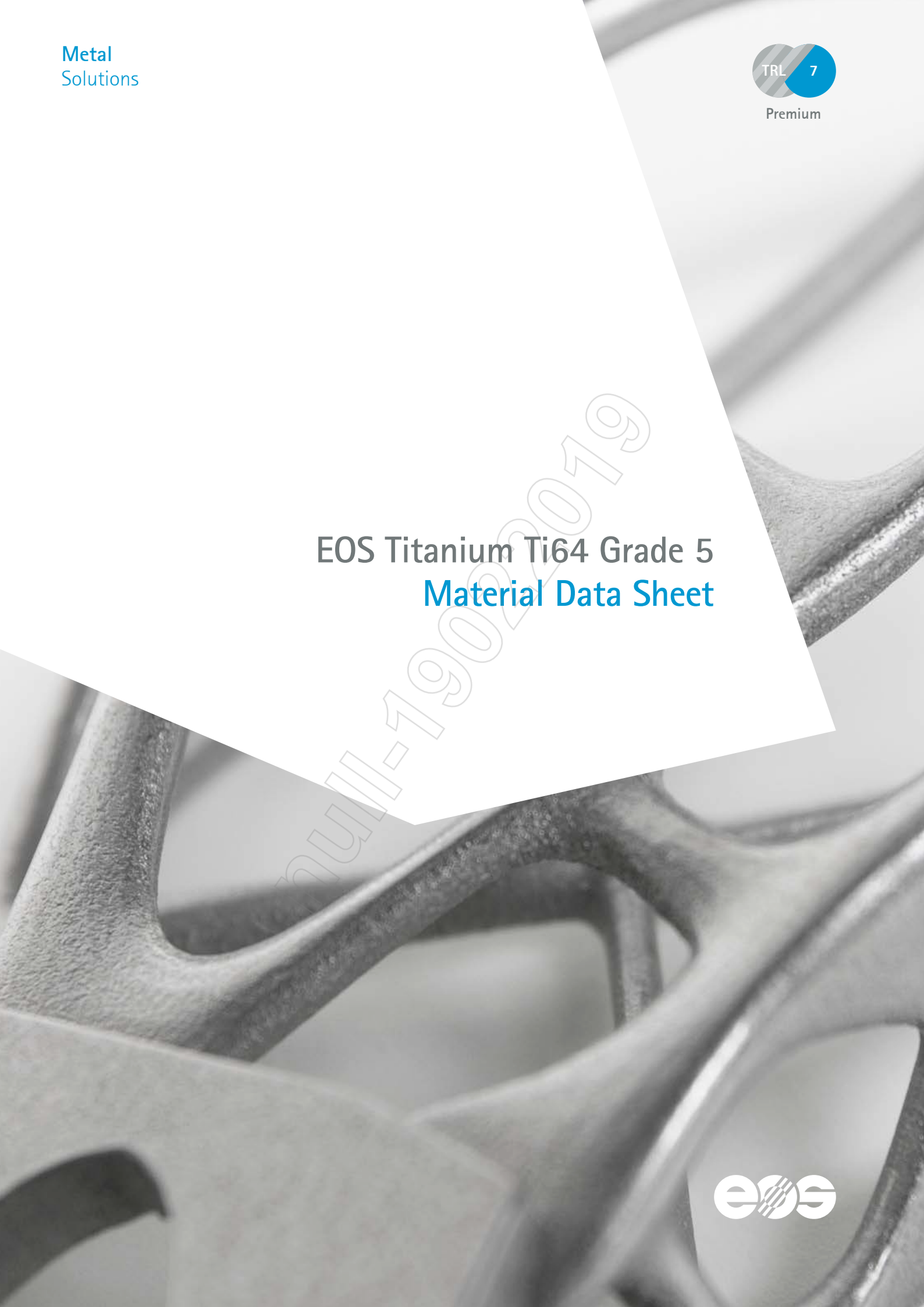
Metal
Solutions

TRL 7
Premium

EOS Titanium Ti64 Grade 5
Material Data Sheet



EOS Titanium Ti64 Grade 5
High Fatigue Strength without HIP

EOS Titanium Ti64 Grade 5 is a Ti6Al4V alloy, which is well-known for having excellent mechanical properties: low density with high strength and excellent corrosion resistance. The alloy has low weight compared to superalloys and steels and higher fatigue resistance compared to other lightweight alloys.

EOS Titanium Ti64 Grade 5 is specially developed to have high fatigue strength without hot isostatic pressing (HIP).

Parts built with EOS Titanium Ti64 Grade 5 powder can be machined, shot-peened and polished in as manufactured and heat treated states. Due to the layerwise building method, the parts have a certain anisotropy. Heat treatment is recommended to reduce internal stresses and increase ductility.

Main Characteristics:

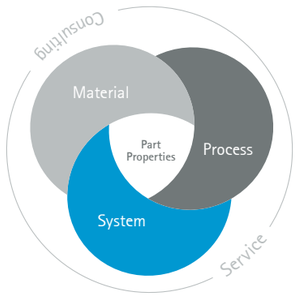
- → Low weight combined with high strength
- → Excellent corrosion resistance
- → High fatigue resistance compared to other lightweight alloys
- → The parts fulfill chemical requirements for Grade 5 alloy

Typical Applications:

- → Aerospace components
- → Automotive components
- → Other industrial applications where low weight in combination with high strength are required

The EOS Quality Triangle

EOS uses an approach that is unique in the AM industry, taking each of the three central technical elements of the production process into account: the system, the material and the process – together simply described as the Quality Triangle. EOS focuses on delivering reproducible part properties for the customer.



All of the data stated in this material data sheet is produced according to EOS Quality Management System and international standards.

Powder Properties

EOS Titanium Ti64 Grade 5 powder is classified as Grade 5 titanium alloy according to ASTM B348. The chemical composition is in compliance with standards ISO5832-3, ASTM F1472, ASTM F2924, and ASTM F3302.

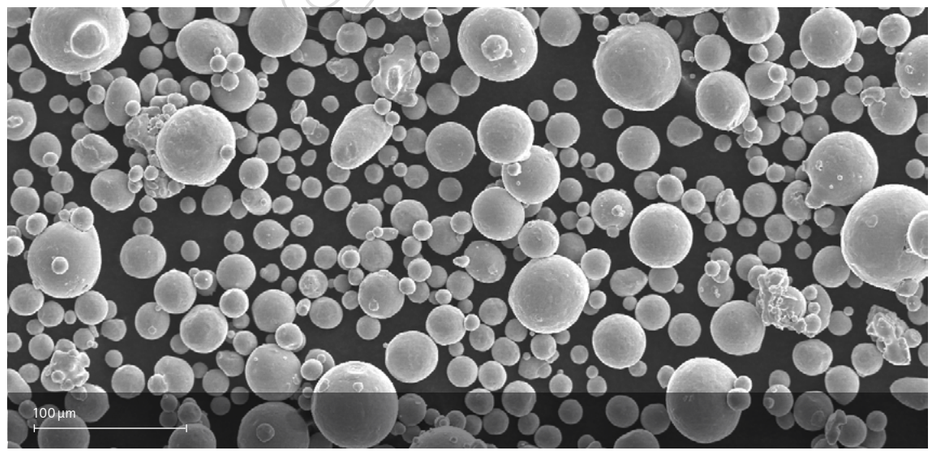
Powder chemical composition (wt.-%)

Element	Min.	Max.
Ti	Balance	
Al	5.50	6.75
V	3.50	4.50
O	-	0.20
N	-	0.05
C	-	0.08
H	-	0.015
Fe	-	0.30
Y	-	0.005
Other elements, each	-	0.10
Other elements, total	-	0.40

Powder particle size

Generic particle size distribution	20 – 80 µm

SEM picture of EOS Titanium Ti64 Grade 5 powder.



Process Information

System set-up	EOS M 290
EOS ParameterSet	M 290 Ti64 Grade 5 040 V1
EOSPAR name	Ti64Grade5_040_HiPerM291_100
Software requirements	EOSPRINT 2.5 or newer EOSYSTEM 2.8 or newer
Powder part no.	9011-0045
Recoater blade	EOS HSS blade
Nozzle	EOS grid nozzle
Inert gas	Argon
Sieve	90 µm

Additional information	
Layer thickness	40 µm
Min. wall thickness	Approx. 0.4 mm
Volume rate	6.2 mm^3/s

Heat Treatment

As manufactured microstructure for additively manufactured Ti64 consists of fully acicular alpha prime (α´) phase. Standard heat treatments for titanium do not necessarily produce desired microstructures due to this different starting microstructure.

Heat treatment is recommended to relieve stresses and to increase ductility. Use of vacuum furnace is highly recommended to avoid the formation of alpha case on the surface of the parts.

Heat Treatment Description:
120 min (± 30 min) at 800 °C (± 10 °C) measured from the part in vacuum (1.3×10^{-3}-1.3×10^{-5} mbar) followed by cooling under vacuum or argon quenching. Material mechanical properties are relatively insensitive to changes in heating and cooling rates, but longer treatment times may result in decreased strength and increased elongation.

Parts heat treated according to the recommended heat treatment have a microstructure consisting of fine alpha + beta (α + β) phase.

Chemical and Physical Properties of Parts

The chemical composition of parts is in compliance with standards ISO5832-3, ASTM F1472, ASTM F2924, and ASTM F3302. Composition complies with EOS Titanium Ti64 Grade 5 powder.

Heat treated microstructure. Etched according to ASTM E407 modified recipe #190.

Defects	Result	Number of samples
Average defect percentage	0.01 %	30

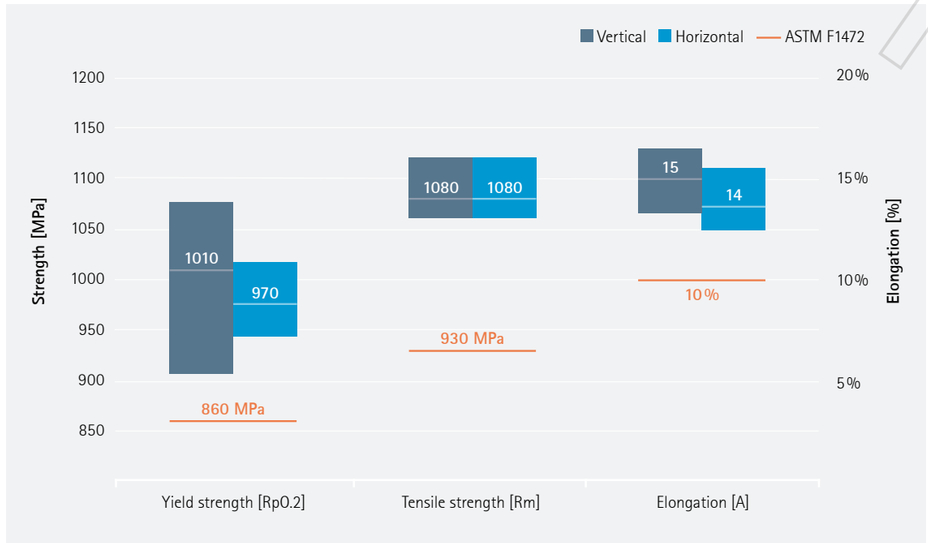
Density, ISO3369	Result	Number of samples
Average density	≥ 4.4 g/cm^3	10

The areal defect percentage was determined from cross-cuts of the built parts using optical microscope fitted with a camera and analysis software. The analysis was carried out for a sample area of 15 x 15 mm. The defects were detected and analyzed with an image capture/analysis software with an automatic histogram based filtering procedure on monochrome images. The density of the built specimen was measured according to ISO3369.

Mechanical Properties in Heat Treated State

Mechanical properties ISO6892-1

	Yield strength Rp0.2 [MPa]	**Tensile strength** Rm [MPa]	**Elongation at break** A [%]	**Reduction of area** Z [%]	**Number of samples**
Vertical	1010	1080	15	≥ 25	84
Horizontal	970	1080	14	≥ 25	72



Additional Data

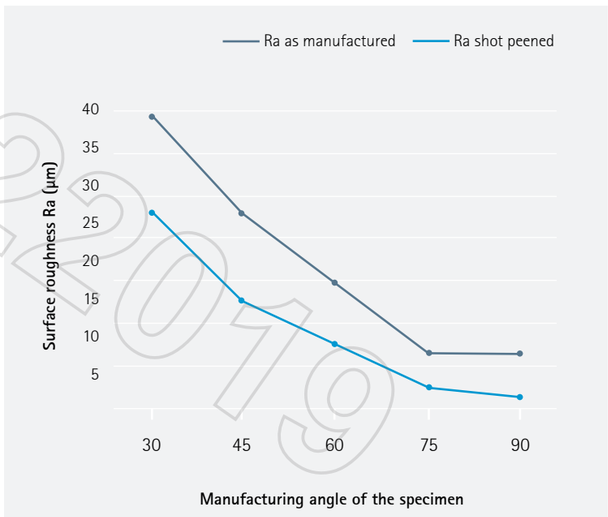
Fatigue Strength

Fatigue strength determines a stress level where specimen fails at a defined number of stress cycles [ISO 12107]. Fatigue strength was estimated statistically according to ISO 12107. Testing was done according to ASTM E466. Fatigue results typically show large deviations due to the nature of the fatigue process [ISO 12107].

Fatigue strength at 1 x 10^7 cycles in heat treated state

Fatigue strength, MPa	595 MPa

Surface Roughness



The surface quality was characterized by optical measurement method from down-facing surfaces according to internal procedure. The 90 degree angle corresponds to vertical surface.

Coefficient of Thermal Expansion ASTM E228

Temperature	25 – 100 °C	25 – 200 °C	25 – 300 °C
CTE	9.0 *10^{-6}/K	9.4 *10^{-6}/K	19.7 *10^{-6}/K

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Cover: This image shows a possible application.