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New Sample Holder for High-Resolution Electron Microscopy at Previously Inaccessible Temperatures

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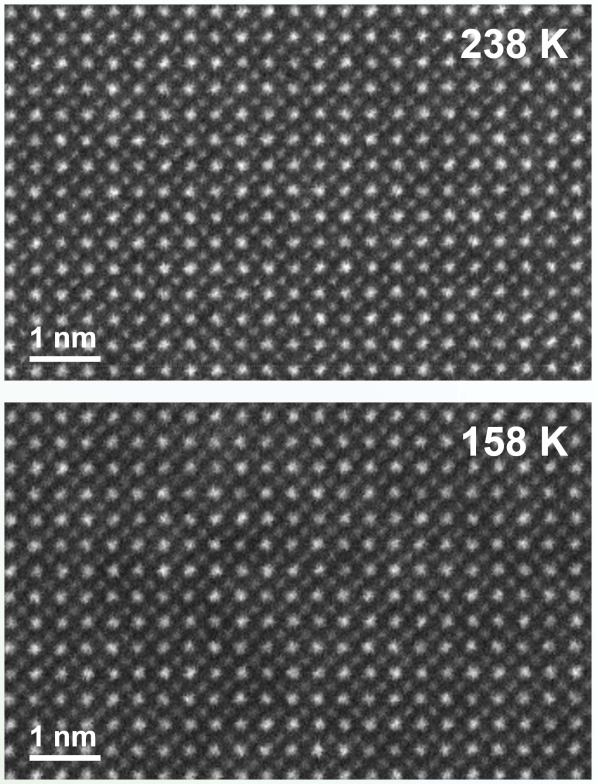
Atomic-resolution cryogenic STEM provides a path to probe the microscopic nature of low-temperature phases in quantum materials. To date, successful high-resolution cryo-experiments have been limited to few and fixed temperatures, dictated by the choice of cryogen, leaving most of the phase space of materials unexplored.

The novel side-entry continuously variable-temperature (CVT) liquid nitrogen cryo-holder specifically addresses this opportunity: the combination of liquid nitrogen cooling with local MEMS heating at the sample permits temperature control between ~100-1000 K. Additional design considerations include a large-volume cryogen reservoir and active rod temperature compensation to further mitigate many of the challenges of standard cryo-STEM experiments, enabling consistent sub-Å imaging resolution and dramatically decreased drift rates.

Our proof-of-concept experiments mark significant progress for the accessibility of variable-temperature cryo-electron microscopy, opening the doors to a new range of high-resolution *in situ* cryo-experiments including the real-time observation of phase transitions, temperature cycling, and access to phases which are stable only in narrow temperature windows.

Broadly tunable, controlled-temperature cryo-STEM is now available to all PARADIM users with the new CVT cryo-holder in and only in PARADIM's Electron Microscopy user facility.

Sub-Å cryo-STEM at variable temperatures allows direct tracking of phase transitions



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