Arcam EBM system

Ti6Al4V Titanium Alloy

CAD TO METAL

Arcam AB®

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Ti6Al4V 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 has replaced heavier, less serviceable or less cost-effective materials. Designing with titanium taking all factors into account has resulted in reliable, economic and more durable systems and components, which in many situations have substantially exceeded performance and service life expectations.

Titanium is available in several different grades. Pure titanium is not as strong as the different titanium alloys are.

Special characteristics

Ti6Al4V is the most widely used titanium alloy. It features good machinability and excellent mechanical properties. The Ti6Al4V 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. Biocompatibility of Ti6Al4V is excellent, especially when direct contact with tissue or bone is required.

Applications

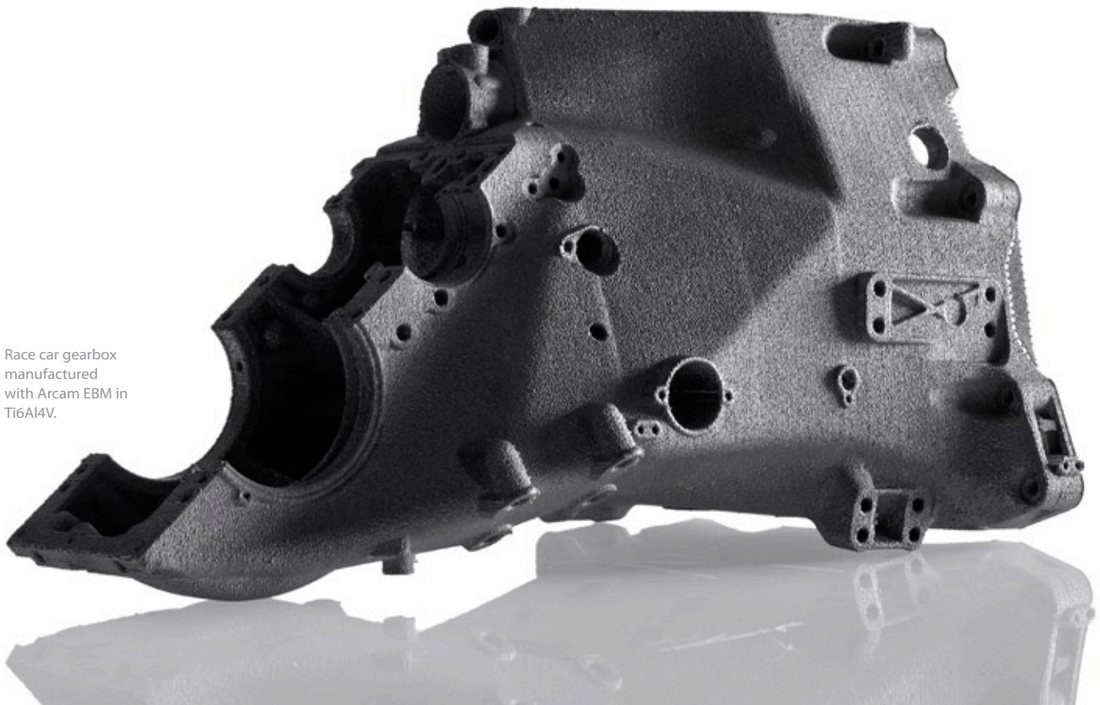
Ti6Al4V is typically used for:

- Direct Manufacturing of parts and prototypes for racing and aerospace industry
- Biomechanical applications, such as implants and prosthesis
- Marine applications
- Chemical industry
- Gas turbines

Powder specification

The Arcam Titanium Ti6Al4V (Grade 5) powder has 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 alloy.



Race car gearbox manufactured with Arcam EBM in Ti6Al4V.

CHEMICAL SPECIFICATION

	Arcam Ti6Al4V, Typical	Ti6Al4V, Required*	Ti6Al4V, Required**
Aluminium, Al	6%	5,5–6,75%	5,5–6,75%
Vanadium, V	4%	3,5–4,5%	3,5–4,5%
Carbon, C	0,03%	< 0,1%	< 0,08%
Iron, Fe	0,1%	< 0,3%	< 0,3%
Oxygen, O	0,15%	< 0,2%	< 0,2%
Nitrogen, N	0,01%	< 0,05%	< 0,05%
Hydrogen, H	0,003%	< 0,015%	< 0,015%
Titanium, Ti	Balance	Balance	Balance

*ASTM F1108 (cast material) **ASTM F1472 (wrought material)

MECHANICAL PROPERTIES

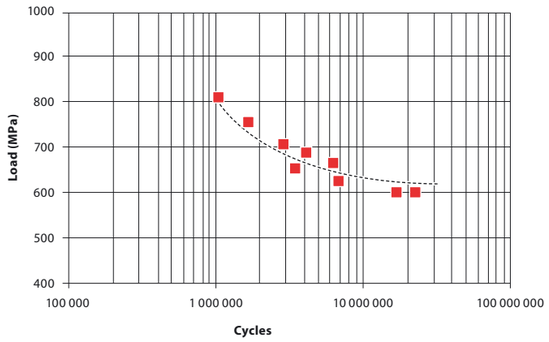
	Arcam Ti6Al4V, Typical	Ti6Al4V, Required**	Ti6Al4V, Required***
Yield Strength (Rp 0,2)	950 MPa	758 MPa	860 MPa
Ultimate Tensile Strength (Rm)	1020 MPa	860 MPa	930 MPa
Elongation	14%	>8%	>10%
Reduction of Area	40%	>14%	>25%
Fatigue strength* @ 600 MPa	>10,000,000 cycles		
Rockwell Hardness	33 HRC		
Modulus of Elasticity	120 GPa		

*After Hot Isostatic Pressing **ASTM F1108 (cast material) ***ASTM F1472 (wrought material)

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

Arcam Ti6Al4V High Cycle Fatigue Test

HCF S/N diagram in MPa units



POST PROCESSING

Heat treatment

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

- 920° C
- 100 MPa
- 120 minutes

Machining

Ti6Al4V parts manufactured in the EBM process feature good machinability and can be machined as stock parts.

The following factors contribute to efficient machining of Ti6Al4V parts:

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

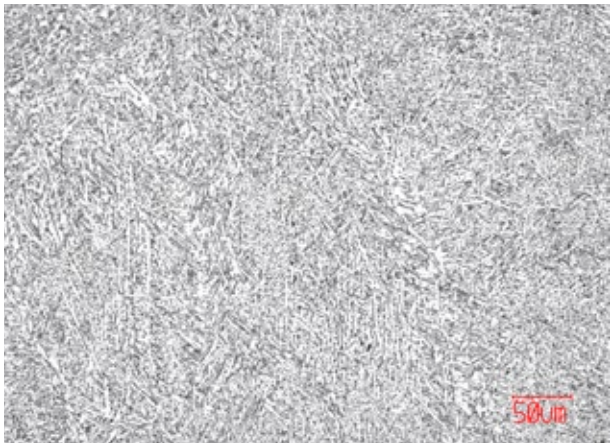
Welding

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

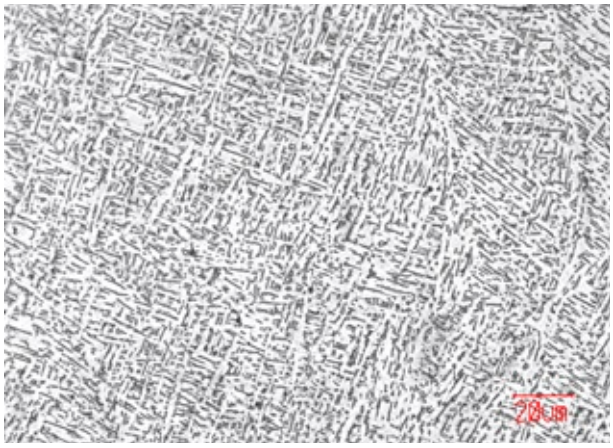
Microstructure

Ti6Al4V parts manufactured in the EBM process have a microstructure better than cast Ti6Al4V 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.

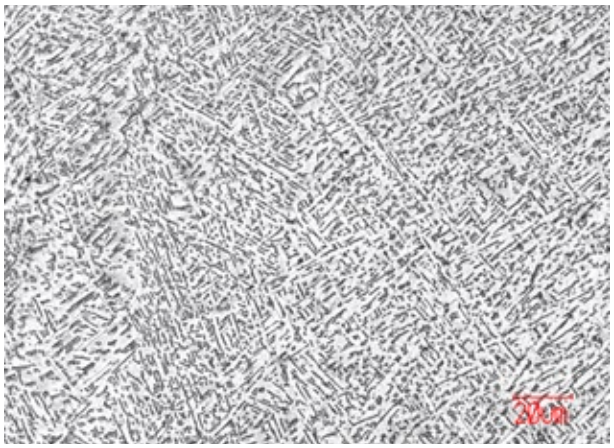
The build chamber is kept at an elevated temperature throughout the entire build, and the material thus comes out of the EBM process in a naturally aged condition.



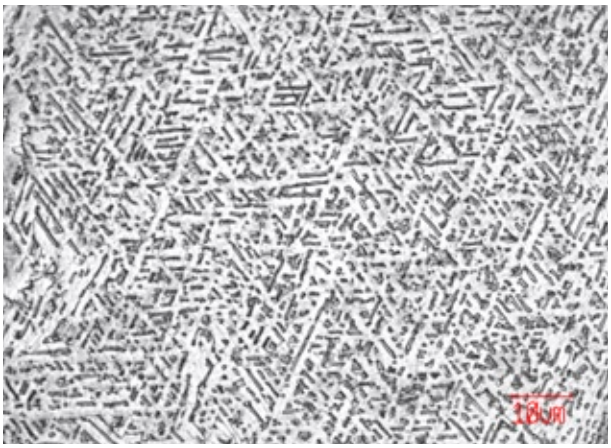
Micrograph of Arcam Ti6Al4V material, 200x.



Micrograph of Arcam Ti6Al4V material, 500x.



Micrograph of Arcam Ti6Al4V material, 500x.



Micrograph of Arcam Ti6Al4V material, 1000x.

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