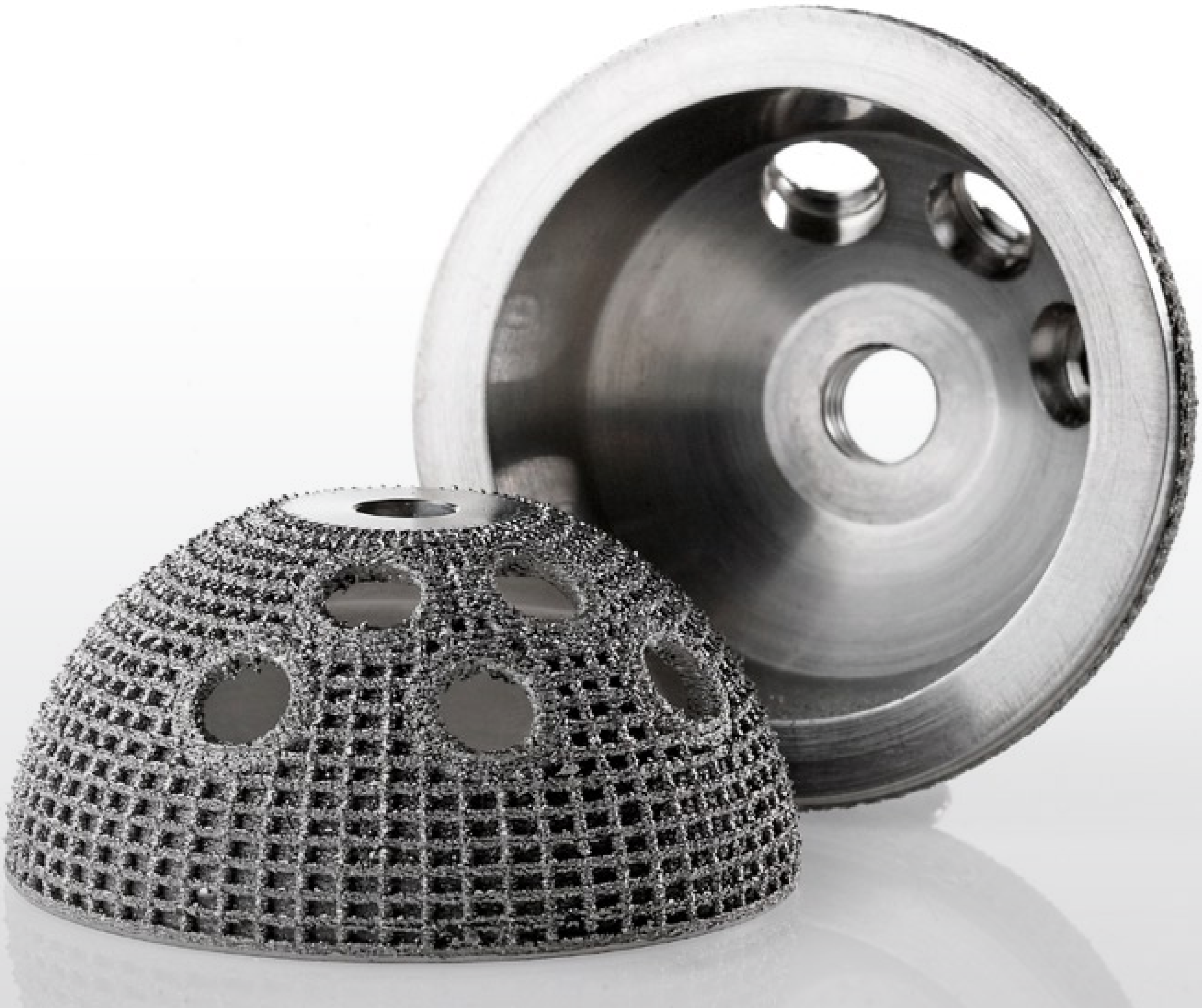
Arcam EBM system

Ti6Al4V ELI Titanium Alloy



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Ti6Al4V ELI Titanium Alloy

General characteristics

The high strength, low weight ratio and outstanding corrosion resistance inherent to titanium and its alloys has led to a wide and diversified range of successful applications which demand high levels of reliable performance in surgery and medicine as well as in aerospace, automotive, chemical plant, power generation, oil and gas extraction, sports, and other major industries.

In the majority of these and other engineering applications, titanium replaces heavier, less serviceable or less cost-effective materials. Designs made using the properties provided by titanium often result in reliable, economic and more durable systems and components. These titanium components often substantially exceed performance and service life expectations at a lower overall cost.

Titanium is available in several different grades. Pure titanium is not as strong as the different titanium alloys are. Ti6Al4V is the most widely used titanium alloy. It features good machinability and excellent mechanical properties. The alloy offers the best all-round performance for a variety of weight reduction applications in aerospace, automotive and marine equipment.

Ti6Al4V also has numerous applications in the medical industry. The biocompatibility of Ti6Al4V is excellent, especially when direct contact with tissue or bone is required.

Special characteristics

Ti6Al4V ELI (Grade 23) is very similar to Ti6Al4V (Grade 5), except that Ti6Al4V ELI contains reduced levels of oxygen, nitrogen, carbon and iron. ELI is short for “Extra Low Interstitials”, and these lower interstitials provide improved ductility and better fracture toughness for the Ti6Al4V ELI material.

Applications

Ti6Al4V ELI is typically used for:

- Biomedical implants
- Aerospace components
- Cryogenic applications
- Offshore equipment

The alloy’s high resistance to stress corrosion cracking (SCC) in sea water makes Ti6Al4V ELI an obvious choice in applications that require both high strength and corrosion resistance.

Scull with lattice custom implant.

Powder specification

The Arcam Titanium Ti6Al4V ELI (Grade 23) is a gas-atomized powder with a particle size between 45 and 100 microns. This limit on the minimum particle size ensures safe handling of the powder.

Please refer to the Arcam MSDS (Material Safety Data Sheet) for more information about the handling and safety of the Arcam Ti6Al4V ELI alloy.

POST PROCESSING

Heat treatment

Hot Isostatic Pressing (HIP) is recommended for fatigue-loaded components. The following HIP parameters are recommended:

- 920° C
- 1000 bar
- 120 minutes

Machining

Ti6Al4V ELI parts manufactured in the EBM process feature good machinability and can be machined without additional operations.

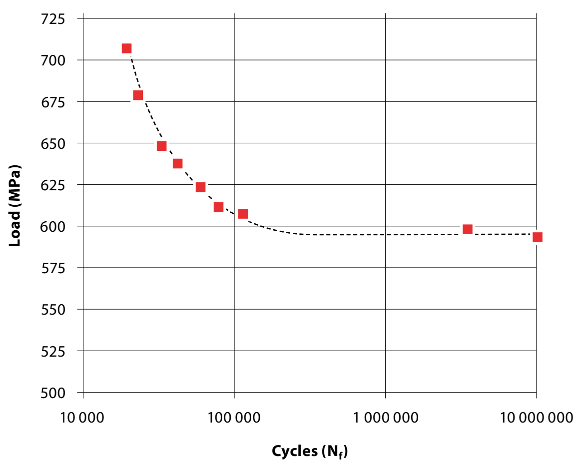
The following factors contribute to efficient machining of Ti6Al4V ELI parts:

- Low cutting speeds
- High feed rate
- Generous quantities of cutting fluid
- Sharp tools
- Rigid setup

Welding

Ti6Al4V ELI may be welded by a wide variety of conventional fusion and solid-state processes, although its chemical reactivity typically requires special measures and procedures.

Arcam Ti6Al4V ELI Rotating Beam Fatigue Test



Titanium powder.

CHEMICAL SPECIFICATION

	Arcam Ti6Al4V ELI *	Ti6Al4V ELI Required**
Aluminium, Al	6,0%	5,5–6,5%
Vanadium, V	4,0%	3,5–4,5%
Carbon, C	0,03%	< 0,08%
Iron, Fe	0,1%	< 0,25%
Oxygen, O	0,10%	< 0,13%
Nitrogen, N	0,01%	< 0,05%
Hydrogen, H	< 0,003%	< 0,012%
Titanium, Ti	Balance	Balance

* Typical ** ASTM F136

MECHANICAL PROPERTIES

	Arcam Ti6Al4V ELI*	Ti6Al4V ELI Required**
Yield Strength (Rp 0,2)	930 MPa	795 MPa
Ultimate Tensile Strength (Rm)	970 MPa	860 MPa
Rockwell Hardness	32 HRC	30–35 HRC
Elongation	16%	>10%
Reduction of Area	50%	>25%
Fatigue strength @ 600 MPa	>10,000,000 cycles	>1,000,000 cycles
Modulus of Elasticity	120 GPa	114 GPa

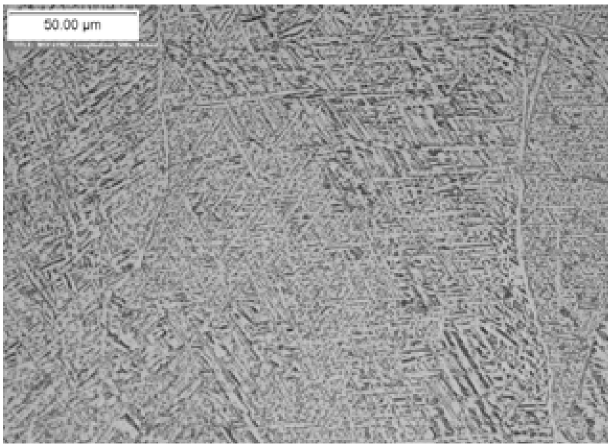
* Typical ** ASTM F136

The mechanical properties of materials produced in the EBM process are comparable to wrought annealed materials and are better than cast materials.

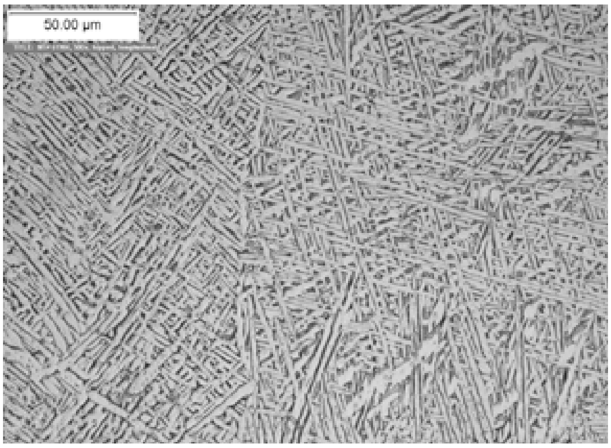
Microstructure

Ti6Al4V ELI parts manufactured in the EBM process have a microstructure better than cast Ti6Al4V ELI containing a lamellar α-phase with larger β-grains, and with a higher density and significantly finer grain, thanks to the rapid cooling of the melt pool.

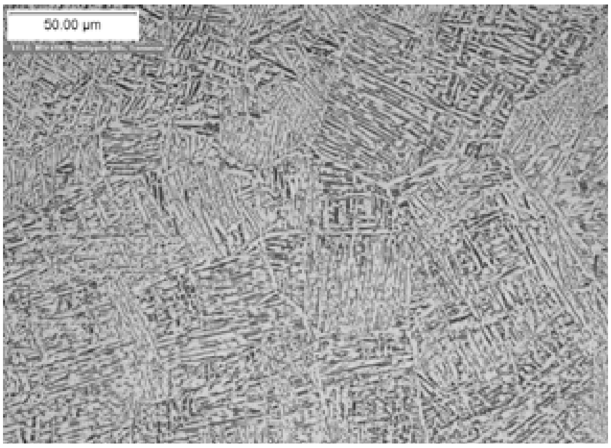
The build chamber is kept at an elevated temperature throughout the entire build process, and the material therefore comes out of the EBM process in a naturally aged condition.



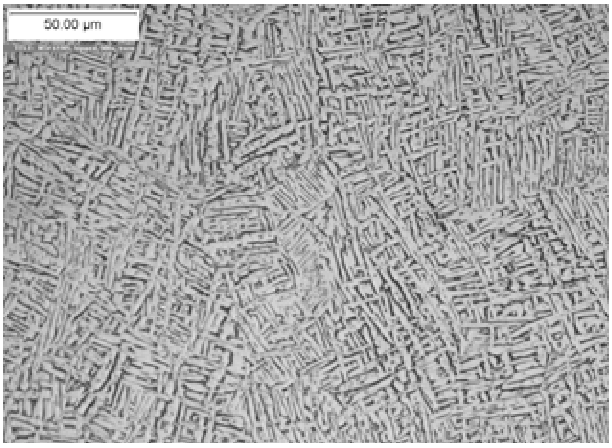
Micrograph of Arcam Ti6Al4V ELI material, 500x.
Longitudinal



Micrograph of Arcam Ti6Al4V ELI material, 500x.
Hipped, longitudinal



Micrograph of Arcam Ti6Al4V ELI material, 500x.
Transverse



Micrograph of Arcam Ti6Al4V ELI material, 500x.
Hipped, transverse

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