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New Mechanism for the Growth of 2D Materials

The role of additives in facilitating the growth of conventional semiconducting thin films for cutting-edge electronics is well established. Apparently, their presence is also decisive in the growth of two-dimensional transition metal dichalcogenides (TMDs), yet their role remains ambiguous. Current dominant model suggest that the salt additives promote the growth by lowering the melting points of the refractory metal oxide precursors. In this work we will show that the growth of TMD monolayers enabled by a salt additive is governed by a surfactant-mediated mechanism. Specifically, we discovered that when using sodium bromide as an additive to molybdenum dioxide precursors, the sodium atoms chemically passivate the edges of the growing molybdenum disulfide monolayer crystals, relaxing in-plane strains so as to suppress 3D islanding and promote monolayer growth. Furthermore, pre-deposited salt on substrates acts as a removable template for patterned growth of monolayers aiming at lithography-free device fabrication. This finding provides a strategy for the synthesis of new TMD monolayers on various surfaces with desirable patterns.