



## > Cryo Biasing

### Technical Specs



|   |                      |
|---|----------------------|
|   | 1950 Series          |
| <b>Sample Temperature Range</b>                   | < -170°C to > 1000°C |
| <b>Temperature Control</b>                        | Yes                  |
| <b>Dewar Lifetime to Refill</b>                   | 4 hours*             |
| <b>Number of electrical contacts</b>              | 9*                   |
| <b>Contact Type</b>                               | Direct Chip Contact  |
| <b>Settled Resolutions at Minimum Temperature</b> | Up to TEM Resolution |
| <b>EELS / EDS Compatible</b>                      | Yes                  |
| <b>TEM Compatibility</b>                          | TFS, JEOL, Hitachi   |

*\*Contact us for custom configurations*

### Overview



Hummingbird Scientific's Cryo-Biasing TEM Sample Holder enables researchers to conduct in-situ electrical biasing experiments of materials at cryogenic temperatures. The sample can be cooled down to liquid nitrogen temperatures with closed-loop control and accurate sensing of temperatures at the desired setpoint. Key characteristics of the holder include:

- > Stable high-resolution imaging at variable temperatures.
- > Electrical biasing for electrical transport measurements.
- > MEMS chips compatibility for biasing & heating.
- > User-friendly and less pre-work for operation.

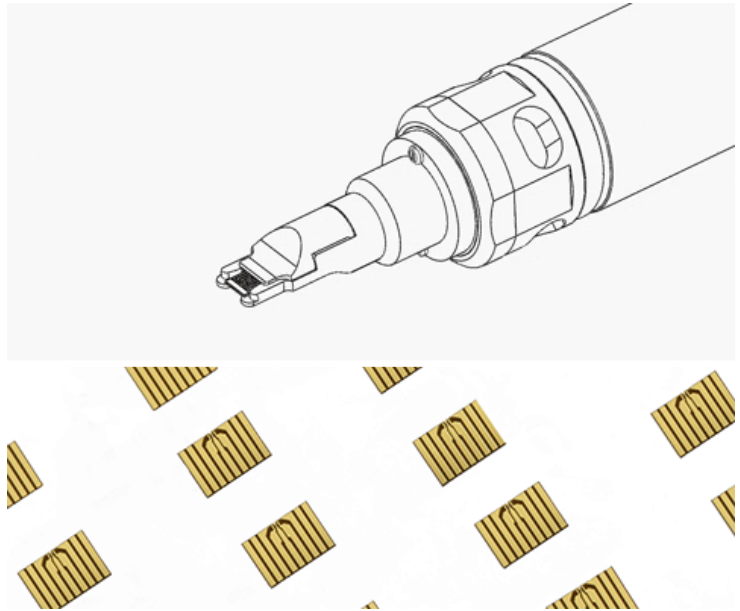
Example research applications of this holder include transport measurements in quantum materials like:

- > Emergent monopoles
- > Skyrmions
- > Topological insulators
- > Superconductors
- > Batteries

## How it Works

The Cryo Biasing TEM Holder cools the sample using liquid nitrogen stored in the dewar and can control sample temperature with closed-loop control. The intuitive software combines both the temperature control system and MEMS chip-based electrical biasing signals to allow the user to manage all aspects of the experiment in a single interface.

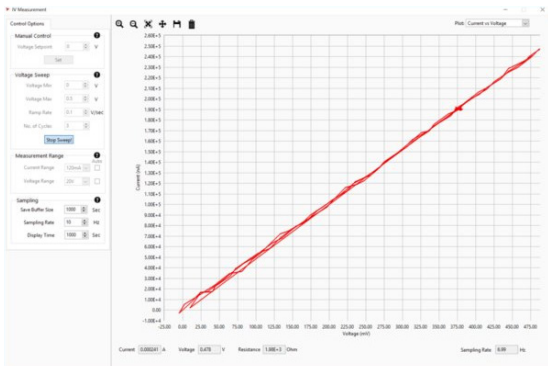
The sample chip can be easily loaded via a Direct Chip Insertion connector with 9 electrical contacts. The sample is prepared directly on one of the many sample substrate chip configurations we offer as standard from stock. Pre-patterned metal leads connect to electron transparent membranes or holes in the substrate to electrically bias the sample. We also offer dedicated chips to streamline FIB sample preparation. Holder consumables are available for customers in our webstore.



## Options

The 1950-series Cryo-Biasing TEM Sample Holder also features a range of options:

- Wide range of biasing power-supply options. Contact us to find out which one suits your needs best.
- Specialized sample biasing substrates – including ones for easy FIB lift-out sample prep



## Related Products



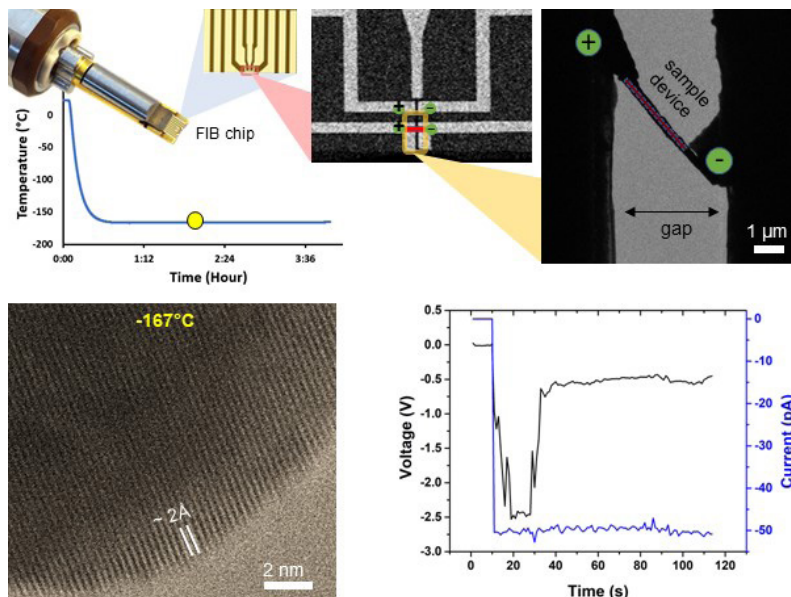
- **Biasing Holder**  
Wire-bonded samples to investigate working devices
- **MEMS Biasing + Heating Holder**  
High temperature transport measurements—phase changes
- **Biasing Manipulator Holder**  
In-situ electrical contacts with mobile probe
- **Air-Free Transfer Biasing Holder**  
Air-free sample transfer to the TEM

## Featured Research

### Real-time transport properties of materials observed at cryogenic temperature

There has been a significant scientific interest in studying material transport behavior at cryogenic temperature in real-time. Hummingbird Scientific's Cryo Biasing TEM holder allows researchers to concurrently cool their sample to liquid nitrogen (LN2) temperatures and apply electrical stimuli. This new capability shows promise in the study of quantum materials with high Curie temperatures ( $T_c$ ) and degradation behavior of batteries at extreme environmental conditions.

Image Right: Top: In-situ TEM temperature cool down and stability (~4 hour Dewar life) along with high-resolution imaging (Au particle) at  $-167^\circ\text{C}$  in the Cryo-Biasing TEM holder in a JEOL 2100 200 kV LaB6 TEM. Bottom (Courtesy of UCSD/Battery500 Consortium): Electrical biasing nanowire in which nanowire sits between the ridge of a FIB-biasing chip at low temperatures in the Cryo-Biasing holder. A constant current experiment on the nanowire in the Cryo-Biasing holder showing voltage drop as the reaction proceeds.



## Accessories



Accessories available for your cryo-biasing holder include:

- > MEMS heating/biasing controller
- > Wide range of biasing power-supply options. Contact us to discuss the best option for your range of applications.
- > Specialized sample biasing substrates – including ones for easy FIB sample prep
- > Vacuum Tip Cover

## Selected Publications

Khim Karki, Daan Hein Alsem and Norman Salmon. **"Cryo-Electrical Microscopy for Quantum and Advanced Energy Applications."** *Microscopy and Microanalysis*, 27 (Suppl 1) August 2021

Khim Karki, Daan Hein Alsem and Norman Salmon. **"Cryo-Electrical Microscopy Platform for Battery and Quantum Energy Applications."** *Materials Research Society Meeting* (2021)

For the most up-to-date Selected Publications please visit: <https://hummingbirdscientific.com/products/cryo-biasing/>



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