# Meltio Titanium 64

Ti-6Al-4V / ER Ti-5 / S Ti 6402c / 3.7165

Ti64 is a popular and widely used alloy due to its excellent combination of strength, low density, and corrosion resistance. It is used in a variety of industries, including aerospace, and chemical processing, due to its properties. Its high strength-to-weight ratio makes it a preferred choice for lightweight applications.

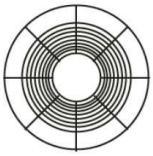
| | |
|---|---|
| **Properties** | High Strength, Low Weight and Corrosion Resistance |
| **Applications** | Aerospace, Marine, Chemical industries and Automotive |

| **Wire Chemical Composition** | Ti | Al | V | Fe | C | N | H | O |
|---|---|---|---|---|---|---|---|---|
| **Weight Percent [%]** | Bal. | 5.5 | 3.5 | 0.4 | 0.08 | 0.05 | 0.015 | 0.2 |

| **Wire Density** |
|---|
| 4.4 g/cm³ |

| **Melting Point** | | |
|---|---|---|
| 1947 K | 1674 ºC | 3045 °F |

## Spool Specs



Meltio Materials are tightly spooled and packaged to ensure the best compatibility with Meltio systems.

| | |
|---|---|
| **Wire Diameter** | 1.0 mm |
| **Weight on Spool** | 7.5 kg |
| **Volume on Spool** | 1704 cm³ |
| **Spool Type** | BS300 |
| **Wire Coating** | Uncoated |

## Heat Treatment

Heat treatment is recommended for Ti64 to enhance its mechanical properties. Through heat treatment, the alloy becomes stronger, more ductile, and more resistant to fatigue, making it suitable for high-stress applications. Heat treatment also eliminates residual stresses and helps to refine the microstructure of the alloy, leading to improved toughness and increased resistance to crack growth. Heat treatment of Ti64 after 3D printing is a crucial step in maximizing its performance in applications.

## Age Hardening

| | |
|---|---|
| Vacuum atmosphere<br>Heat up to 920ºC<br>Hold at 920ºC during 2h | Cool to 400ºC during 10h<br>Cold down to RT |

## Age Hardening

| | |
|---|---|
| Vacuum atmosphere<br>Heat up to 920ºC<br>103 MPa of pressure | Hold for 2h<br>Cold down to RT |

**Typical Parameters for a Sample of 160x60x30 mm*

## Deposition Parameters

The following 3D printing parameters were found to provide fully dense samples. Please use the provided “Density Profiles” and refer to the document “Printing Parameters and their effect on part density” for additional information.

| **Laser Power [W]** | **Velocity [mm/s]** | **Argon Flow [l/min]** | **Layer Height [mm]** | **Wire Speed [mm/s]** | **Energy Density [J/mm3]** |
|---|---|---|---|---|---|
| 1100 | 7.5 | 20 | 1.0 | 9.6 | 147 |

Meltio Material Datasheet

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## Micrography

The observed microstructure is composed of acicular martensite embedded in the beta phase. The columnar shape of the grains extends along the manufacturing direction due to epitaxial growth of the original beta phase. In the XY section, the microstructure appears as polyhedral grains of α´ + β, with alpha phases at grain boundaries.

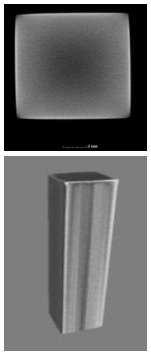
As-printed XY
100x Magnification

As-printed XY
1000x Magnification

As-printed XZ
1000x Magnification

## Tomography

Computed Tomography Scan of 3D printed sample part in Ti64 without detectable voids or defects. Resolution of 24 µm per pixel.



3D / Top View

Left View

Front View

| | |
|---|---|
| Relative density as 3D printed | 99.994% |

## Mechanical Properties

Results show that specimens printed using Meltio's wire-laser metal 3D printed process perform at the same level as samples made with conventional manufacturing methods. Results show low deviations and near isotropic properties after heat treatment. As printed data is not shown as it is not industrially relevant.

| | | | *UNE EN ISO 6892-1* | |
|---|---|---|---|---|
| | **Cast Properties (ASTM F1108)** | **Wrought Properties (ASTM F1472)** | **Meltio XY properties (Age Hardened)** | **Meltio XZ properties (Age Hardened)** |
| **Ultimate Tensile strength (UTS) [MPa]** | 860 | 930 | 802 ± 7 | 788 ± 12 |
| **Yield strength [MPa]** | 758 | 860 | 727 ± 17 | 693 ± 16 |
| **Elongation [%]** | 8 | 10 | 7 ± 1 | 9 ± 1 |
| | | | **Test Carried Out In IDONIAL* info@idonial.com | |

| | | | *UNE EN ISO 6507-1* | |
|---|---|---|---|---|
| | **Cast Properties (ASTM F1108)** | **Wrought Properties (ASTM F1472)** | **Meltio (Age Hardened)** | **Meltio Properties (As printed)** |
| **Hardness [HV-30]** | 342 | 349 | 311 | 303 |
| | | | **Test Carried Out In the University of Jaen (UJA)* info@strainanalysisuja.es | |

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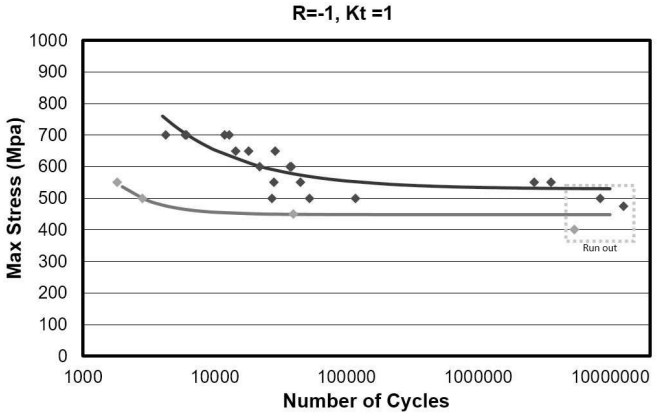
## Fatigue

Meltio carried out a fatigue study on 3D printed specimens using two heat treatments, namely age hardening and hot isostatic pressing. The presence of residual porosity in the sample parts during the study, which has been resolved through process improvements, may explain the difference in fatigue behavior between the age-hardened and hot isostatic pressed specimens.



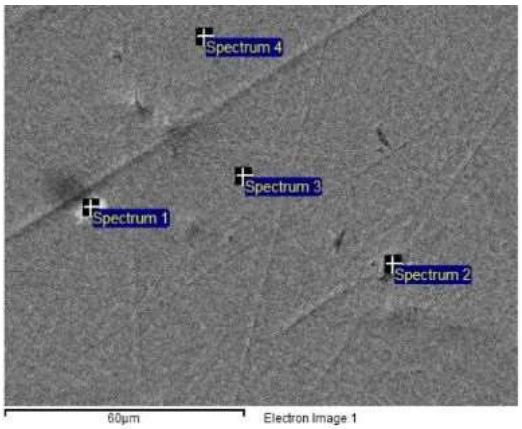

## Fatigue Strength

| | | | UNE-EN ISO 1143 | |
|---|---|---|---|---|
| | **Cast Properties (ASTM E466)** | **Wrought Properties (ASTM E466)** | **Meltio XZ properties (Age Hardened)** | **Meltio XZ properties (Hot Isostatic Pressing)** |
| **Fatigue Strength 10^7 Cycles [MPa]** | 310 | 560 | 450 | 530 |

## Oxidation

Oxidation is a crucial factor that particularly affects the properties and performance of 3D printed titanium samples. Titanium has a high affinity for oxygen when exposed to air at high temperatures, which leads to embrittlement and reduced mechanical properties, such as decreased resistance to wear, fatigue, and corrosion.

Manufacturing parts in the Meltio M450 with only local gas shielding from the laser head resulted in components with 0.25 % in oxygen content. The SEM image showed dispersed oxides, including rutile and alumina and EDX spectra revealed the presence of titanium and aluminum oxides.




| Spectrum | In stats. | O | Al | Ti | V | Total |
|---|---|---|---|---|---|---|
| Spectrum 1 | Yes | 62.00 | 6.74 | 31.26 | | 100.00 |
| Spectrum 2 | Yes | 52.16 | 35.61 | 12.23 | | 100.00 |
| Spectrum 3 | Yes | 53.14 | 24.32 | 22.54 | | 100.00 |
| Spectrum 4 | Yes | | 7.14 | 89.69 | 3.17 | 100.00 |

*SEM Image in XY plane at 1000x magnification*

** Meltio's work on material characterization is carried out using the Meltio M450 and it remains under constant development. Specifications provided herein may not reflect the latest state of our research. For further information and questions please contact us via info@meltio3d.com.*

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