thermoscientific

DATASHEET

μHeater

Fully integrated, ultra-fast heating solution for *in situ* high resolution imaging at temperatures up to 1200 °C

One product, diverse applications

The Thermo Scientific™ μHeater holder is a high vacuum compatible ultra-fast heating stage for *in situ* sample heating up to 1200 °C. It takes advantage of the dual nature of our DualBeam™ instruments by allowing for sample preparation by FIB and transfer to a MEMS device without breaking vacuum in the vacuum chamber. First, the area of interest is selected; then, a chunk of material is cut with the FIB and attached to the micromanipulator needle using beam-induced deposition. After lift-out, it can then be shaped using the FIB. The chunk is then placed on the MEMS heating holder, fixed with beam-induced deposition, and cut loose from the needle. In a similar way, a TEM lamella can be placed on the heating holder. Various sized powders and nanoparticles can also be directly deposited on a MEMS chip, allowing using the heating stage in SEM.

Faster heating, new insights

The tiny thermal mass of the μHeater holder allows for temperature changes of 1,200 °C in just 100 ms (10^4 °C/s), including settling to within 1 °C, enabling a variety of new experiments. The uniformly heated area of the MEMS heating chip is 100 μm large. Recommended dimensions for chunks are up to 50x50x50 μm^3. The μHeater holder allows you to combine *in situ* heating experiments with electrical measurements. Contact pads located on the MEMS chip allow for the application of four independent sample biases as well as allowing for resistivity measurement of the heated sample using a four-point probe method.

Novel imaging capabilities

Transparent silicon nitride grids provide excellent support and limited reaction with the sample while also supporting imaging conditions for both surface and in transmission mode (STEM). The low thermal radiation of the heater enables use of any available detectors, including EDS and EBSD imaging at high temperatures, which is very challenging or impossible when using typical bulk heating stage due to EDS spectra shifts and excessive thermal radiation saturating the signal. The stage is mounted on a multi-purpose holder (MPH) and enables 360 ° endless rotation while maintaining full utilization of the MPH capabilities.

Full integration with Thermo Scientific DualBeam platforms

Control of the stage is automatic or manual and is fully integrated in the microscope user interface, providing easy and intuitive operation. The system provides direct read-out of the temperature value during use. The software control allows definition of custom ramp/soak profiles to easily manage an experiment or process simulation. The μHeater holder works with guaranteed performance on Thermo Scientific DualBeam platforms to ensure perfect mechanical, thermal, and electrical stability during *in situ* experiments.

Key Benefits

Rapid and precise heating in high vacuum. Fast heating of materials to 1,200 °C in 100 ms.

EDS and EBSD imaging at >1000 °C temperature. Enabled by the low thermal radiation of the heater.

Stable solution for *in situ* nanometer scale imaging. μHeater holder has been developed with high-resolution imaging in mind. It maintains highest DualBeam performance at elevated temperatures.

Uniform temperature distribution. The MEMS device design of the μHeater holder delivers consistent, reproducible, and uniform temperature distribution over the heated area.

One solution for assured performance. Full integration with microscope control software on Thermo Scientific DualBeam instruments.

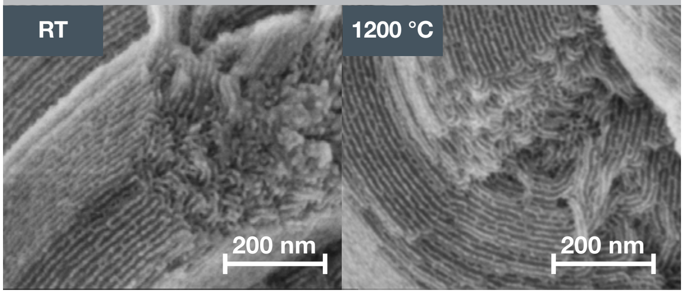

Figure 1. Sample SBA-15. High resolution preserved at 1200 °C. SEM images at 1keV.

ThermoFisher SCIENTIFIC

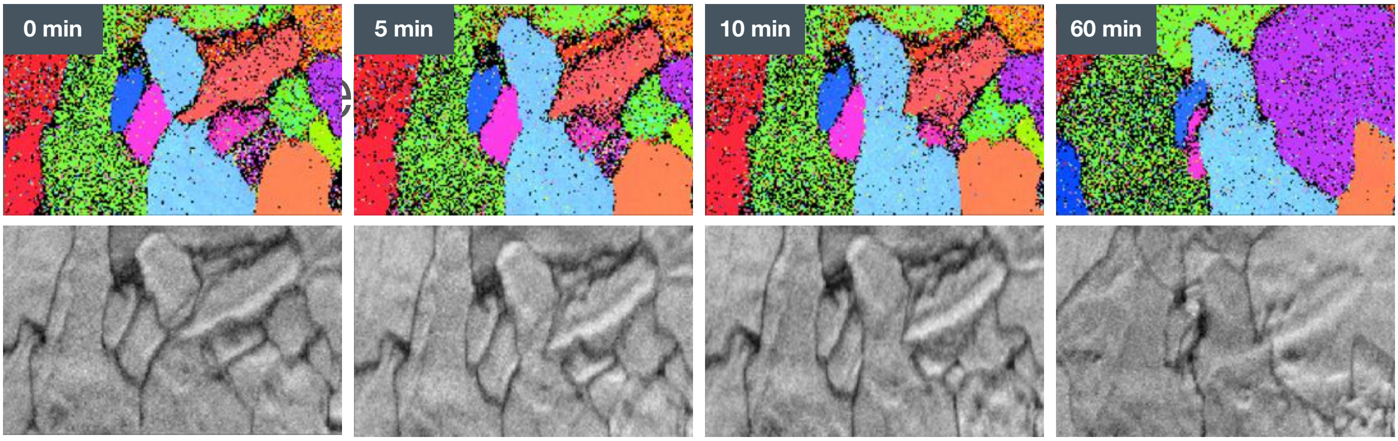

Figure 2. Microstructure evolution of deformed Ti_6Al_4V alloys shown by sequence of EBSD IPFZ images (top row) and corresponding IQM (bottom row), obtained at 1100 °C using μHeater holder. The horizontal field of view is 20 μm.

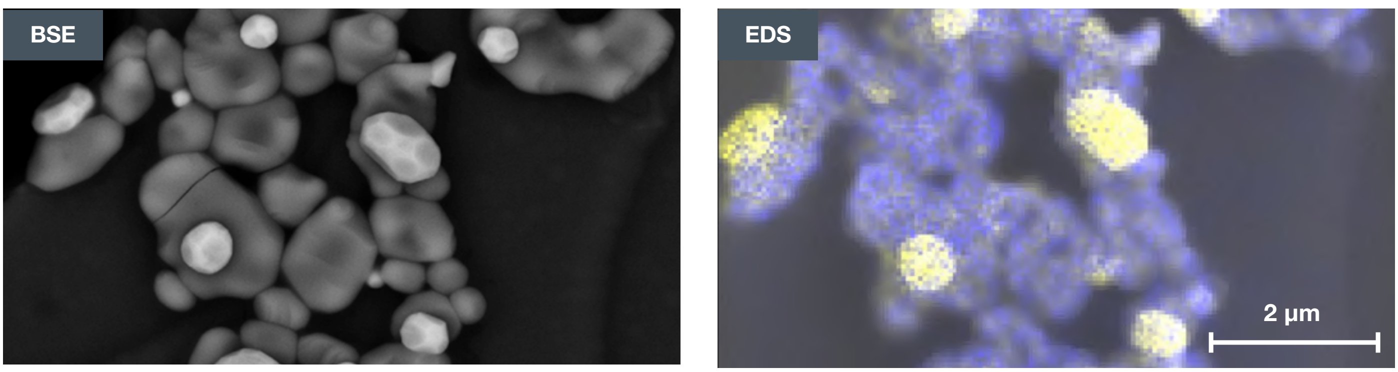

Figure 3. Mixture of magnetite and hematite nanoparticles heated at 1030 °C. Backscattered electron image and EDS maps of iron and oxygen acquired simultaneously.

Specification	μHeater	Typical 3rd party bulk stage
Sample types	Small samples, nanoparticles, chunks or TEM lamella	Nanoparticles, bulk samples
Temperature range	40 °C - 1200 °C	Up to 1500 °C
Ramp rate	$>10^4$ C/s and any slower	Slow (~ 5°C/s)
Max sample size	Heated area is ~100μm, recommended chunk size is 50x50x50 μm^3	Several mm
Compatible detectors	All integrated + EDS + EBSD	Most detectors are available only at low temperatures
Vacuum mode	Any (HiVac or LoVac)	Mostly LoVac
Stage limits	No (incl. full rotation)	Very limited due to large size of a stage
Electrical experiments	Standard ±40V	Typically an expensive option
Seamless operation	Yes, fully integrated in the UI	No, standalone PC and software
Thermal radiation	Low	High
Temperature calibration per sample	Not needed	Needed to match readout to actual sample temperature

Find out more at **Thermofisher.com/EM-Sales**