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# Direct growth of sub-10nm $MoS_2$ nanoribbons and their width dependent quantum properties

Many of the electronic and optical behaviors of atomically thin transition metal dichalcogenides are strongly dependant on their number of layers and width. Therefore, it is of central importance to develop facile methods for their controllable synthesis. We report the growth of bilayer $MoS_2$ nanoribbons enabled by nickel nanoparticles, which promotes both heterogenous nucleation of the first layer of $MoS_2$ and simultaneously catalyzes homoepitaxial tip-growth of a second layer via vapor-liquid-solid (VLS) mechanism, resulting in bilayer nanoribbons with width controlled by the nanoparticle diameter. Theoretical simulations also confirm the VLS growth mechanism towards nanoribbons and its orders of magnitude higher growth speed compared to the conventional non-catalytic growth of flakes. Coulomb blockade oscillations are observed in the transfer characteristics of the nanoribbons at low temperatures. Such an oscillation behavior is width-dependent, only showing in nanoribbons with width <20 nm, and observable at temperatures up to 80 K. The phenomenon evidences the value of this proposed synthesis strategy for future nanoelectronics and quantum applications.

## References

[1] X. Li *et al*., *Sci. Adv.* **7**, abk1892 (2021).

## Figures

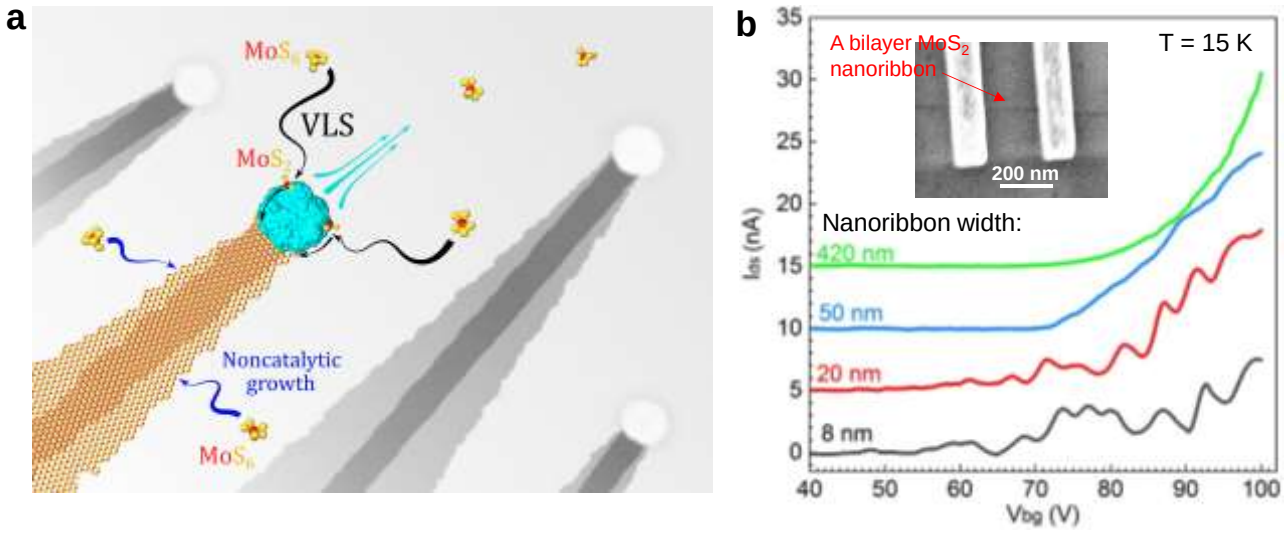


**Figure 1:** (**a**) Schematic illustration of the bidirectional growth of the bilayer $MoS_2$ ribbons (top layer: VLS, bottom layer: non-catalytic). (**b**) Transfer curves of nanoribbons with different widths (420−8 nm) at 15 K. The nanoribbons width with <20 nm show strong Coulomb blockade oscillations. Inset is the SEM image of a typical device.