe	0.22	0.25
		C	0.07	0.08
		H	0.01	0.0125
		N	0.03	0.03
		Others		
Particle size [5]		15-45 µm	50-150 µm	
Particle shape		Spherical	Spherical	

ZTP [1]

Mechanical Data at 25°C Layer thickness 30 µm M: Mean SD: Standard deviation			Stress relieved M	SD	Ti64 [11] M
Tensile test [6]					
Tensile strength	R_m [MPa]	ZTP10	1135	19	860
		ZTP25	1403	26	
Offset yield strength	$R_{p0,2}$ [MPa]	ZTP10	910	11	795
		ZTP25	1124	13	
Elongation at break	A [%]	ZTP10	11	1	10
		ZTP25	7	2	
Young's modulus	E [GPa]	ZTP10	110	2	113
		ZTP25	120	4	
Hardness test [7]					
Vickers micro-hardness	$HV_{0.2}$	ZTP10	410	6	340
		ZTP25	540	15	
Roughness measurements [8]					
Roughness average	R_a [µm]		7	2	
Mean roughness depth	R_z [µm]		88	17	
Compression test [9]					
Compressive strength	R_m [MPa]	ZTP10	1806	12	
		ZTP25	2208	25	
Compressive strain	A [%]	ZTP10	15	3	
		ZTP25	21	2	

Z3DLAB SAS | 2 Chemin de Coye | 95270 | Chaumontel | France
Phone : +33 1 75 38 98 92 | E-mail : ahattal@z3dlab.com

Fatigue endurance **Layer thickness 30 µm; 10^6 fatigue cycle** M: Mean SD: Standard deviation		Stress relieved		Ti64 [11]
		M	SD	M
ZTP10				
Stress at 10^7 cycle	R_{effe} [MPa]	620	12	430
Stress at 10^7 cycle [12] (After HIP)	R_{effe} [MPa]	850	7	600

Mechanical Data at 850 °C **Layer thickness 30 µm** M: Mean SD: Standard deviation Testing speed 0.1 to 0.001 s^{-1}		Stress relieved		Ti64 [11]
		M	SD	M

Compression test [10]

		Speed	ZTP10	ZTP25	SD_{Min}	SD_{Max}	
Compressive strength	R_m [MPa]	0.1	230	381	9	11	167
		0.01	190	216	3	2	142
		0.001	105	127	2	4	55
Compressive yield strength	$R_{p0.2}$ [MPa]	0.1	143	191	3	7	133
		0.01	105	129	1	4	93
		0.001	72	83	3	3	49

Material Data Sheet

ZTi-Powder® meting parameters are developed and enhanced at Z3DLAB facility. The physical and mechanical properties of ZTi-Powder® made via additive manufacturing in addition to its powder were analyzed and tested according to ASTM and ISO standards by The French National Centre for Scientific Research (CNRS). More details about measurements procedures used by Z3DLAB are available upon request. However, some results are detailed in our research papers published in Materials & Design (JMAD) , MATEC Web of Conferences and Data in Brief (DIB) journals. We inform our clients that they are responsible for the qualified verification of the properties and their suitability for specific applications of parts made by their own technology.

[1] Property and ownership of Z3DLAB. All results here represent ZTi-Powder®1% (ZTP10) and ZTi-Powder®2.5% (ZTP25) made via Selective Laser Melting (SLM) technology. Further details are provided upon request.

[2] Subject to minor change within the range of possible chemical composition.
Measurements according to ASTM-B962 and ASTM B923.

[3] Rough value, subject to minor change within the range of possible chemical composition.
Theoretical density measurements via XRD.
Optical density via optical light microscopy.
~99.98% density obtained after HIP post-treatment.

[4] Chemical composition made via inductively coupled plasma (ICP) & Energy Dispersive X-Ray Spectroscopy (EDX).

[5] With respect to powder material; for PBF technology (15-45µm) and DED (50-150µm).

[6] Tensile tests were performed according to ASTM E8; stress relief heat treatment; testing machine Zwick 10KN; testing speed 0.001 s^{-1} at room temperature; The numbers are average values and are determined from samples with horizontal and vertical orientation.

[7] Micro-hardness testing according to ASTM E384.

[8] Roughness measurement according to DIN EN ISO 4288 λc = 2,4 mm.

[9] Compression tests were performed according to ASTM E9; stress relief heat treatment; testing machine Zwick 10KN; testing speed 0.001 s-1 at room temperature; The numbers are average values and are determined from samples with horizontal and vertical orientation.

[10] Compression tests were performed according to ASTM E9; stress relief heat treatment; testing machine Gleeble 3800; testing speed 0.1 to 0.001 s^{-1} at near transus temperature (850°C) (alpha+beta domain); parts were held for 3 minutes at 850 °C before starting hot deformation; experiments performed in high vacuum environment.

[11] Minimum values according to ASTM F3001-14: Standard Specification for Additive Manufacturing Titanium-6 Aluminum-4 Vanadium ELI (Extra Low Interstitial) with Powder Bed Fusion.

[12] After an in-house HIP post-treatment