Catalyst-driven growth kinetics for control of crystalline structures of two-dimensional MoS_2

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Catalysts play key roles to determine the growth kinetics of two-dimensional transition metal dichalcogenides by chemical vapor deposition. However, the roles of different catalytic intermediates on each growth step are still largely unknown. Here, we study the catalyst-assisted metal-organic chemical vapor deposition of monolayer MoS_2 with different atomic/molecular elements, supplied by growth substrates. Na elements embedded in the substrates similarly enhance the growth rates, regardless of the surrounding mediums. On the other hand, the domain sizes can vary by an order of magnitude, depending on the composition of seed elements. Na-Mo-O eutectic alloys reduced the density of nuclei by Ostwald ripening, resulting in large MoS_2 domains by vapor-liquid-solid mechanism. Growths mediated by different catalysts resulted in high crystalline films as electrical channel of field-effect transistor, and nano-crystalline flakes for enhanced hydrogen evolution reaction.