Application of cryogenic in situ biasing (S)TEM holder to study phase transitions in complex oxides

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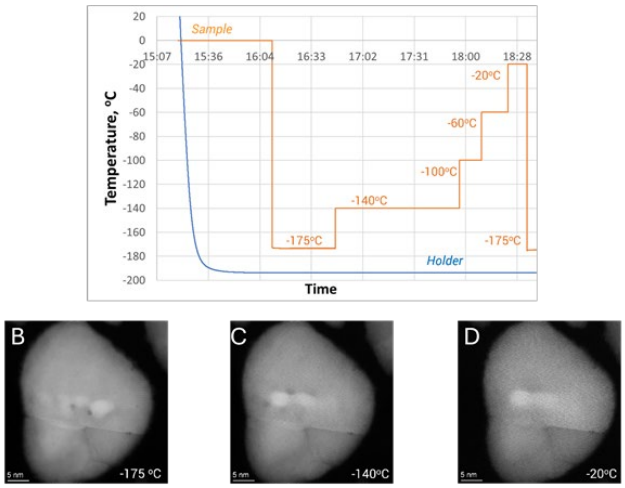
Cryo scanning transmission electron microscopy (STEM) is becoming an indispensable tool for studying phase transitions in a vast range of applications in the field of quantum materials [1], magnetic materials and nanostructures, ferroelectrics [2], topological insulators, etc. at the atomic scale. A detailed characterization of a sample's structural and electronic properties across phase transitions necessitates a sample holder with double tilt capability and a continuous temperature control of the specimen while maintaining a sample stability that enables atomic resolution imaging.

In this contribution, we will share our latest developments of a combined in situ cooling, biasing, and heating holder able to achieve atomic resolution imaging in a wide temperature range [3]. The holder, cooled by liquid nitrogen, allows to set any user-defined temperature (Figure 1). The temperature control is achieved using microelectromechanical systems (MEMS)-based heating and biasing chips [4, 5] in combination with a dedicated cryo TEM sample holder. Due to the low power consumption of the microheater, it is possible to sweep the temperature of the sample from -175oC to +800oC, while maintaining the holder at liquid nitrogen temperatures. It was found that atomic resolution imaging can be attained while continuously varying the temperature over a thousand degrees with marginal focus and image shift.

We will present several application examples applied to ferroelectrics that that include thermal and electrical cycling including cooling conditions.

Graphic:



Keywords:

In Situ, cooling, phase transitions

Reference:

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2. N. Schnitzer, et al., Microscopy and Microanalysis 26 (2020) 2034.
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