Single- and few-layer metallic NbS_2: growth, optical identification and transport properties

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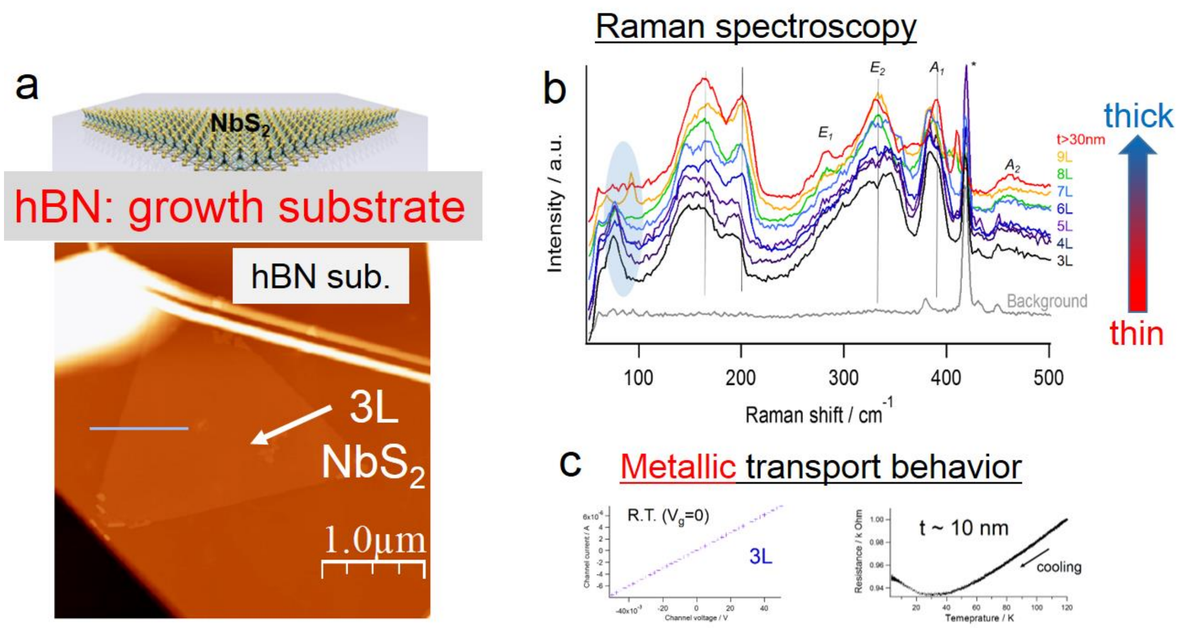
The recent discovery of superconductivity in two-dimensional (2D) systems has provided great research impacts in both communities of superconductivity and 2D materials[1-2]. The discovery has broken through the well-accepted idea that the 2D superconductivity has been considered to be susceptible to quantum fluctuations, expanding the research on superconductors to various 2D materials. Superconductivity in two-dimensional (2D) materials strongly relies on the growth of 2D layered metallic systems. Preparation of 2D metallic systems has, however, so far been limited, which is in stark contrast to the well-studied 2D layered semiconductors.

We report the first successful growth of 2D metallic transition metal dichalcogenides (TMDCs), NbS_2, by chemical vapor deposition (CVD) method, where direct growths of monolayer NbS2 and the thinnest 3R-NbS_2 (3 layers) on atomically flat hexagonal boron nitride (hBN) are shown. The key to the successful growth of ultrathin NbS_2 can be summarized by the following two factors: (1) the precise tuning of growth condition using the 3-funace CVD method and (2) the utilization of atomically flat hBN as growth substrates. Raman spectroscopy and optical transmission imaging are performed for the detailed optical characterization of 2D NbS_2, providing the basis for layer-number-dependent structure identification. The transport measurements on thin-layered 3R-NbS_2 with different thickness show that 3R-NbS_2 with thickness down to 2D limit is still metal, being consistent with DFT-based calculations[3]. The current study opens up new synthetic routes for controllable growth of 2D layered metallic materials and thus offers new fundamental and technological pathways for the research of metallic 2D systems, which may lead to finding novel 2D superconductors and underlying new physics.



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