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Experiment Brief

K3 IS Camera

Title

Electric field-induced structural dynamics in MoS_2 observed using *in-situ* transmission electron microscopy

Gatan Instrument Used

K3™ IS direct detection camera delivers simultaneous low-dose imaging via real-time electron counting, fast continuous data capture, and a large field of view.

Background

Grain boundaries and other defects enable tuning of electronic and optical properties of layered transition metal dichalcogenides like MoS_2. However, these grain boundaries may serve as sites for preferential heating and oxidation during device operation. It is ideal to observe and correlate these processes with properties via dynamic high-resolution techniques, such as *in-situ* TEM. By using the lowest possible electron dose rate, the contribution of the electron beam to the observed behavior is limited.

Materials and Methods

Gatan K3 IS camera was used to capture TEM images and videos before and during *in-situ* biasing. The biasing was applied using a Nanofactory holder, customized with a set of electrodes shown in Figure 1a below. A JEOL ARM 300F was used for the experiment.

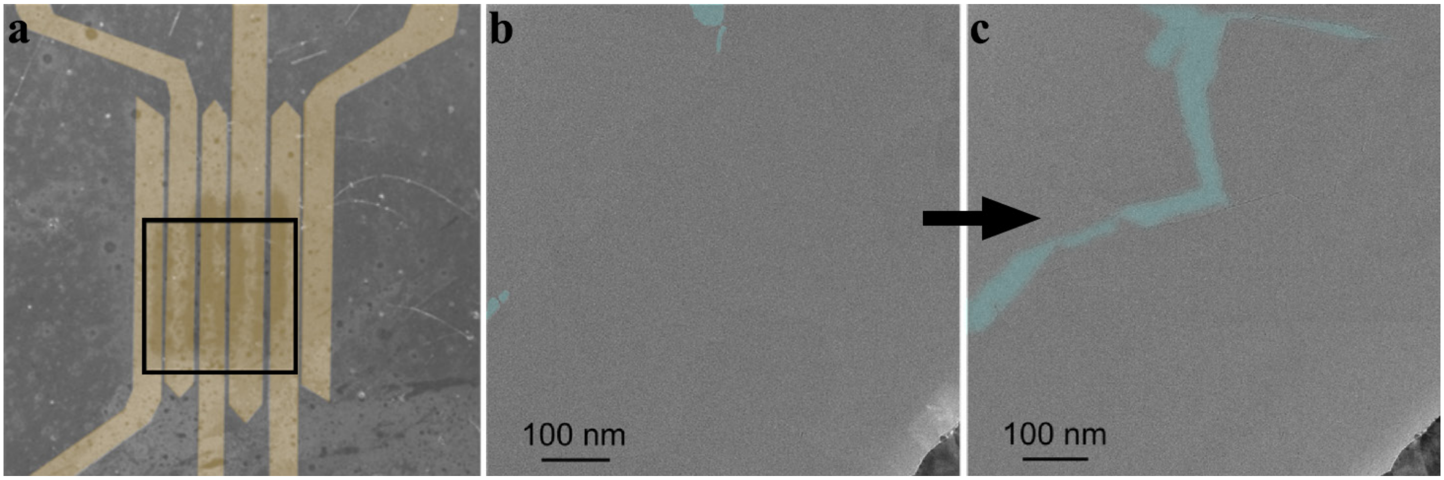

Figure 1. Grain separation during biasing. a) Optical image shows electrodes used to bias the MoS_2. The MoS_2 is deposited on the electrodes roughly in the boxed area. b-c) Low magnification, low-dose, TEM images of one MoS_2 grain boundary region before and after biasing to 1 V potential (electric field: 1 x 103 V/cm). The dose rate used was 15 e-/Å2/s. Voids are colored in blue. Neighboring voids coalesce to form porous chains during biasing. Figure modified from Murthy, A., et al. Direct Visualization of Electric Field induced Structural Dynamics in Monolayer Transition Metal Dichalcogenides. arXiv:1910.02879.

Summary

Low-dose, *in-situ* TEM imaging showed that neighboring voids coalesce to form channels. This is likely due to the migration of S and Mo atoms. This *in-situ* biasing TEM technique could be applied to a variety of monolayer transition metal dichalcogenide interfaces to better understand the fundamental interactions that give rise to observed macroscopic properties.

Credit(s)

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Gatan, Inc. is the world's leading manufacturer of instrumentation and software used to enhance and extend electron microscopes—from specimen preparation and manipulation to imaging and analysis.

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