# An atomic-scale look at point defects in truly 2D semiconductors

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Point defects play an important role in semiconductor physics to tune physical and chemical properties of the host material. Due to the intrinsic confinement, two-dimensional semiconductors such as transition metal dichalcogenides (TMDs) are even more affected by structural defects. In this talk I will give an overview on the structural and electronic properties of an abundant chalcogen-site point defect common to $MoSe_2$ and $WS_2$ monolayers grown by molecular beam epitaxy and chemical vapor deposition, respectively.

Using 4K scanning tunneling microscopy and spectroscopy, and non-contact atomic force microscopy we visualize and directly correlate the morphology and electronic properties of the most abundant type of structural defect in the described TMDs with atomic resolution. Surprisingly, we observe no in-gap states. We propose that the observed chalcogen defects are oxygen substitutional defects[1], rather than vacancies, as commonly reported. Furthermore, by annealing our $WS_2$ samples at about 600° C in ultra high vacuum conditions, we also observe the formation of pristine sulfur vacancies, which reveals a characteristic fingerprint with two narrow unoccupied defect states[2].

## References

[1] Barja, S. et al., Nature Communications, 10 (2019) 3382
[2] Schuler, B, et al. Physical Review Letters, 123, (2019) 076801

## Figures

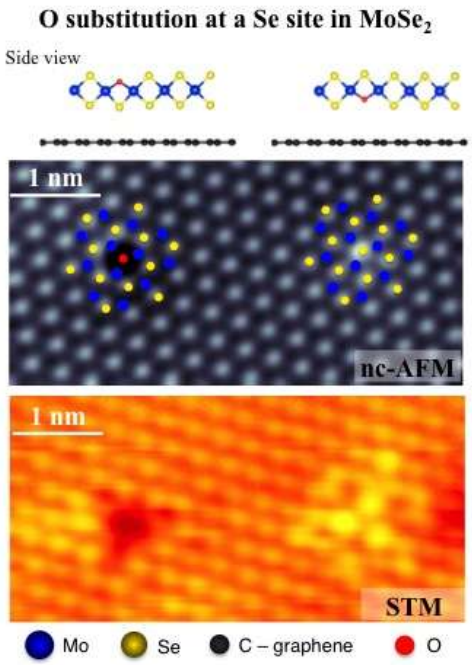


**Figure 1:** Nc-AFM and STM images of the two same atomic size defects, identified as O-passivated Se vacancies placed in the top (left defect) and bottom (right defect) Se-sublattices.