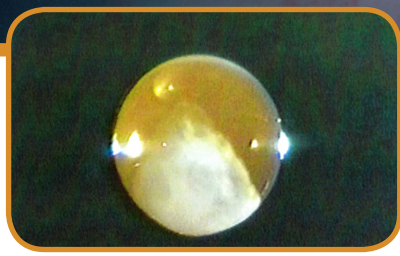
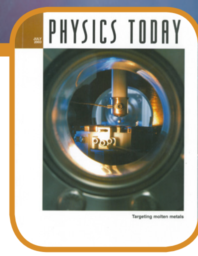
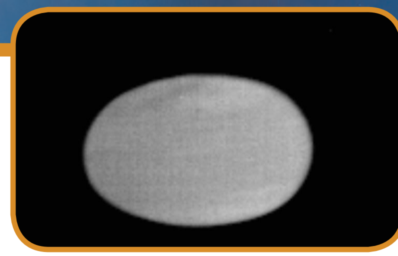
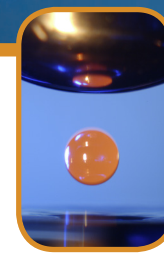
National Aeronautics and
Space Administration

Marshall Space Flight Center
Electrostatic Levitation Laboratory

Credit: Physics Today, July 2003



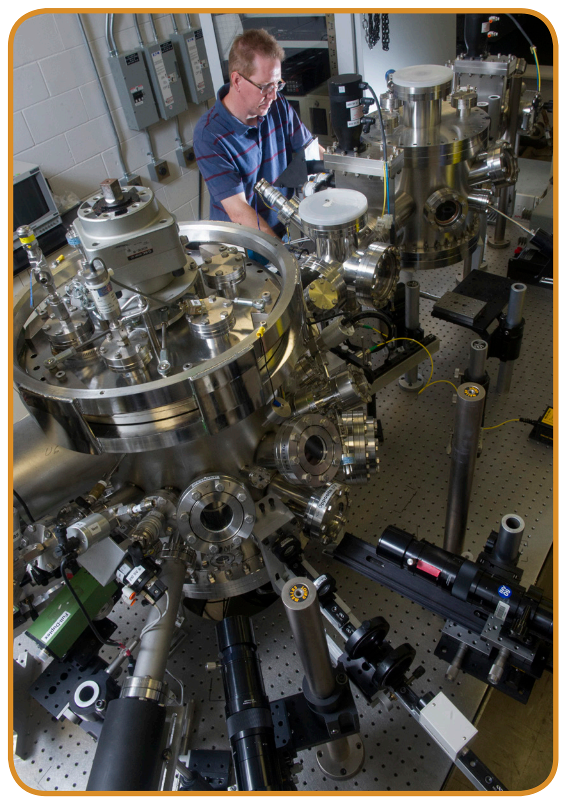
Engineering Solutions for Space Science and Exploration

MSFC's Electrostatic Levitation Laboratory is a national resource for researchers developing advanced materials for new technologies. Electrostatic levitation (ESL) minimizes gravitational effects and allows materials to be studied without contact with a container or instrumentation, avoiding any container-sample interaction.

MSFC's ESL Laboratory hosts Government, academic, and commercial investigations. NASA invests in electrostatic levitation to develop new high-temperature materials for better rocket engine nozzles, radiator panels, and habitat surfaces. Researchers have used MSFC's ESL Laboratory to improve medical and industrial lasers, develop metallic glasses stronger than steel, and create materials with memory.

One component of the ESL Laboratory is an electrostatic levitator that features a broad range of capabilities, including high-temperature heating with or without rotation in both vacuum and neutral gas environments and non-intrusive data-gathering accessories. This levitator has been instrumental in many pioneering materials investigations of thermo-physical properties, e.g., creep measurements, solidification, and triggered nucleation. A second levitator supports phase diagram studies, density, viscosity, and test plan development. The High Temperature Emissivity Measurement System (HiTEMS) provides a state-of-the-art capability for emissivity measurements of samples at temperature. In its non-levitation mode, HiTEMS extends the range of the laboratory to study larger samples and coated samples.

On-site scientific/engineering experts assist with planning and operation of experiments and modify the levitators to support specific research goals.




Capabilities

Main Electrostatic Levitator

Samples: refractory metals, superalloys, ceramics, oxides, glasses, elemental metals, binary and tertiary alloys

Sample size: 1–3 mm (0.039–0.12 in.) diameter

Atmosphere: vacuum (10^{-8} torr); neutral gases to ≤5 atm

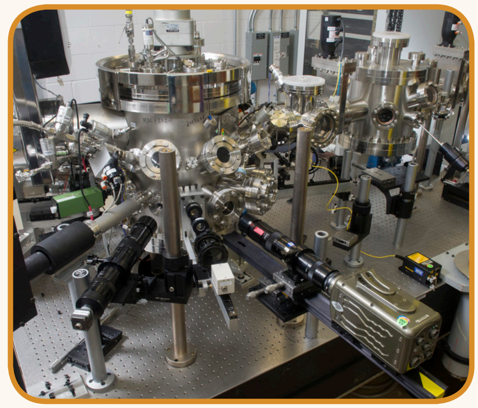
Heating/cooling:

- Focused, steerable 200-W laser
- 1–100% power control
- 0.5- to 10-mm (0.02- to 0.4-in.) spot size

Positioning control: 3-dimensional digital laser feedback

Instrumentation:

- Pyrometer
- Infrared camera
- High-speed and ultra-high-speed cameras
- Oxygen partial pressure control system
- Quenching system
- Magnetic rotation device with controlled sample spin (30,000+ Hz)



Portable Electrostatic Levitator

Samples: refractory metals, superalloys, ceramics, oxides, glasses, elemental metals, binary and tertiary alloys

Sample size: 1–3 mm (0.039–0.12 in.) diameter

Atmosphere: vacuum (10^{-8} torr)

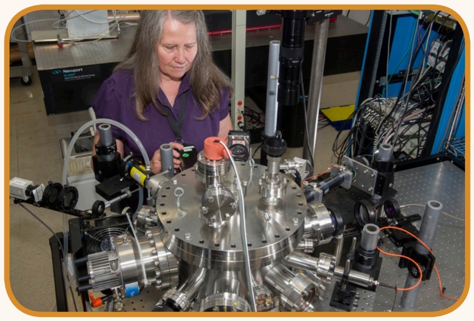
Heating/cooling:

- Focused, steerable 60-W laser
- 1–100% power control
- 0.5- to 10-mm (0.02- to 0.4-in.) spot size

Positioning control: 3-dimensional digital laser feedback

Instrumentation:

- Pyrometer
- Infrared camera
- High-speed and ultra-high-speed cameras



HiTEMS

Samples: refractory metals, superalloys, ceramics, oxides, glasses, elemental metals, binary and tertiary alloys, and coated samples

Sample size:

- Stationary: 9.5 × 9.5 mm (0.375 × 0.375 in.)
- Levitated (under development): 1.0 ≤ dia. ≤ 3.0 mm (0.4 ≤ dia. ≤ 1.2 in.)

Atmosphere: ultra-high vacuum (10^{-7} torr range)

Heating range:

- Current: 827–3,000K (600–2,700 °C)
- Planned additional capability: 300–1,600K (27–1,327 °C)

High-Temperature Measurement Capabilities

Thermophysical Properties

- Emissivity
- Surface tension
- Viscosity
- Heat capacity
- Density
- Irradiation resistance
- Specific heat
- Undercooling
- Creep

Solidification

- Nucleation temperature and rate
- Solidification velocity

Other

- Phase behavior/equilibrium
- Phase diagram
- Time-temperature-transformation diagram
- Metastable phase transformation
- Preliminary sample processing for test plan evaluation/development

For more information, please visit www.nasa.gov/centers/marshall/about/business.html

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