Emergent 2D magnetism in MBE-grown van der Waals superstructures

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Two-dimensional (2D) quantum materials and their integrated superstructures host emergent phenomena associated with reduced dimensionality, modified lattice symmetry, and enhanced proximity coupling. Such 2D quantum materials and their superstructures have been mainly fabricated by a top-down approach by combining exfoliation, pick-up, and dry-transfer techniques, while a bottom-up synthesis by molecular-beam epitaxy (MBE) should provide an alternative approach, enabling growth and integration of different types of materials including hardly-cleavable, chemically-unstable, as well as thermally-metastable compounds. We have so far established a route to layer-by-layer epitaxial growth of a number of 2D materials by MBE on insulating substrates [1], and explored their transport properties in the 2D regime [2-6]. In this presentation, we will introduce our recent activities on exploration of emergent 2D magnetism in MBE-grown van der Waals superstructures [7-9]. We will in particular focus on an emergent ferromagnetic state in 2D $NbSe_2$ induced by a strong proximity coupling at a magnetic van der Waals interface with a 2D ferromagnet V_5Se_8 [8], which was proven by the anomalous-Hall effect signals unique to ferromagnetic $NbSe_2$. Owing to the strong spin-valley locking effect in 2D $NbSe_2$ associated with a characteristic Zeeman-type spin-orbit interaction, this emergent ferromagnetic state should accompany a ferrovalley state with spontaneous valley polarization as well. We will also introduce our attempts to fill a van der Waals gap of 2D $NbSe_2$ with 3*d* transition-metal ions to form an "intercalated van der Waals superstructure" [9], which should provide a unique and powerful approach to exploration of emergent 2D magnetic and topological properties.

References

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Figures

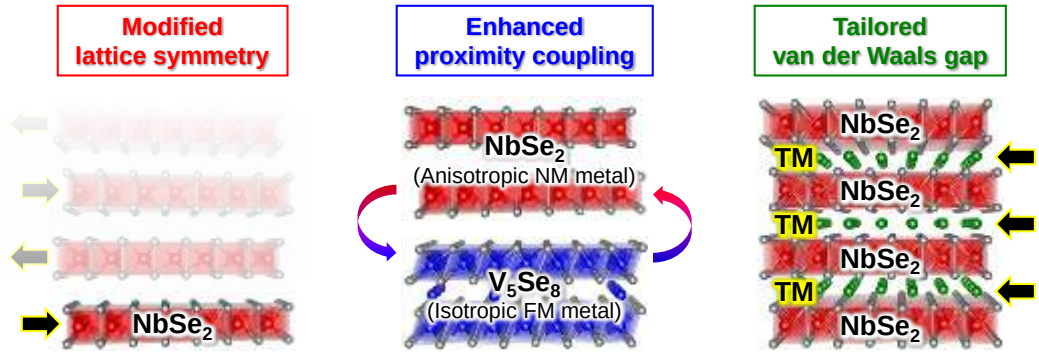

Figure 1: Exploring emergent 2D properties in MBE-grown van der Waals superstructures