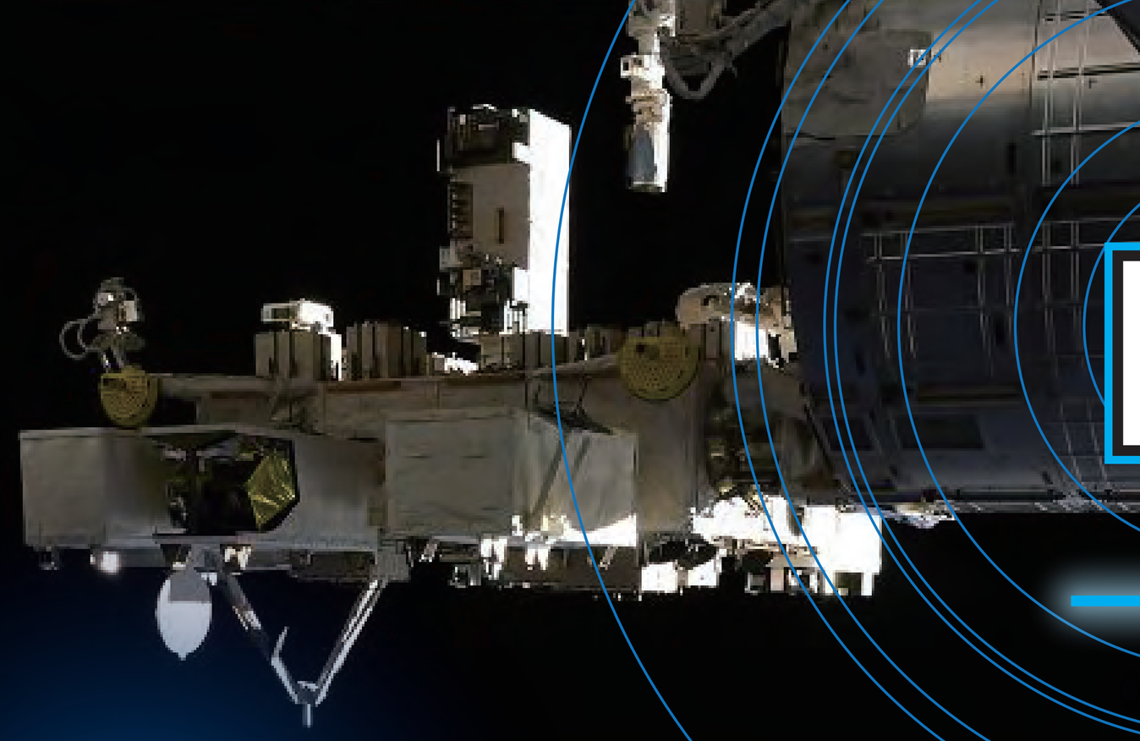


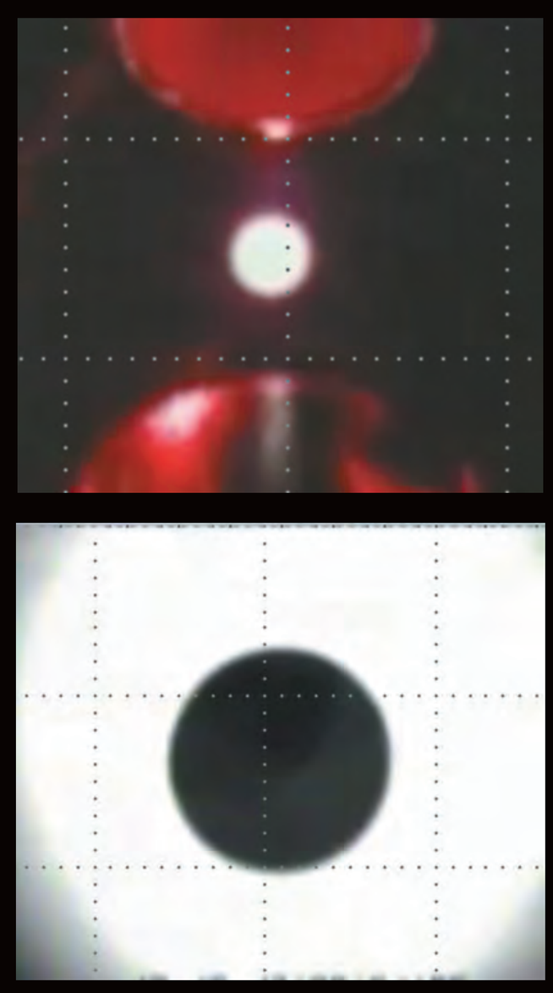
Electrostatic Levitation Furnace (ELF)

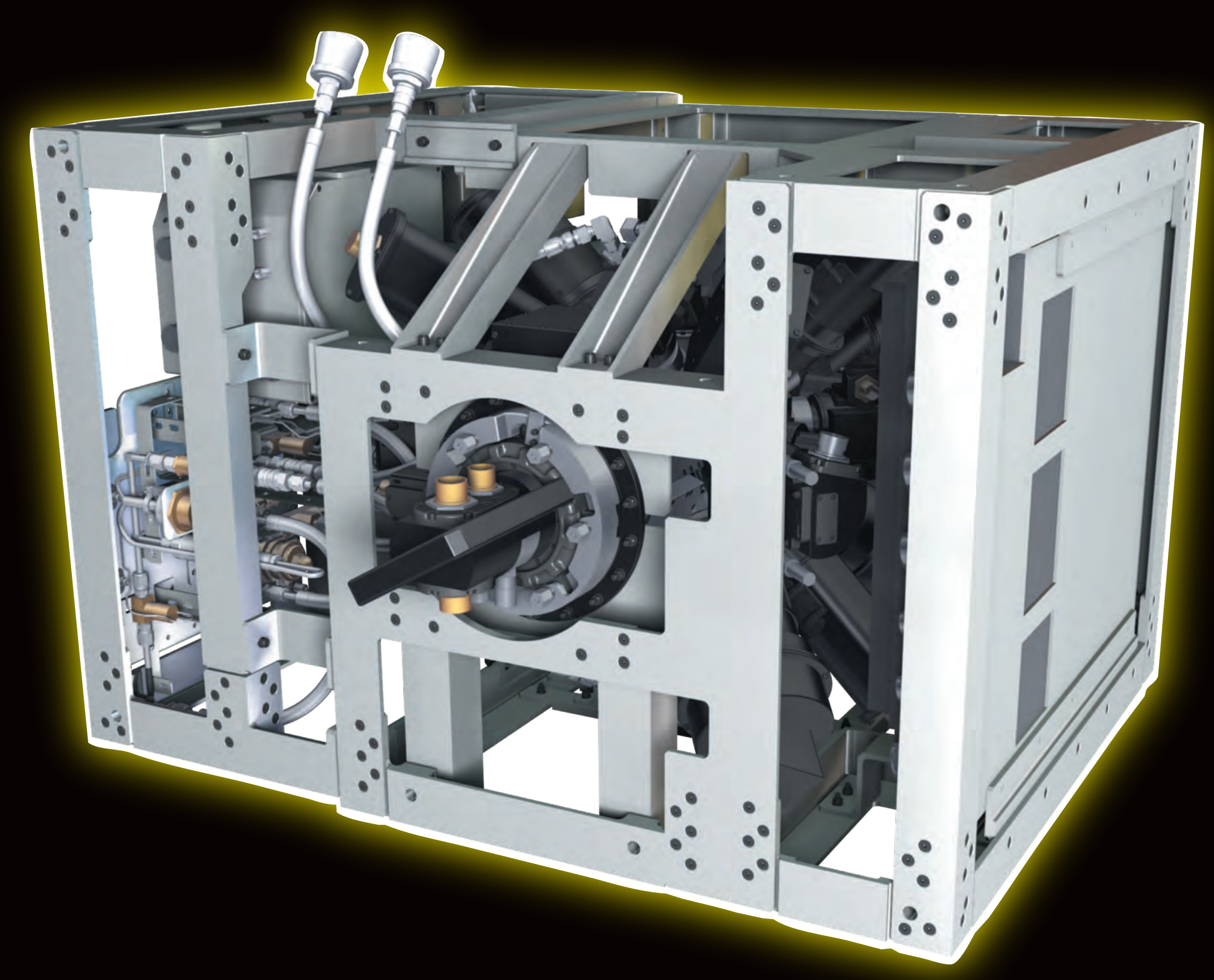
JAXA Explore to Realize

What's ELF

Measure thermophysical properties (density, surface tension, viscosity) of high-temperature melts which were hard to obtain with conventional methods.

- Melt material without container with heating laser.
- Use Coulomb force to control sample position.



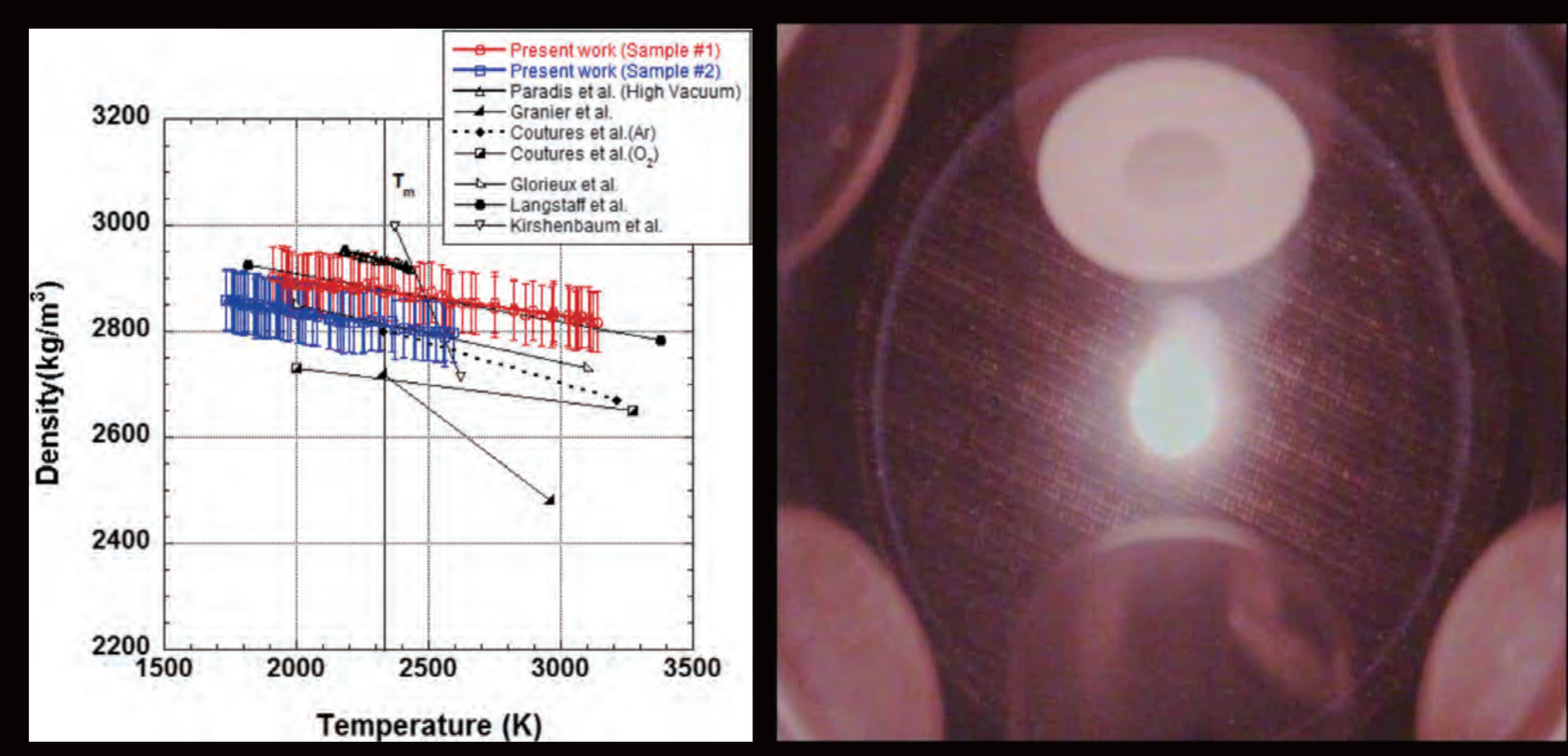


Present work

- Obtained densities of molten zirconium, aluminum oxide and erbium oxides-calcium aluminate

  Tamaru, H. et.al., : Status of the Electrostatic Levitation Furnace (ELF) in the ISS-KIBO. Microgravity Sci. Technol. https://doi.org/10.1007/s12217-018-9631-8

- Also under evaluating for viscosity and surface tension for aluminum oxide



Measured density vs temperature

	Low Temp(<2000 degC)	High Temp(>2000 degC)
Conductors (Metal, Alloy)		ELF Capable zone
Insulators (Oxides)		ELF Capable zone

Microgravity Effectiveness

Sample Types	Metals (elements)	Alloys	Oxides, semiconductors, etc.
Examples	W, Mo, Ta, Nb etc.	Materials in use Quasi-crystals, BMG. etc.	ZrO2,HfO2, ZrB2, CaF2 etc.
Levitation in 1G (Charging tendency)	easy/difficult	easy/difficult	difficult
Effectiveness micro-G	moderate	effective	effective
Note	Ground experiments are satisfactory for metal but micro-G data is useful as "Bench-mark" data.	Those materials are difficult to levitate on ground due to less electrostatic charge amount.	

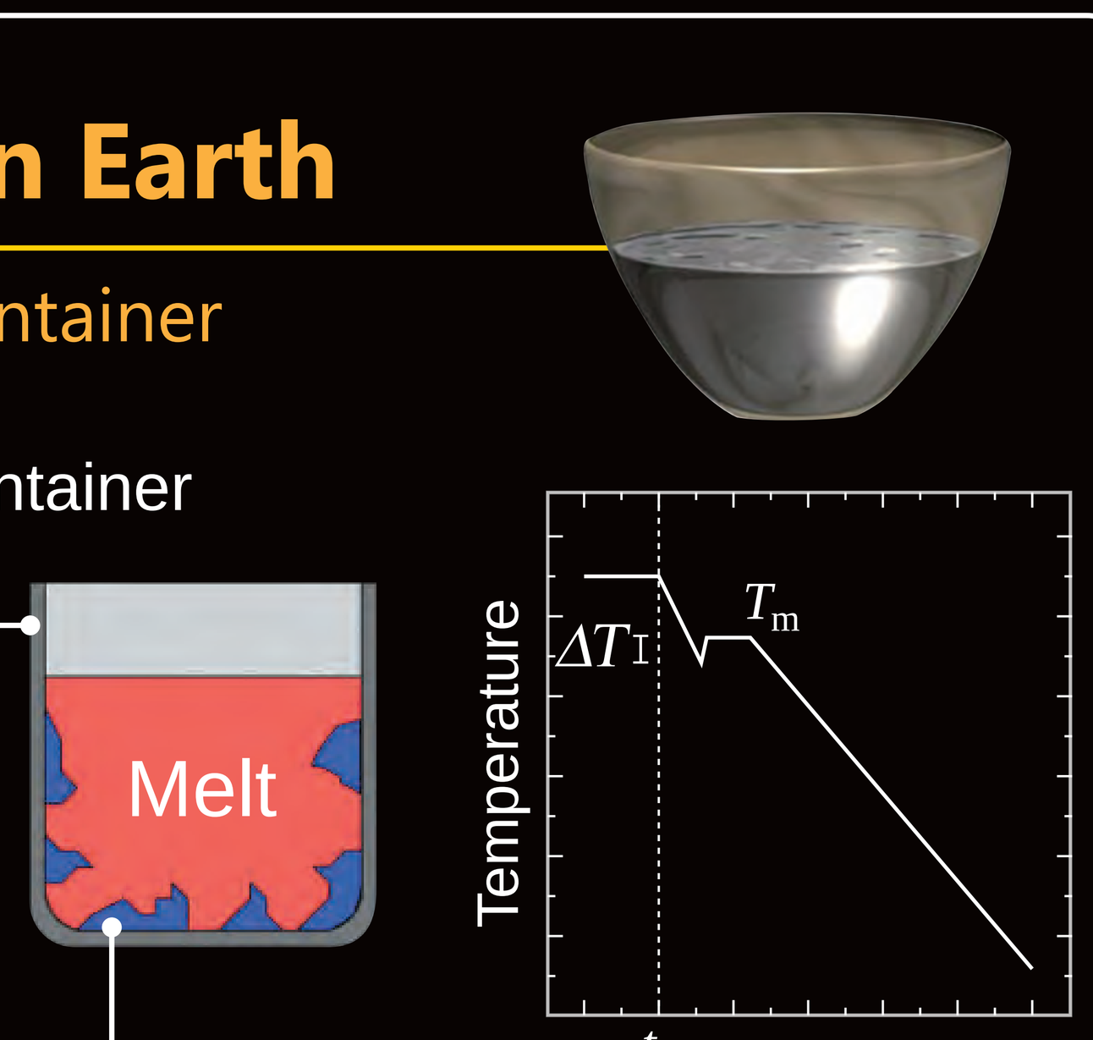
Advantage of Levitation Furnace

ELF can process materials without container.

- There are no contamination from container.
- ▶ ELF can obtain high temperature thermophysical properties.
- ELF can prevent heterogeneous nucleation from container.
- ▶ ELF can achieve super cooling.

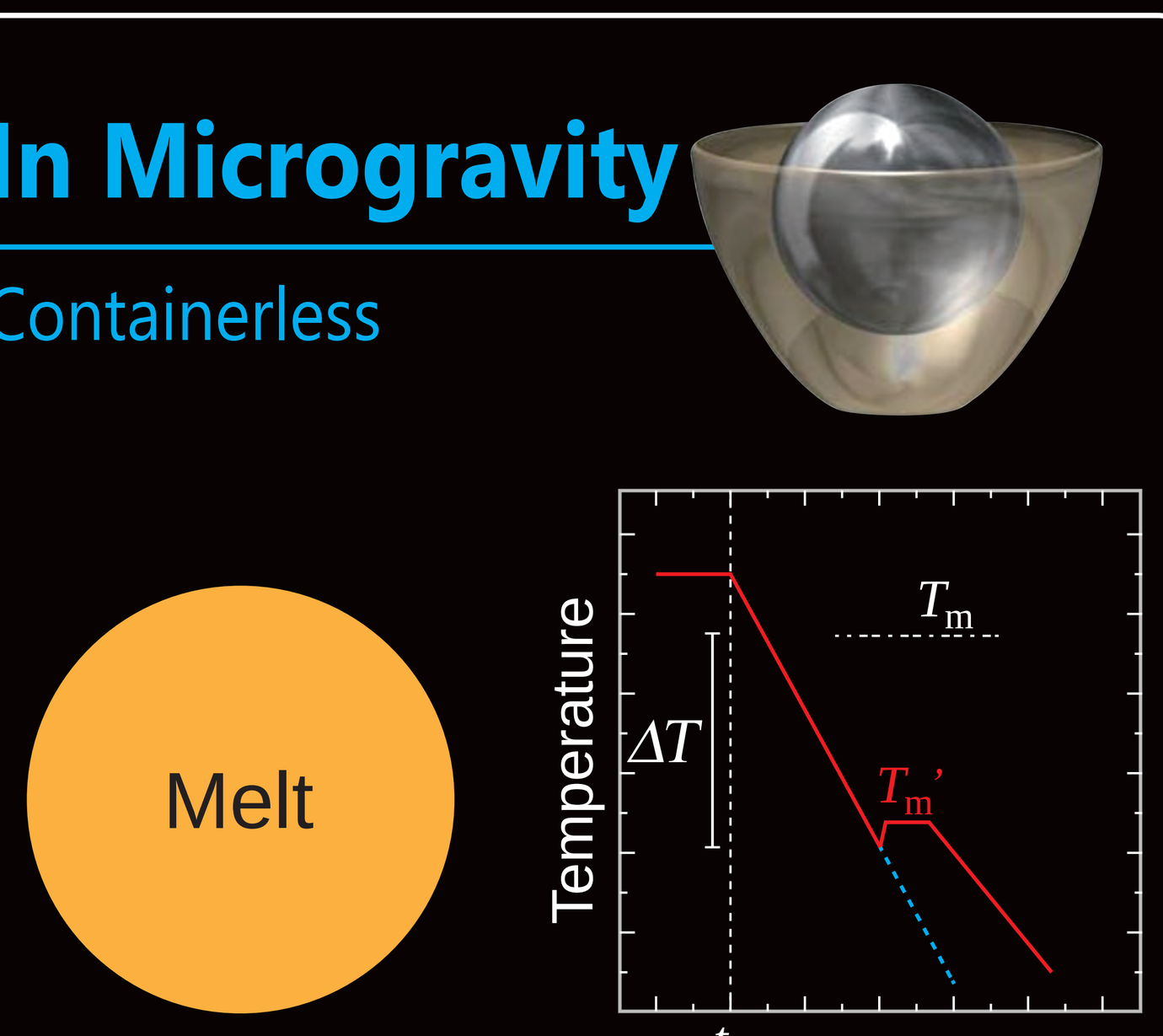
On Earth

Container

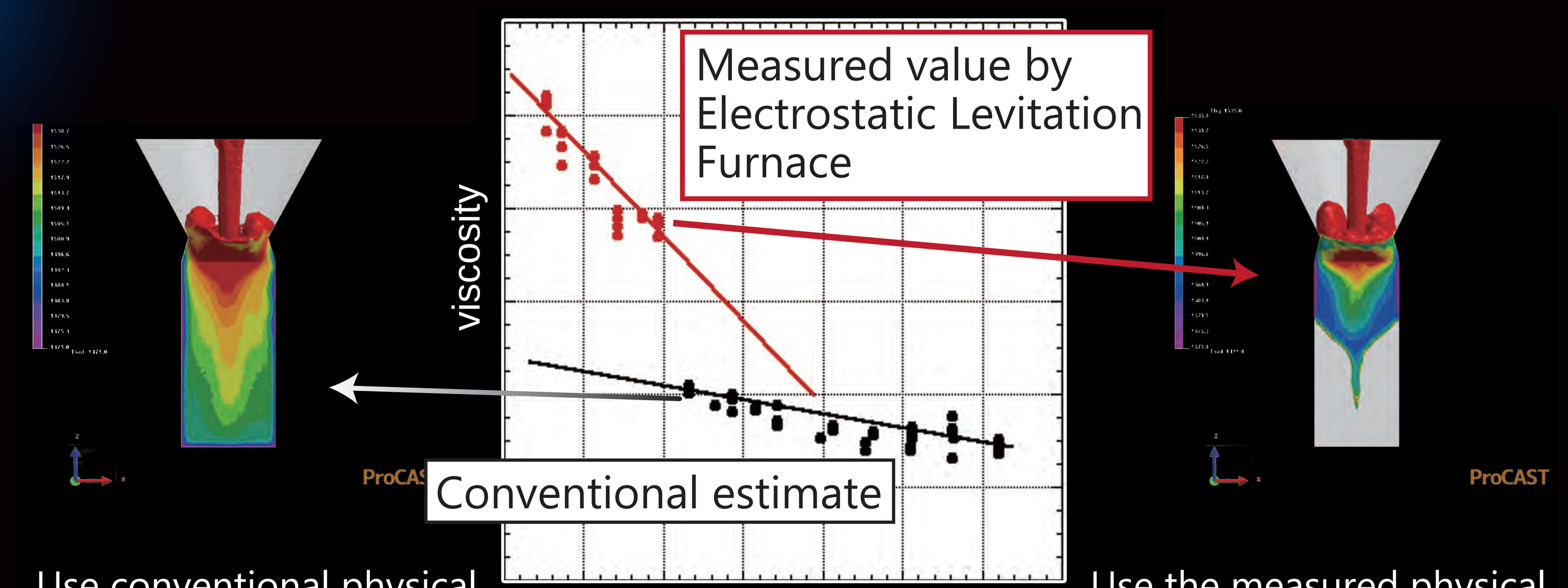


In Microgravity

Containerless



Measurement of viscosity data has greatly changed the simulation results!

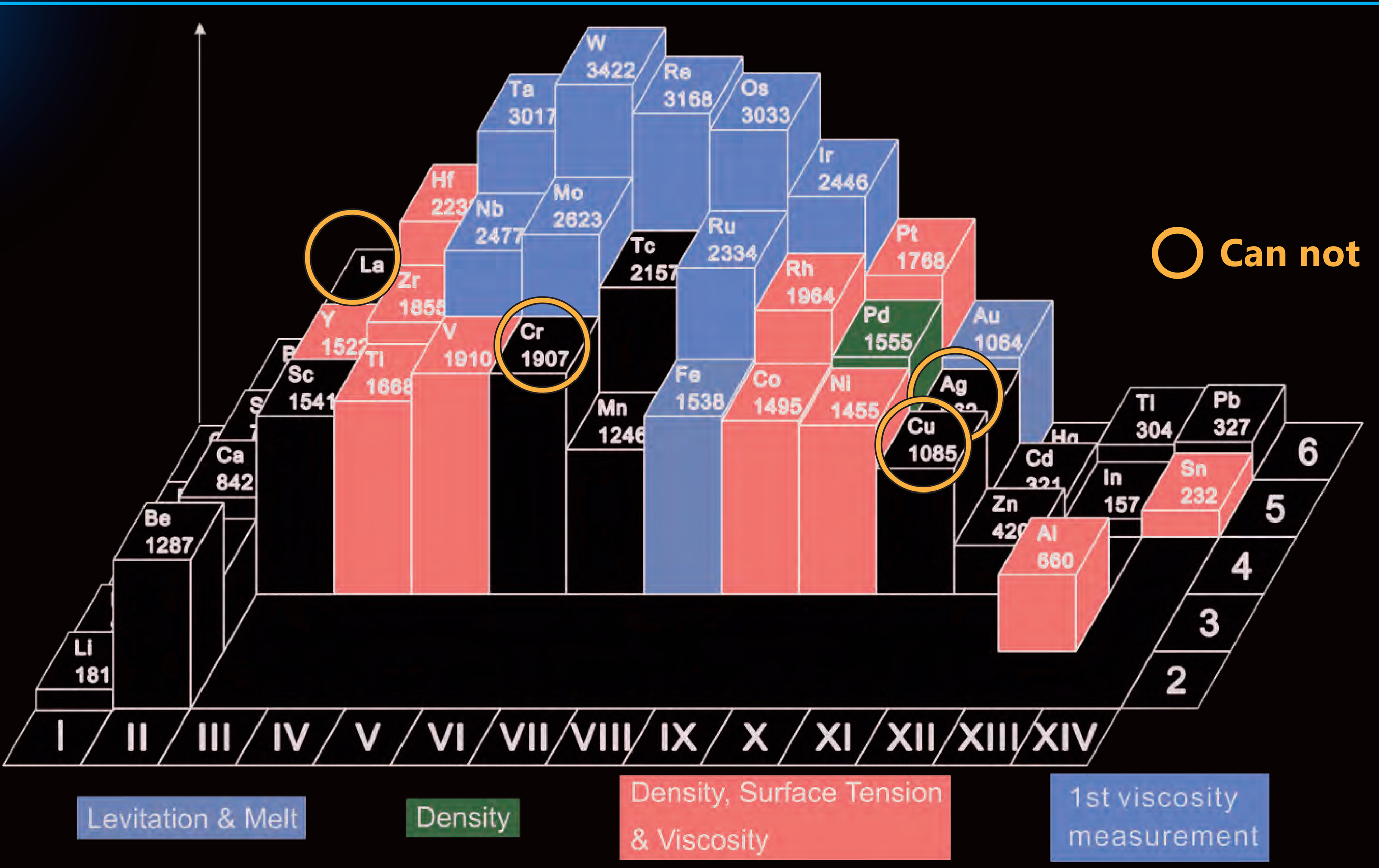


Use conventional physical property values. No shrinkage has appeared.

Use the measured physical properties by Electrostatic Levitation Furnace. Shrink nest appears and flow changes greatly.

Manufacturing heat-resistant turbine blades aimed at improving combustion efficiency.
Process optimization by casting simulation/ Reduce trial and error

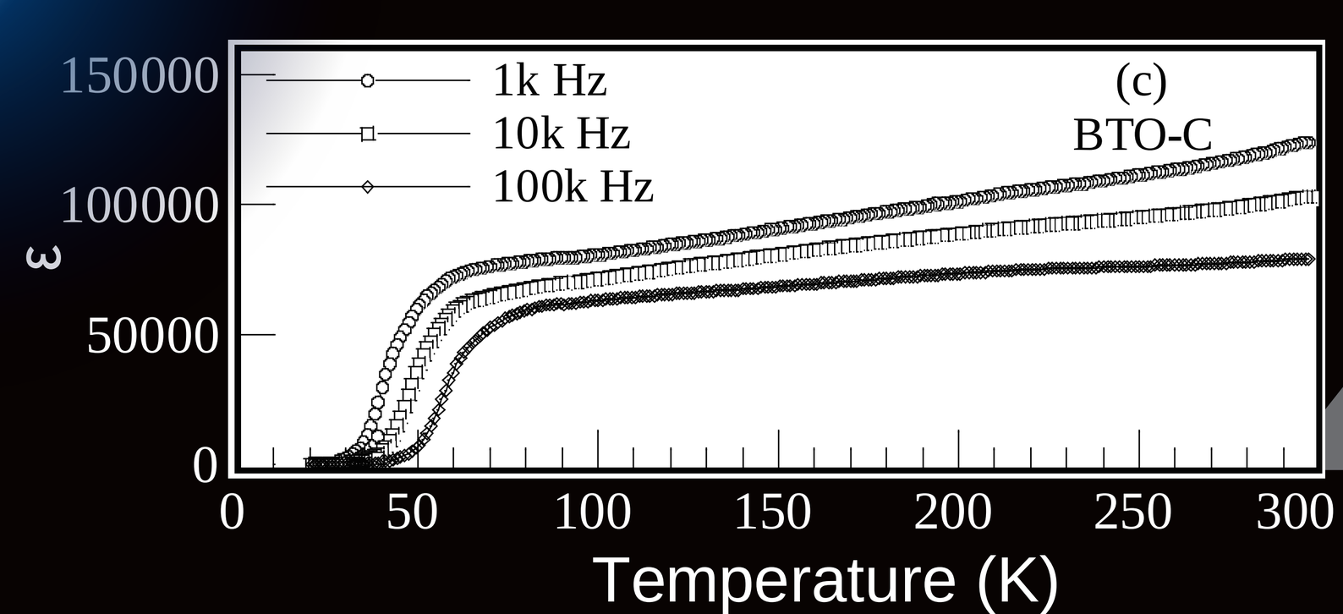
Accurately acquire thermophysical property data of high melting point metal



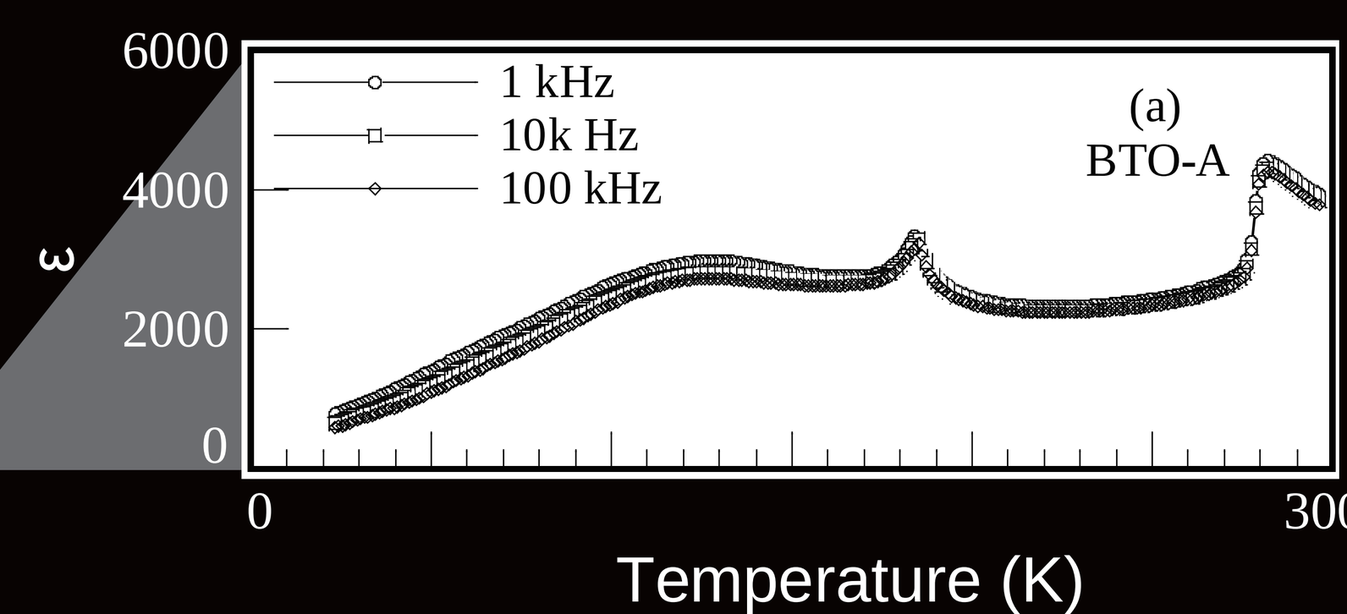
High-temperature thermophysical property acquisition data of metal element melts acquired by experimental equipment developed by JAXA

JAXA has measured high-temperature thermophysical data for many metal elements through research over 10 years. Published in the database, contributing to physical physics research and industry.

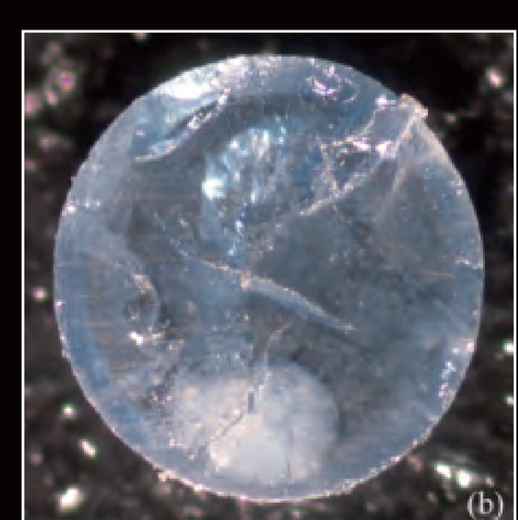
Realize materials with high industrial value by containerless and supercooled solidification



$BaTiO_3$ capacitor processed by Electrostatic Levitation Furnace



Commonly used $BaTiO_3$ Capacitor



Barium titanate
Hexagonal (high temperature phase) single crystal

Creation of ferroelectric

30 times the dielectric constant
→ Ultra-small capacitor by TDK

Creation of high refractive index glass (Maximum refractive index 2.4)

→ High density DVD ball lens by Nippon Sheet Glass