Electrostatic Levitation for Studies of Additive Manufacturing Materials for Extreme Environments

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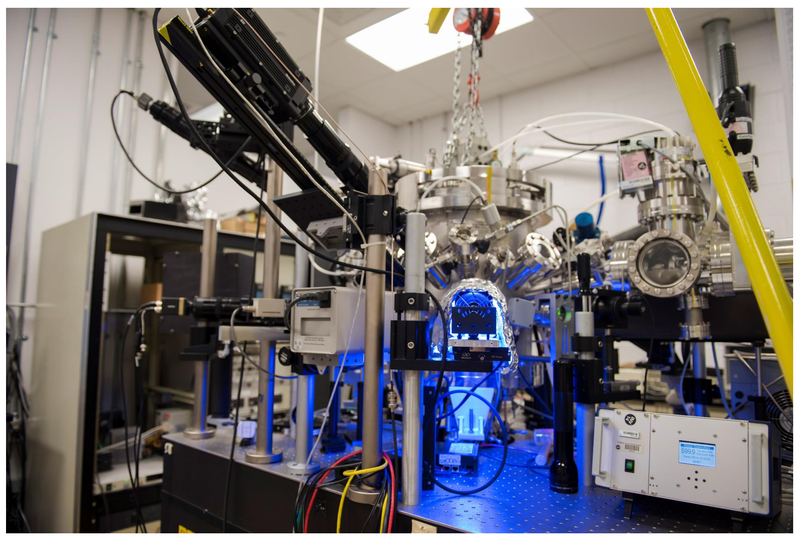
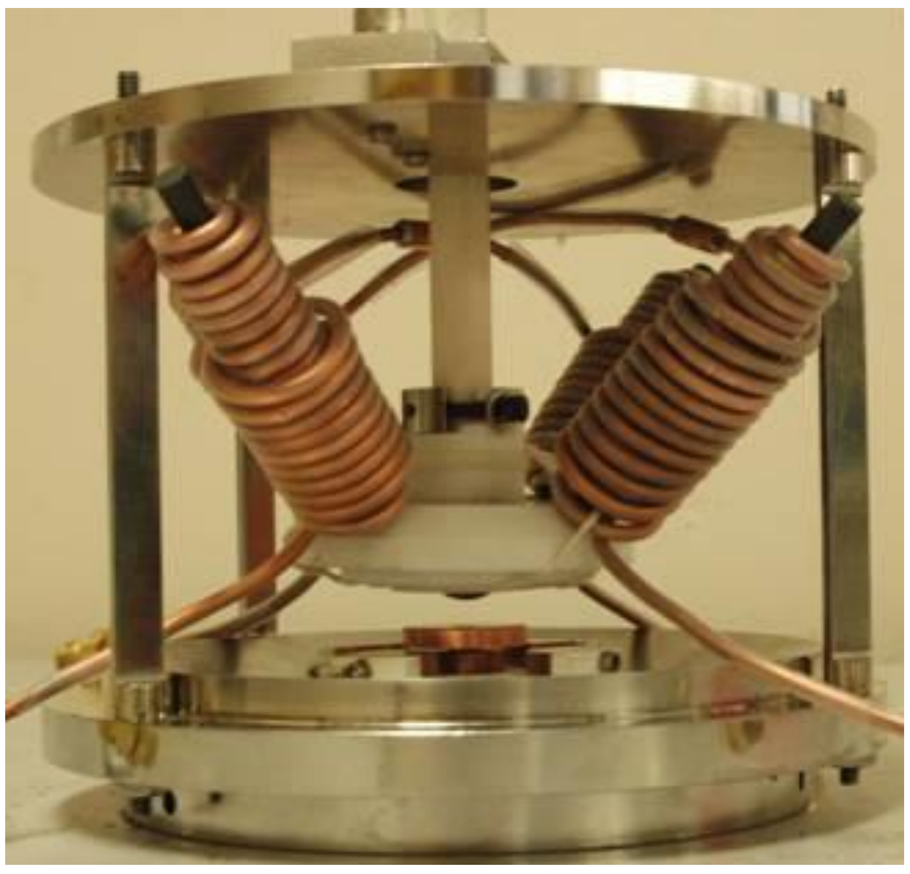
The electrostatic levitation (ESL) laboratory at NASA's Marshall Space Flight Center (MSFC) is a national resource for researchers developing advanced materials for new technologies. Electrostatic levitation minimizes gravitational effects and allows materials to be studied without contact with a container or data-gathering instrumentation.



The NASA Marshall Space Flight Center (MSFC) Electrostatic Levitation (ESL) Laboratory's main levitation chamber.

Modeling of additive manufacturing materials for extreme environments is necessary for the control of their resulting materials properties. Unfortunately, there is very little materials properties data for many additive manufacturing materials, especially of the materials in the liquid state.

The MSFC ESL lab is ideal for the study of additive manufacturing materials To be used in extreme environments. The lab can provide density, surface tension, and viscosity of molten materials, emissivity measurements, and even creep strength measurements.



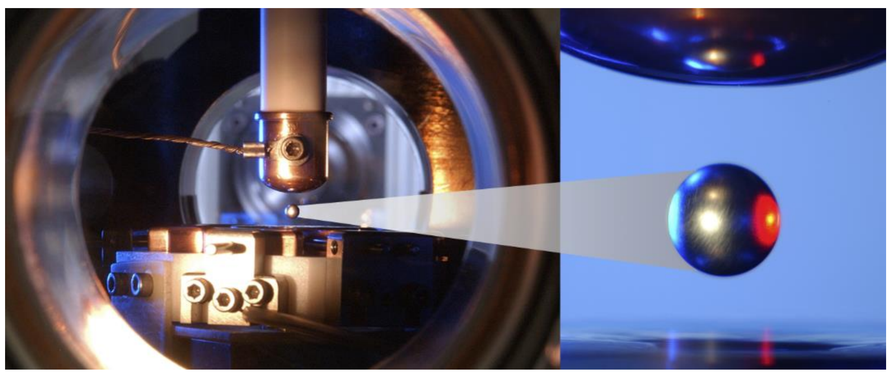
Induction motor above an ESL electrode assembly used during non-contact creep measurements.

The MSFC ESL lab has also studied additive manufacturing materials for hot environments. The lab has studied Inconel 718, which is a commonly used AM material for the aerospace industry.

The lab can also measure the creep strength of materials, which is one of the most important material properties at high temperatures. There is very little creep strength data for additively manufactured materials.

Researchers have used MSFC's ESL Laboratory to develop advanced high-temperature materials for

- aerospace applications
- coatings and structural materials for rocket nozzles
- Improved medical and industrial optics
- metallic glasses
- ablatives for reentry vehicles
- materials with memory.



A levitated 2-mm (0.08-in.) diameter sample of titanium-zirconium-nickel (Ti-Zr-Ni) using ESL at MSFC.

The MSFC ESL lab was involved in the development of Vitreloy 106, which is a zirconium-based bulk metallic glass (BMG).

NASA is currently studying BMGs for cryogenic gears for planetary exploration. Bulk metallic glass doesn't get brittle in extreme cold, and that makes the material perfect for robotics operated in space or on icy planets

Gears made from BMGs can operate both cold and dry, which will allow the gears to have strong torque and smooth turning without lubricant

Research on BMGs as additive manufacturing materials is growing.

A bulk metallic glass (BMG) gear during cryogenic testing by NASA.

Research Programs

Thermophysical Properties

- Emissivity
- Surface tension
- Viscosity
- Density
- Undercooling
- Creep Strength

Solidification

- Nucleation temperature and rate
- Solidification velocity

Other

- Phase behavior/equilibrium
- Time-temperature-transformation diagrams
- Metastable phase transformation