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CVD growth of 2D transition metal dichalcogenides and carbides

We developed an ambient-pressure chemical vapor deposition (AP-CVD) method to grow high-quality and uniform monolayer WS_2 and WSe_2 single crystals of millimeter size and continuous films by using Au foil as a substrate [1,2]. The WS_2 follows a self-limited growth mechanism, and the WSe_2 shows an ultrafast growth rate of ~26 μm s^{-1}. The materials can be transferred to arbitrary substrates by electrochemical bubbling method without sacrificing the Au substrates, and show high crystal quality and electrical properties comparable to mechanically exfoliated samples. We also demonstrated the batch fabrication of large-area flexible monolayer WS_2 film transistor arrays by roll-to-roll/bubbling method. In addition, we developed an AP-CVD method to grow large-size high-quality ultrathin 2D transition metal carbides by using a bilayer of Cu/transition metal as a substrate [3]. The 2D Mo_2C crystals obtained are a few nanometer thick and show 2D superconductivity [3,4]. We also realized the growth of high-quality graphene/2D Mo_2C vertical heterostructures with well-aligned lattice orientation and strong interface coupling by a two-step CVD [5]. Such heterostructures show unique phase diagram of superconducting transition and enable the fabrication of highly transparent Josephson junction devices.

References

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