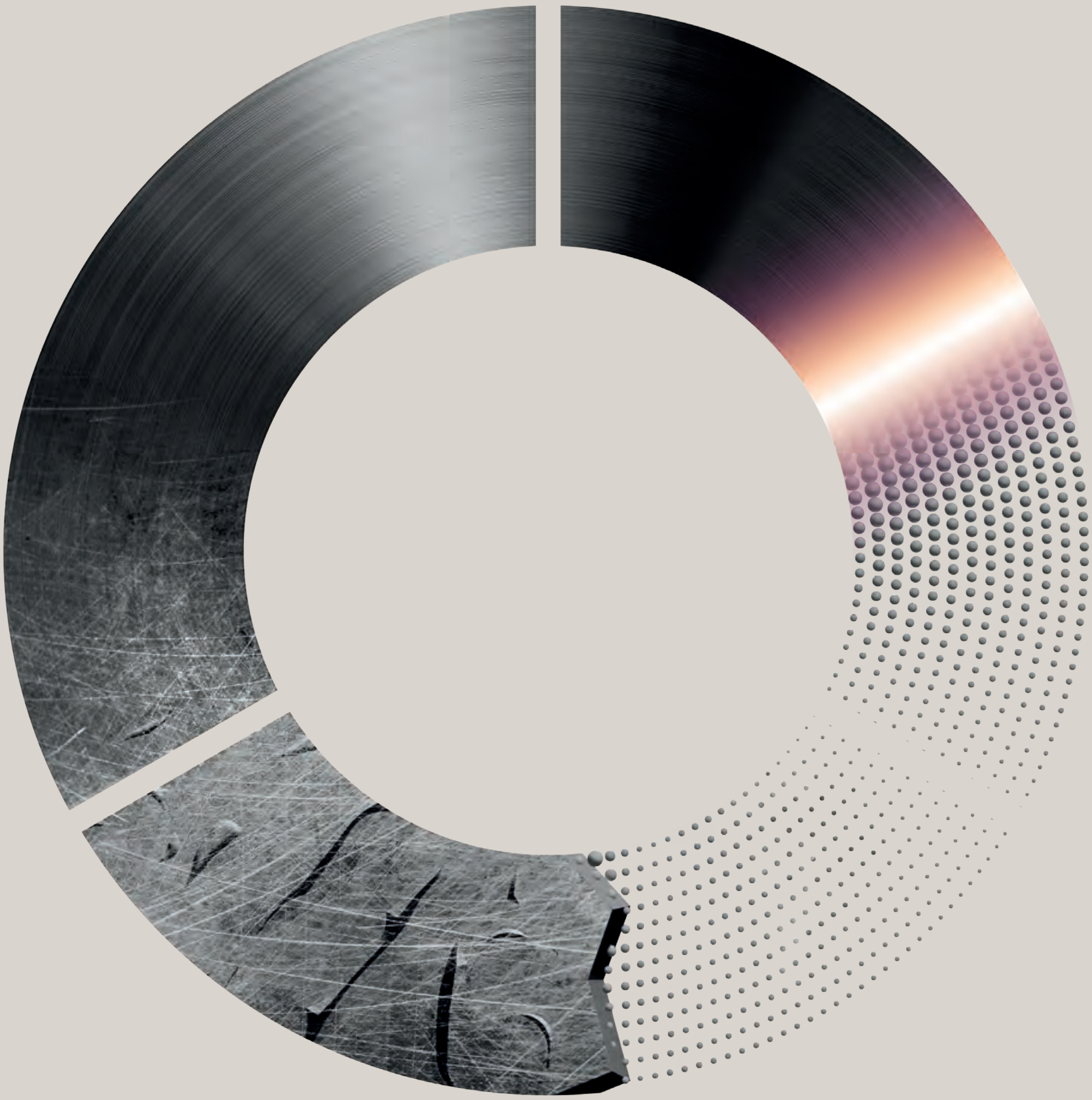
AMAZEMET®

FREEDOM IN METAL AM DEVELOPMENT & PRODUCTION



VALUES WE PROVIDE

It all started with science

A Ph.D. student needed 200 g of bulk metallic glass powder for his research on alloy design for laser powder bed fusion, but gas atomization services exceeded the project budget by two times. The solution was already out there, but it had been forgotten for 40 years – ultrasonic atomization. Upon rediscovering this technique, it was decided to build a new device and produce the powders in-house.

This is the story of AMAZEMET founder and inventor, Łukasz Żrodowski, and the origin of the company's core mission: to broaden scientific possibilities in materials science and metal 3D printing by spreading knowledge and delivering novel tools for researchers worldwide.

This mission has grown over time, focusing on values such as sustainability, providing a closed-loop production chain for metal 3D printing, and the development of industrial metal additive manufacturing (AM). Being both a production company and a Warsaw University of Technology spin-off, AMAZEMET combines the understanding of relevant fundamental science and academic environments with industrial processes and needs.

Possibility of scientific cooperation

One of the most important challenges facing the development of science and industry is the formation of partnerships that foster interdisciplinary and international cooperation – for example, research project collaborations between companies and universities. Over the past few years, AMAZEMET has participated in more than 30 consortia involving projects such as EIC Pathfinder, M-ERA.NET, CETP, RFCS, Horizon 2020, and ESA-funded projects. Currently AMAZEMET has been granted 6 international projects.

The greatest value for partners who collaborate with AMAZEMET is the scientific support of the Warsaw University of Technology. The specialists involved in these projects have extensive experience in materials engineering, and they understand the need for research and development. Applying these skills while using innovative technologies, such as ultrasonic atomization, makes AMAZEMET a unique contributor to the consortium.

Involving AMAZEMET in project collaboration comes with many benefits, including access to:

- Laboratories fully equipped to perform atomization of nearly all alloying system,
- A 3D printing machine with integrated laser powder bed fusion (LPBF) technology dedicated to optimizing new materials,
- A highly-skilled interdisciplinary team eager to solve complex engineering problems,
- The possibility to atomize metallic powders with tailored chemical compositions,
- Expertise in fields related to materials science, ultrasonics, and vacuum technologies, and access to additional resources at the Warsaw University of Technology.

Projects in which we participate

Research Fund for Coal & Steel | M-ERA.NET | cet Partnership – Enhanced Zero Emission Power Technologies

HORIZON 2020

| rePOWDER |

Ultrasonic powder atomizer and alloy prototyping platform

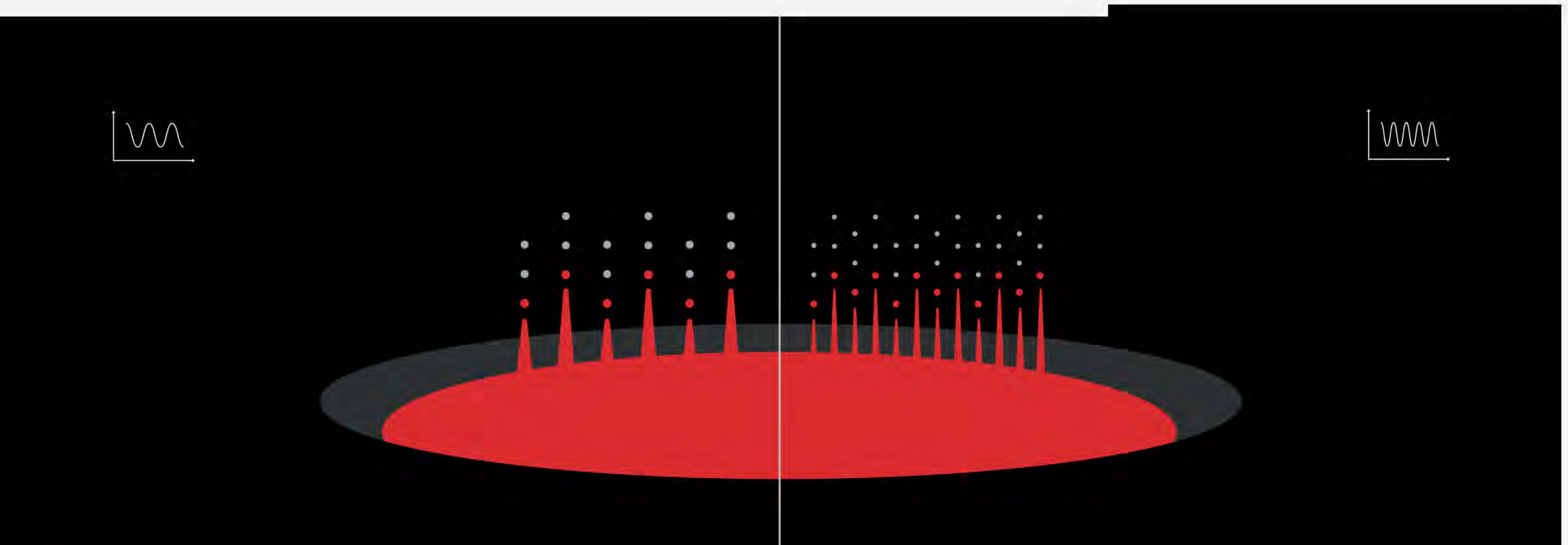
Ultrasonic atomization is a liquid-to-solid type of process, where ultrasonic vibrations are used to create powders. The main principles of this technology are based on amplitude and surface wettability. When the threshold vibrational amplitude in the liquid layer wetted to the sonotrode is exceeded, standing capillary waves are generated (Lierke et al., 1967). Further increasing the amplitude disrupts the internal forces of the liquid, thereby ejecting small droplets from the melt.

The size of the produced particles depends primarily on the ultrasonic frequency, although it is also influenced by the physical properties of the liquid material like desity.

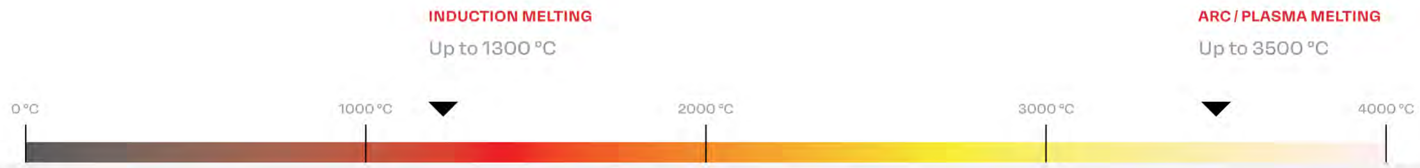
The PSD can be modulated by using different frequencies:

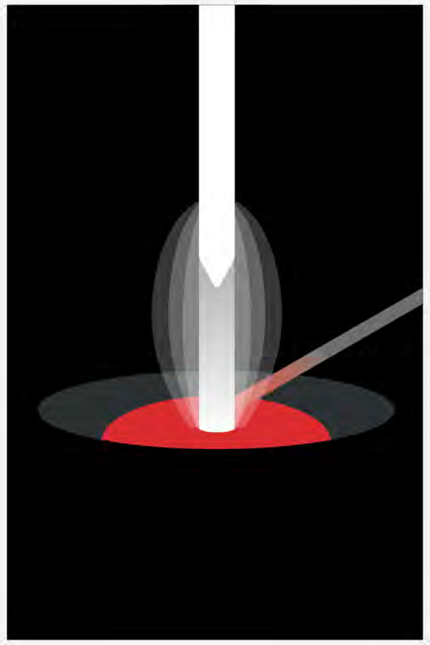
- 20 kHz is most suitable for electron beam melting (EBM) and direct energy deposition (DED), leading to a d50 between 80–100 µm, depending on the atomized material,
- 40 kHz is most suitable for LPBF and sintering technologies, leading to a d50 between 45–60 µm,
- 60 kHz is most suitable for LPBF, binder jetting (BJ), thermal spraying and sintering technologies leading to a d50 between 30–45 µm.

The resulting narrow particle size distribution (PSD) allows up to 80% of the manufactured powder to be used for dedicated technology.



2 types of heat source





Arc / Plasma Melting

Heating can be carried under an inert or reactive gas atmosphere using an electric arc (TIG generator) or focused plasma. Material is fed and melted directly to the top of the sonotrode. It is crucial to have an appropriate sonotrode material with good wetability to the melted material. Such an approach allows the transfer of the mechanical waves to the workpiece and minimizes possibility of efficient contamination.

Suitable for working with all medium and high-melting materials including:

- Fe-based alloys,
- Ti, Ni, Pt, Ir based alloys,
- High Entropy Alloys,
- Refractory materials such as W, Ta, V, Mo, Nb, Re, etc.
- Metal Matrix Composite powders.

Induction Melting

Induction Melting is usually used to process alloys with melting points up to 1300 °C, for example:

- Relatively low melting point and volatile elements that tend to evaporate in the plasma, such as Sn, Zn, Mg, Pb, and Al alloys,
- Materials with high thermal capacities and conductivities, like Cu and precious metals such as Ag, and Au alloys.

The material in any shape and form can be placed into the crucible, including final alloy, master alloys, or pure elements.

All materials are easily alloyed thanks to the magnetic stirring effect.

Core benefits & features

Processing of any elements or alloys

Ultrasonic atomization can be carried out on a wide range of pure elements (e.g., Zn, Mg to Pt, Mo, Ta), as well as any alloy composition (e.g., Mg-Li, CuSn6, TiTaZrRuCu, MoRe).

Any form of feedstock

The ability to atomize chips, failed AM prints, damaged samples, rods, wire, powder, and more.

Various capacities depending on specific needs

The ability to produce powder from a few grams (e.g., for small amounts of an alloy or rare and expensive elements) up to several kg per day (when processing wire material or using induction module).

Various particle sizes

Powder particle size distribution is adjustable based on the ultrasonic frequency. 20 kHz: d50 = 80–100 µm; 40 kHz: d50 = 45–60 µm; 60 kHz: d50 = 30–45 µm (exact value depends on the material atomized).

Modularity and openness

The rePowder platform has a modular design. New modules can be added at any time. All connections in the device follow current standards (e.g., ISO-KF), so each customer can create and connect their modules as needed.

One device - many possibilities

The rePowder platform was designed to enable many different types of processes to be performed using a single device, including the preparation of a new composition, alloy homogenization, ultrasonic atomization, suction casting, and further options in development.

Multiple alloys in one day

The device is laboratory-scale, easy to clean, and allows for rapid material changeover. Several atomization processes can be carried out for different alloys on different ultrasonic systems in the course of one day.

Multiple applications

The obtained powder can be used in a variety of technologies, including additive manufacturing, sintering, thermal spraying, catalysis etc.

Recycling

The device allows reprocessing of printed parts or scraps material into powder for further use in the desired application.

Low maintenance costs

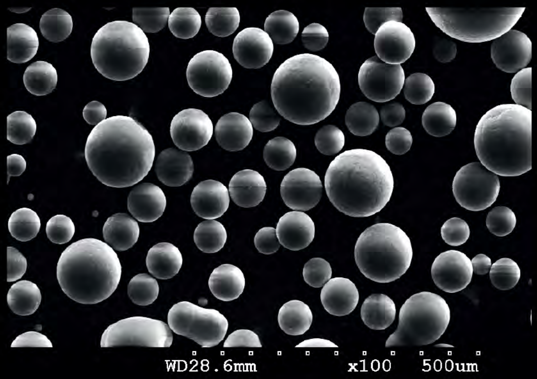
The device uses minimal amounts of noble gases (~10 L/min). The cost of a single atomization process is minuscule.

| rePOWDER |

Ultrasonic powder atomizer and alloy prototyping platform

In-house processed materials

rePOWDER



MgLi

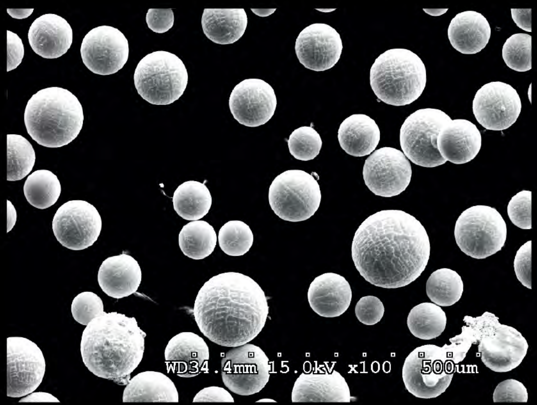
HEAT SOURCE
Induction

TEMPERATURE [°C]
750

ULTRASONIC FREQUENCY [KHZ]
40

SONOTRODE MATERIAL
Refractory plate

FEEDSTOCK FORM
Cast



PtRh

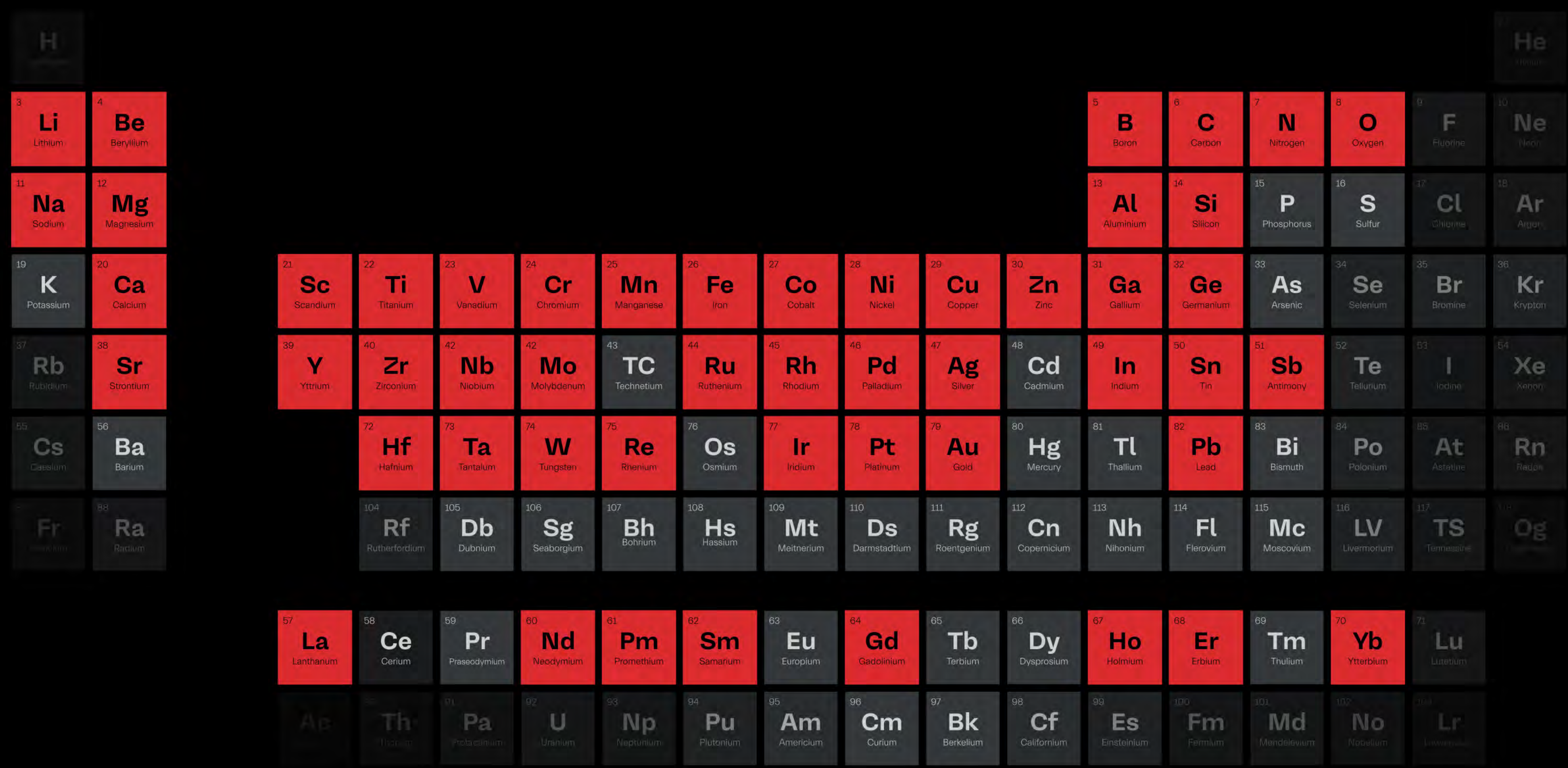
HEAT SOURCE
Arc

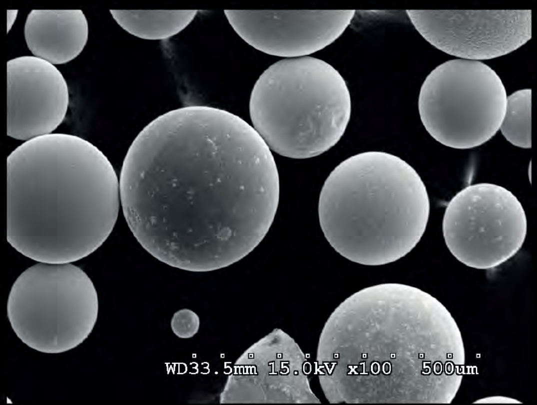
ARC CURRENT [A]
300

ULTRASONIC FREQUENCY [KHZ]
40

SONOTRODE MATERIAL
W-refractory alloy

FEEDSTOCK FORM
Rod





AMZ4 metalic glass

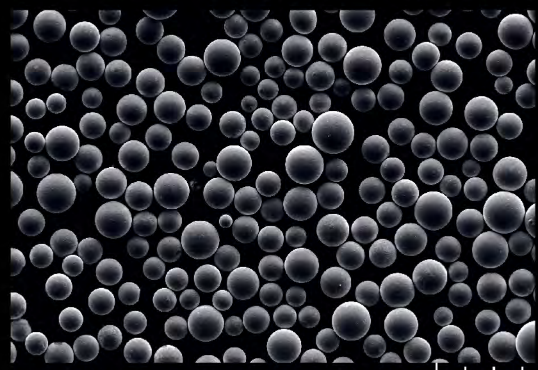
HEAT SOURCE
Arc

ARC CURRENT [A]
300

ULTRASONIC FREQUENCY [KHZ]
40

SONOTRODE MATERIAL
Cu-alloy

FEEDSTOCK FORM
Rod



WUT_SU8000 15.0kV 14.8mm x100 LM(L)

WTaVTi HEA

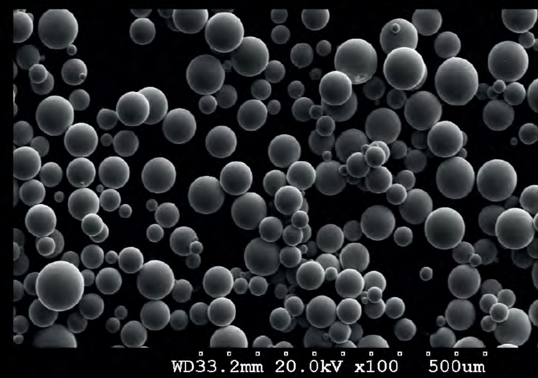
HEAT SOURCE
Arc

ARC CURRENT [A]
300

ULTRASONIC FREQUENCY [KHZ]
40

SONOTRODE MATERIAL
W-refractory alloy

FEEDSTOCK FORM
Raw elements



Ag

HEAT SOURCE
Induction

TEMPERATURE [°C]
1100

ULTRASONIC FREQUENCY [KHZ]
40

SONOTRODE MATERIAL
Refractory plate

FEEDSTOCK FORM
Granulate

| inFURNER |

Compact high vacuum furnace

Distortion is one of the main problems in AM process. Proper heat treatment is an obligatory step for high-quality products. High vacuum provides reliable heat treatment conditions in every process.

Heaters and thermal screens material vary depending on the maximum temperature option:

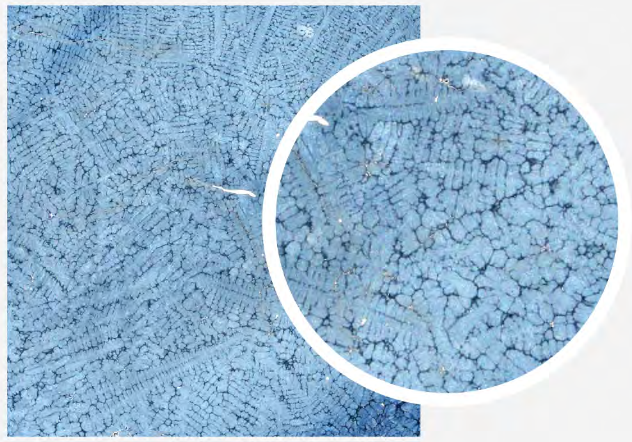
- 1200 °C – molybdenum heaters and thermal screens – process example: Ti-based alloys stress relief,
- 1600 °C – tantalum heaters and tungsten thermal screens – process example: sintering of refractory alloys.

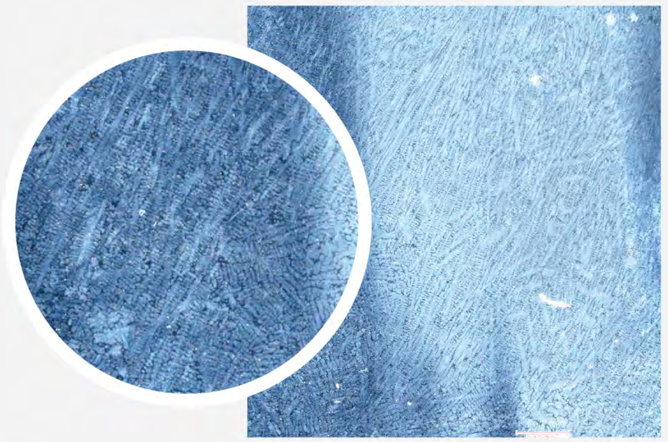
For both temperature options there are two hot zone sizes available:

- Φ120 mm x 100 mm height – compatible with small build plate 3D printers,
- Φ200 mm x 200 mm height – compatible with popular medium-sized build plate 3D printers.

In all setups vacuum down to 10^{-2} mbar is reached with the preliminary pump. Then, the high-vacuum pump takes over to reach a vacuum of $2{\times}10^{-7}$ mbar (with a turbomolecular pump) or $3{\times}10^{-9}$ mbar (with an ionization pump).

BEFORE **AFTER**





Core benefits & features

Laboratory-size device

Total dimensions of 1200 × 800 mm with a cylindrical working chamber. Hot zone dimensions range from 120–200 mm in diameter and 100–200 mm in height.

Maximum temperature

Depending on specific needs, two options are available: up to 1200 °C (ideal for titanium heat treatment in LPBF, brazing) or up to 1600 °C (sintering of refractory metals).

High vacuum

The furnace is adaptable with diffusion, turbomolecular, or ion vacuum pumps to provide a maximum vacuum ranging from $3{\times}10^{-5}$ to $3{\times}10^{-9}$ mbar.

High-pressure gas quenching

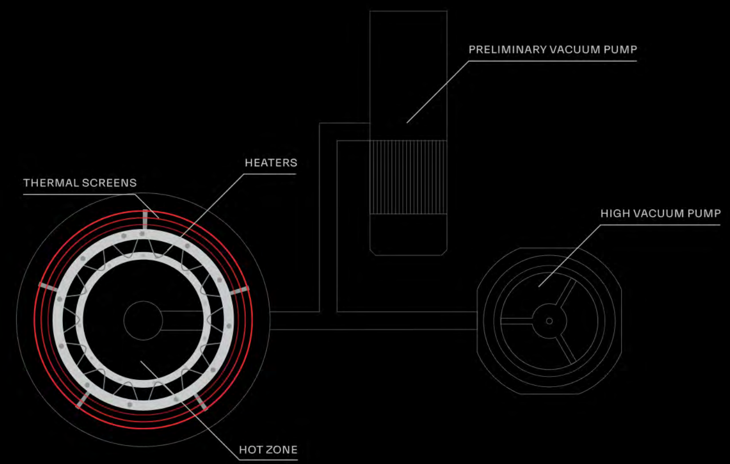
This option offers unprecedented part cleanliness, faster furnace cooling, and less overall dimensional change. Common quench gases include nitrogen, argon, and helium.

Data collection

The unit collects and stores all processing data necessary for validating parts for medical and aerospace applications and scientific research.

Various applications

The furnace is ideal for the heat treatment of LPBF-titanium, brazing, sintering, or other scientific and R&D projects.



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