Abstract Submitted
for the MAR17 Meeting of
The American Physical Society

Correlating Crystal Quality with Electronic Properties in Transition Metal Dichalcogenide Semiconductors DREW EDELBERG, IRENE ZHANG, DANIEL RHODES, BENJAMIN FOUTTY, Columbia University, FERNANDO STAVALE, Centro Brasileiro de Pesquisas Fsicas, LUIS BALICAS, National High Magnetic Field Lab, JAMES HONE, ABHAY PASUPATHY, Columbia University — Monolayer transition metal dichalcogenides (TMD) have given rise to a new era of two-dimensional layered, semiconducting devices for electronics and optoelectronics applications. One of the limiting features in TMD materials is the presence of traps and scattering centers that lead to a degradation of performance. These defects can lie either in the monolayer TMD itself, or can exist in the substrate that the monolayer is placed on. A better understanding of the disorder affecting these materials can be achieved by separating intrinsic sources of disorder (ie, defects within the crystal) from extrinsic ones. To do this, we present a study of cleaved bulk crystals of the TMD semiconductor MoSe2 using atomic-resolution scanning tunneling microscopy (STM) and spectroscopy (STS). We study bulk crystals of MoSe2 grown using two established techniques, chemical vapor transport (CVT) and flux-based growth. STM measurements reveal that crystals grown by selenium flux have a sharply lower defect concentration when compared to images taken on CVT grown crystals. Analysis of local electronic structure using STS reveals both acceptor and donor defects that cause local bandgap shifts. Finally, we correlate our STM data with optical measurements of excitonic lifetimes to show that intrinsic defects have a direct relationship to the quality of monolayer TMD devices.

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Date submitted: 11 Nov 2016

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