

Grade 2 Titanium



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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 different grades, unalloyed or alloyed.

Special characteristics

Unalloyed Commercially Pure (CP) Titanium is available in four different grades, 1, 2, 3 and 4, which are used based on the corrosion resistance, ductility and strength requirements of the specific application. Grade 1 has the highest formability, while Grade 4 has the highest strength and moderate formability.

CP Titanium users utilize its excellent corrosion resistance, formability and weldable characteristics in many critical applications.

Titanium Grade 2 is stronger than Grade 1 and equally corrosion-resistant against most applications.

Titanium Grade 2 has numerous applications in the medical industry. Biocompatibility of Titanium Grade 2 is excellent, especially when direct contact with tissue or bone is required.

Applications

Titanium Grade 2 is typically used for:

- Orthopaedic applications, such as implants and prosthesis
- Airframe and aircraft engine parts
- Marine chemical parts
- Condenser tubing
- Heat exchangers

Powder specification

The Arcam Titanium Grade 2 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 Titanium Grade 2.

CHEMICAL SPECIFICATION

| | Arcam Titanium Grade 2, Typical | Titanium Grade 2, Required * |
|--------------|---------------------------------|------------------------------|
| Carbon, C | 0,005% | <0,08% |
| Iron, Fe | 0,05% | <0,3% |
| Oxygen, O | 0,19% | <0,25% |
| Nitrogen, N | 0,004% | <0,03% |
| Hydrogen, H | 0,0009% | <0,015% |
| Titanium, Ti | Balance | Balance |

*ASTM F67 (Unalloyed Titanium for Surgical Implant Applications)

MECHANICAL PROPERTIES

| | Arcam Titanium Grade 2, Typical | Titanium Grade 2, Required * |
|--------------------------------|---------------------------------|------------------------------|
| Yield Strength (Rp 0,2) | 540 MPa | 275 MPa |
| Ultimate Tensile Strength (Rm) | 570 MPa | 345 MPa |
| Elongation | 21% | >20% |
| Reduction of Area | 55% | >30% |

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

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

Titanium Grade 2 parts manufactured in the EBM process feature good machinability and can be machined as stock parts. The following factors contribute to efficient machining of Titanium Grade 2 parts:

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

Welding

Titanium Grade 2 may be welded by a wide variety of conventional fusion and solid-state processes, although its chemical reactivity typically requires special measures and procedures.

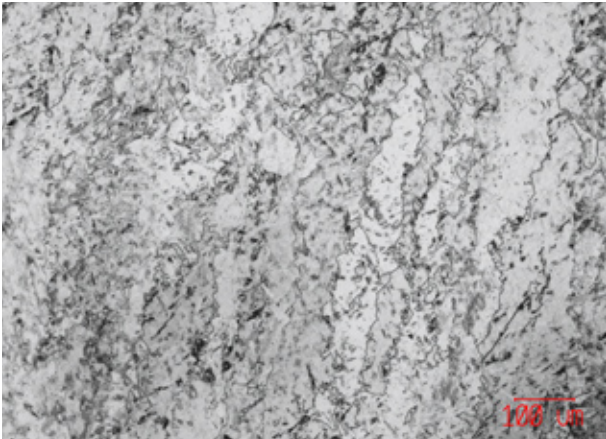
Lattice skull implant manufactured with Arcam EBM.



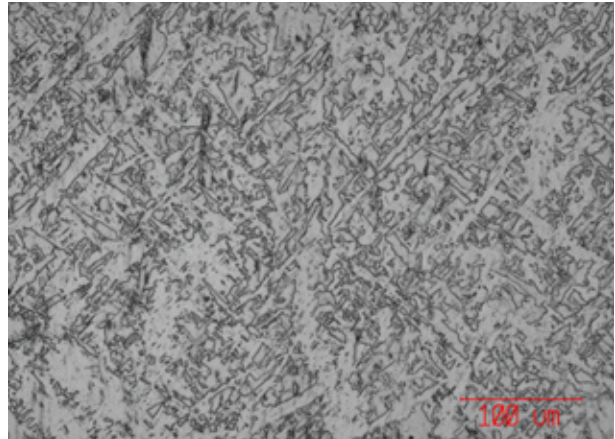
Microstructure

Titanium Grade 2 parts manufactured in the EBM process have a microstructure consisting of fine α -grains, 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 Titanium Grade 2 material, 100x.



Micrograph of Arcam Titanium Grade 2 material, 200x.



Arcam AB | Krokslättis Fabriker 27A, SE 431 37 Mölndal, Sweden | Phone: +46 31 710 32 00 | Fax: +46 31 710 32 01 | info@arcam.com | www.arcam.com

Arcam provides **Free Form Fabrication** machines for **Direct Manufacturing** of metal parts. The technology offers ultimate geometric freedom combined with first class material properties. Arcam is guided by our vision to revolutionize the art of manufacturing. Use Arcam to manufacture your future.