Non trivial doping evolution of electronic properties in an aliovalent transition metal dichalcogenide alloy.

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Transition metal dichalcogenides (TMDs) offer unprecedented versatility to engineer two dimensional (2D) materials with tailored properties to explore novel structural and electronic phase transitions. The possibility of substituting one of the atomic elements by different species has greatly expanded the potential of this family of 2D materials. So far, isovalent group VI TMD alloys (such as $Mo_\delta W_{1-\delta}S_2$, $WS_{2(1-\delta)}Se_{2\delta}$, etc.) have received most of the attention due to the possibility to tune the electronic and optical bandgaps[1,2]. Regarding aliovalent TMD alloys where TMs with different valences are involved, most efforts have focused on the dilute limit. In this talk, an experimental and theoretical investigation of the aliovalent TMD alloy $Nb_{1-\delta}Mo_\delta Se_2$ is presented[3]. We have successfully synthesized high-quality monolayers across the entire $0 < \delta < 1$ range, and examine the evolution of the atomic and electronic structure using low-temperature (0.34 – 4.2 K) STM/STS. Our measurements enable us to explore the effect of electron doping on the monolayer $NbSe_2$ and track its impact on the electronic bands. Particularly, the semiconductor to metallic transition, the robustness of charge density waves and evolution of superconductivity is discussed for this system.

References

[1] Zheng et.al., ACS Nano, 2014, 8,7, 7130-7137
[2] Mann et.al., Advanced Materials, 2014, 26, 9, 1399-1404
[3] Wan et.al., (article submitted)

Figures

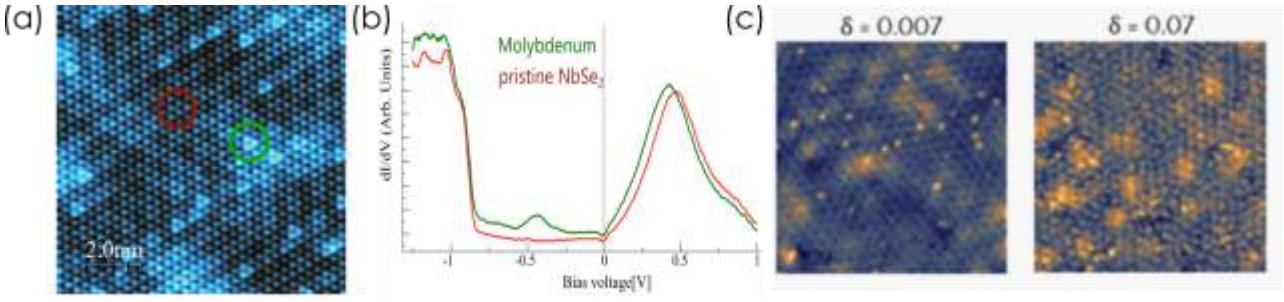

Figure 1: Identifying a Mo defect in $NbSe_2$ lattice by (a) STM topography and (b) the corresponding STS comparison. (c) High-resolution STM images showing charge density waves for different Mo concentrations (left shows for 0.7 % and right one for 7 % Mo doping)