EELS Analysis on MoS_2 Layers Transferred on Silicon

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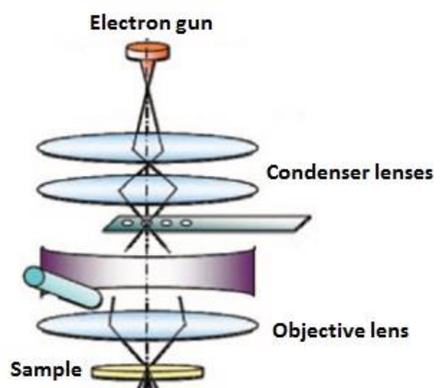
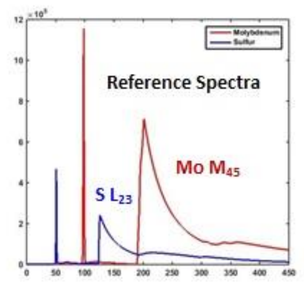
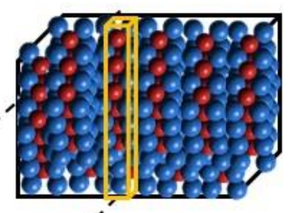
Introduction

Layered two-dimensional (2D) materials that can be mechanically exfoliated into single monolayers have great potential for novel information processing such as spin-based and valley-based electronics. In this paper, the authors have carried out high resolution TEM and electron energy loss spectroscopy (EELS) to investigate MoS_2 layers and their interface with silicon dioxide. Due to the weak nature of van der Waal forces between the S-S layers, stability of layers poses a challenge at high electron acceleration voltages. Dark field STEM (DF-STEM) and EELS, used on 11 layers of MoS_2, reveal an interlayer spacing of ~ 6.25 Å, which is consistent with the reported crystal structure of MoS_2 [1].

System Schematic

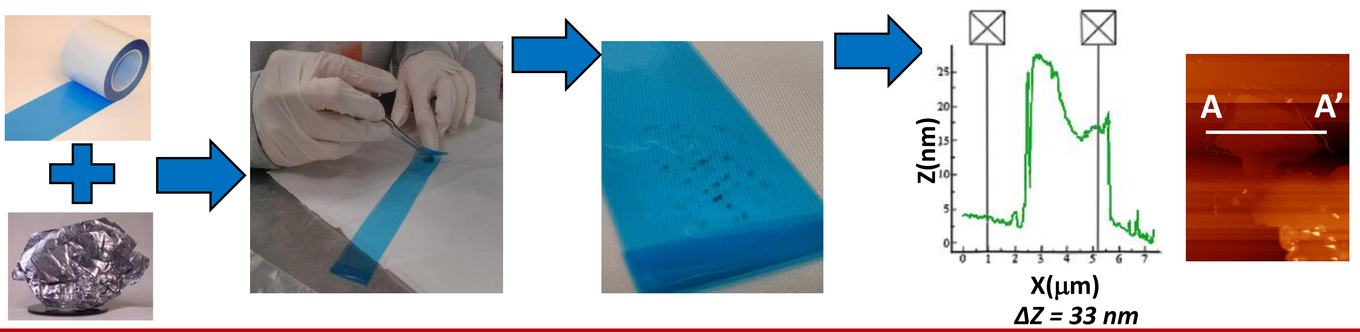






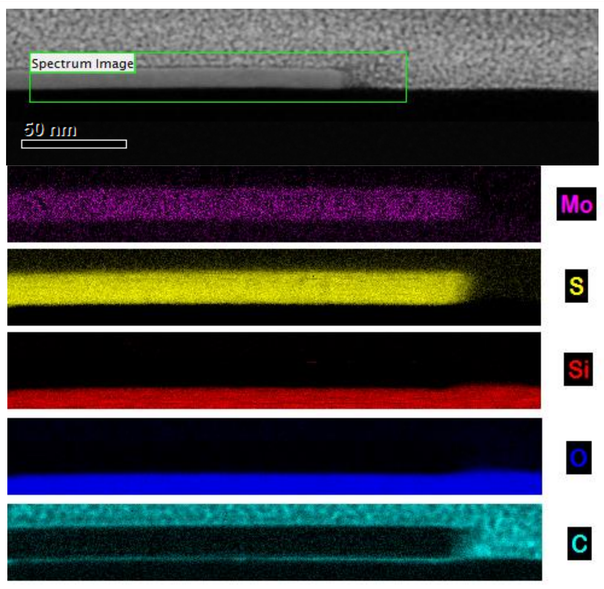
Exfoliation of MoS_2

Layers of MoS_2 are obtained through mechanical exfoliation of bulk MoS_2 crystals (SPI Supplies) on top of SiO_2 layer, thermally grown on highly doped p-type silicon substrate.

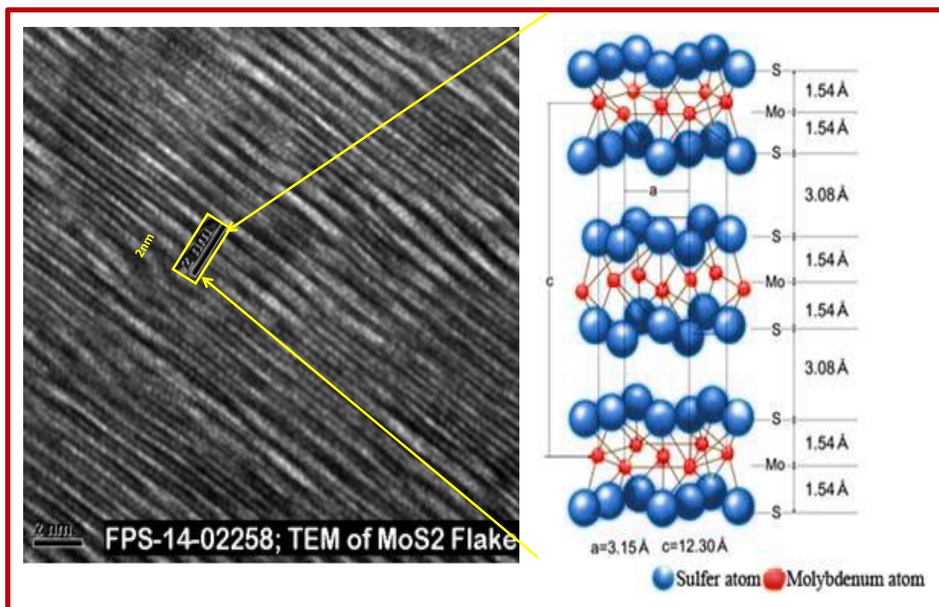


HRSTEM/PEELS

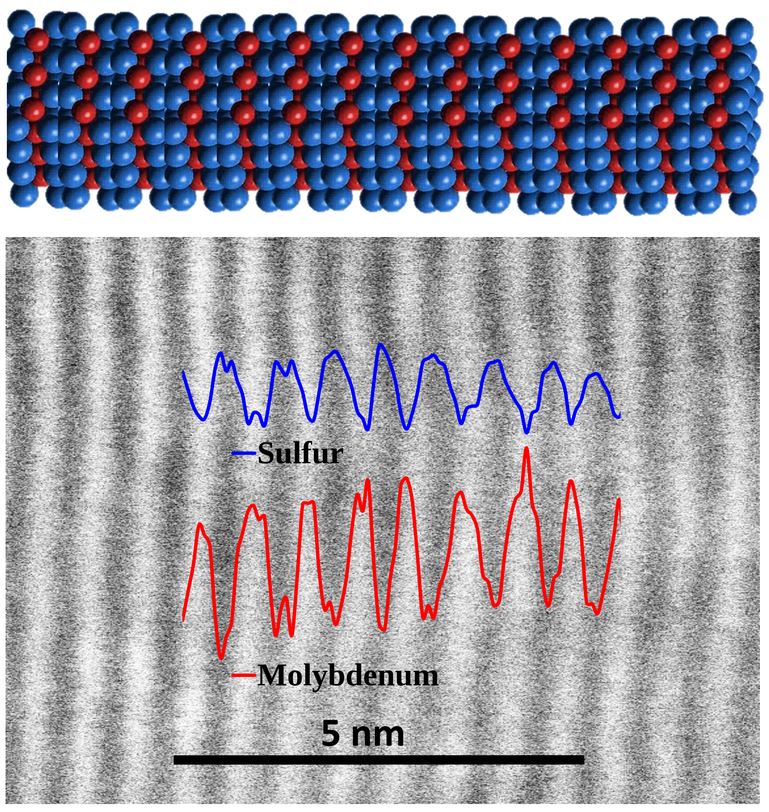
The parallel electron energy loss spectroscopy (PEELS) studies were carried out by employing a Hitachi HD-2300A STEM fitted with a Gatan Enfina PEELS Spectrometer at Micron Inc's Manassas facility. The samples were prepared using a focused ion beam (FIB) with In-Situ Lift Out (INLO). Prior to INLO, a MoS_2 flake was coated with SEM induced Pt deposition at 5kV. The lamella were prepared with 30kV FIB down to 100nm thickness, with a final thinning to ~30nm with 5kV FIB.



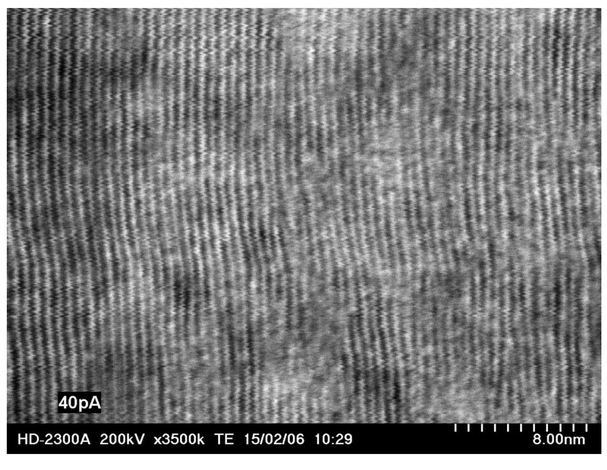
Areal EELS scans for its elemental composition.

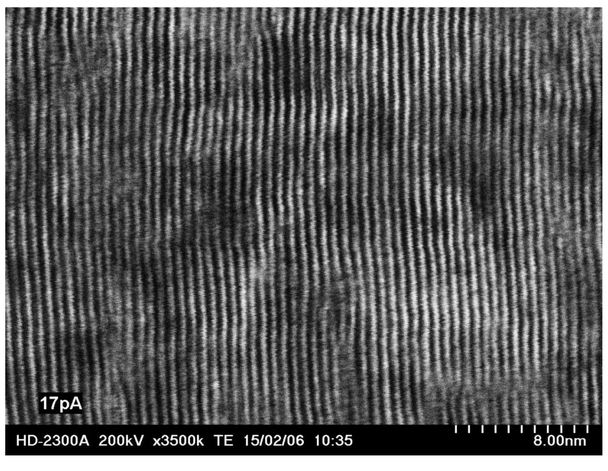


HRTEM image of MoS_2 flake showing its layers. The structure of MoS_2 is shown on the right.



DF-STEM image with EELS line scans for S and Mo.





Phase contrast STEM images taken at 40pA and 17pA beam current at 200kV.

References

[1] B. Radisavljevic, A. Radenovic, J. Brivio V. Giacometti V, Kis A, *Nature Nanotechnology* 6, 147-150 (2011).
[2] Xiao Feng Zhang, Microscopy Today, p. 26-29, 2011

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