

ARS CryoTable

Ultra-low vibration cryogenic platform for AFM topography

Application description

Near field atomic force microscope (AFM) with subwavelength spatial resolution is a powerful tool to study the light-matter interaction of various 2D materials such as graphene and TMDs. Phenomena such as graphene plasmons, hBN polaritons and waveguide modes can be directly accessed at ambient environment and have been extensively studied. However, there are still many promising behaviors in 2D materials which only show up at certain low temperature and are rarely explored due to the lack of a cryogenic near field AFM system. The objective of this research is to build a near field AFM system that can work at variable temperatures and allow us to study the temperature related behaviors of TMDs.

Purpose of the system

In order to realize a near field AFM system, the most critical factor is the vibration isolation. With modifications to the ARS cryostat, the AFM topography noise reduces to 0.3 nm which is acceptable for most measurements. The cooling power comes from two copper braids connecting the AFM to the cold copper plate.

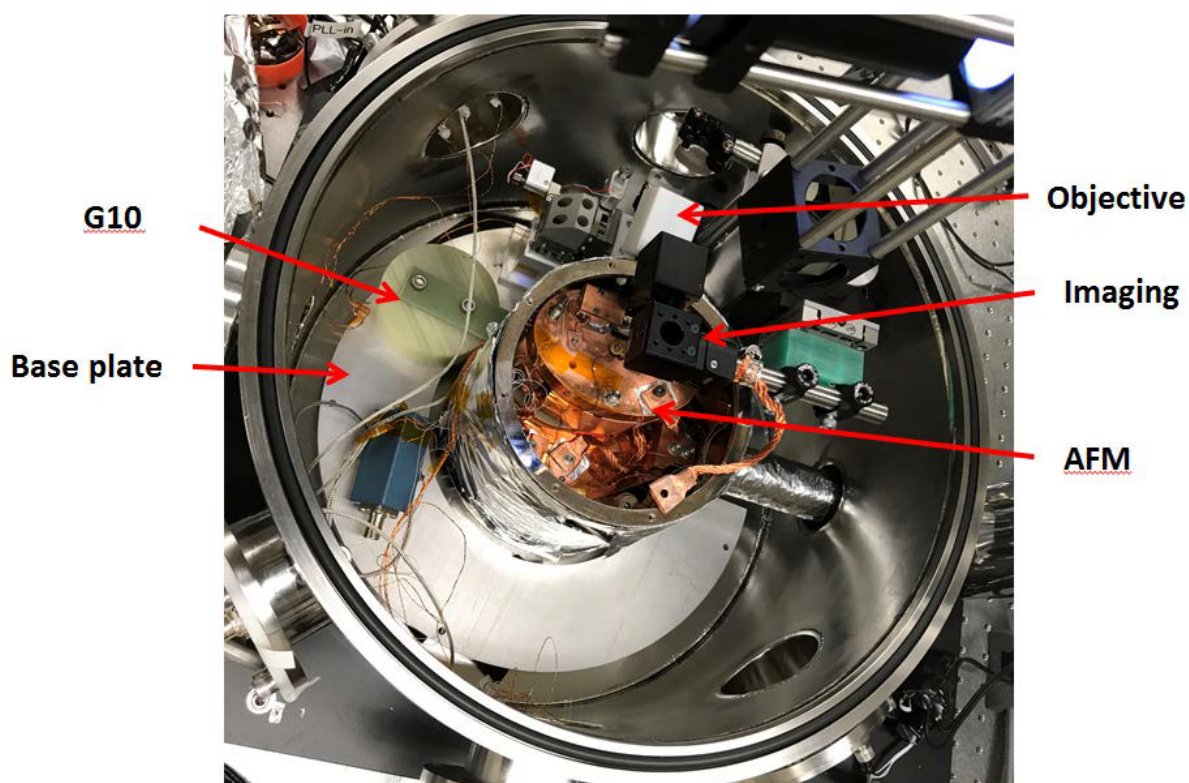


Figure 2: Image of the chamber

Materials under testing

Figure 3 shows the topography and frequency shift images of a metal grating sample. The period of the sample is 10 micron and the height is 183 nm.

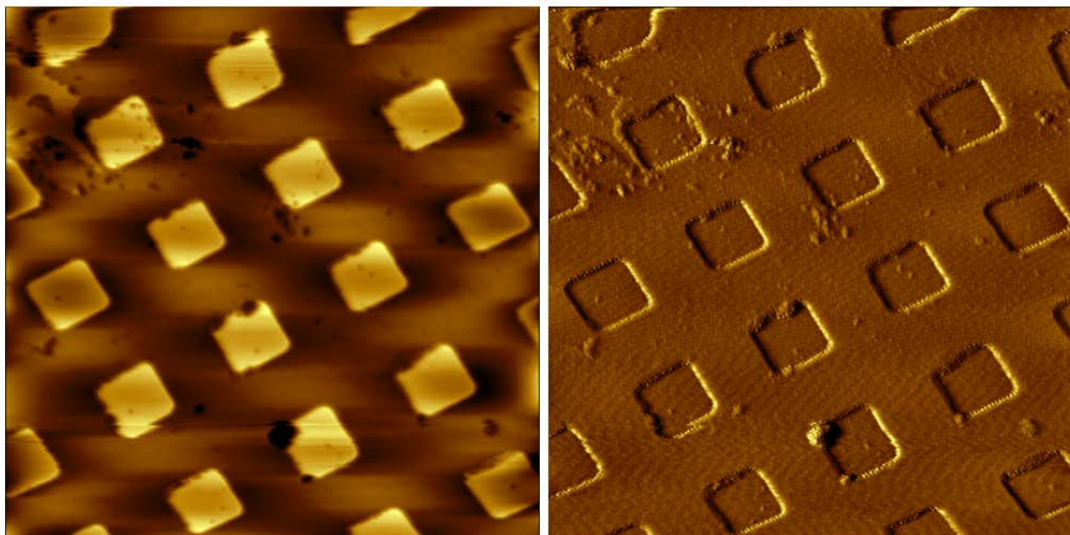


Figure 3: Topography and frequency shift images of a metal grating sample

Figure 4 shows the topography and near field images of a WSe₂ sample. The period in the near field image is due to the interference of the waveguide mode at the edge.

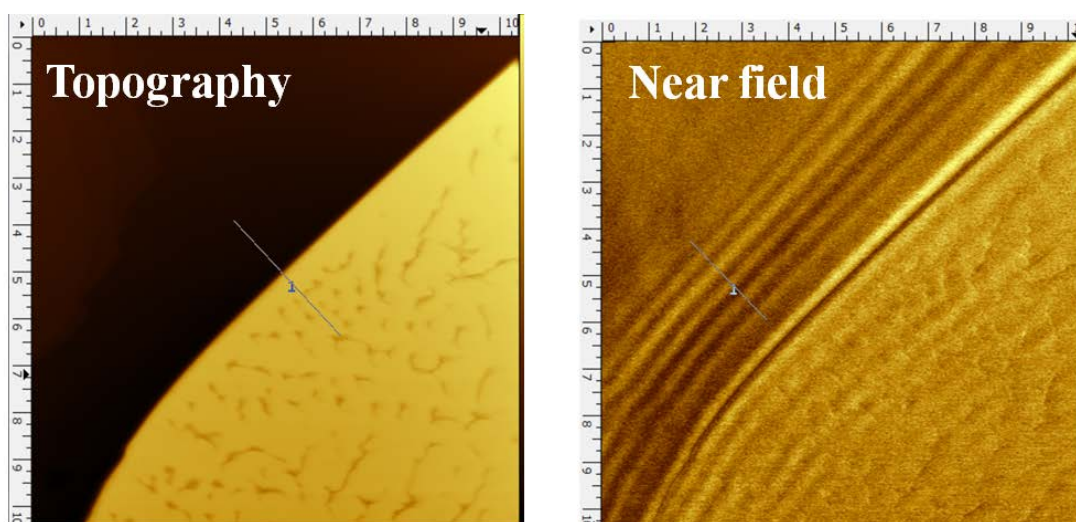


Figure 4: Topography and near field images of a WSe₂ sample. The measurement units are microns.

Measurements taken at the University of California-Berkeley

System configuration and key features

- AFM CryoTable, 14" Vacuum Chamber:
 - o Six ports for 3" windows for optical access and short-distance wiring
 - o Special 14" M6 - threaded chamber baseplate for mounting stages, optomechanics, etc.
- [DE_204PE](#) Closed-Cycle Cryocooler. (< 5.5 K - 350 K)
- [Ultra-Low Vibration](#) Interface - 3-5 nm level vibrations (or better)
- [Feedthrough](#), BNC, 4 each
- [Feedthrough](#), 32 pin
- [AR Coated Zinc Selenide Window](#), 76.2mm Diam, By 6mm Thick