Ultrafast Interfacial Self-Assembly of 2D Transition Metal Dichalcogenides Monolayer Films and Their Vertical and In-Plane Heterostructures

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For the real-world applications of 2D TMD and their heterostructures, it is essential to develop cost-effective reliable methods for uniform thin films. In this regard, solution processing has great advantages for large area scalable continuous processing.[1] Unfortunately, the inherent low dispersibility of atomic 2D materials in common solvents makes it challenging to attain large area scalability and reliable controllability of layer numbers. In this work, we report reliable and unusually fast interfacial self-assembly of chemically exfoliated TMD from dilute dispersions. Chemically exfoliated 2D TMD flakes are assembled into large-area monolayer films with high surface coverage in a few minutes by simple addition of ethyl acetate (EA) to the dilute aqueous solution. This interfacial assembly can be universally applied to various TMDs such as MoS_2, WS_2, $NbSe_2$ and, moreover, can be extended to the fabrication of complex structures, such as lateral or vertical assembled heterostructured TMD thin films by assembling more than two different TMD flakes in a simultaneous or sequential manner.

References

[1] S. O. Kim et al., ACS Nano 6(2012), 159-167.

Figures

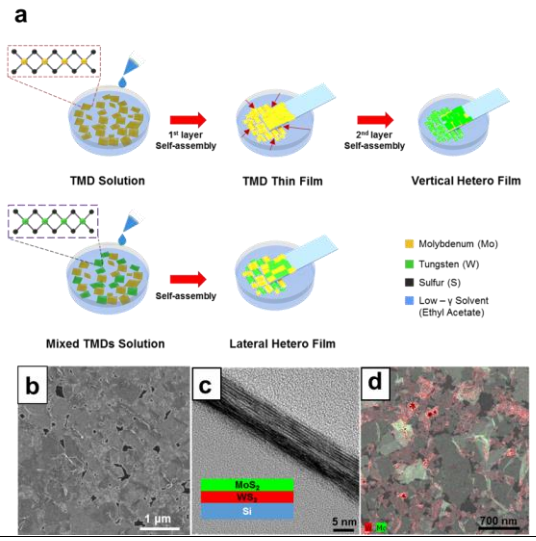

Figure 1: (a) Schematic illustration of interfacial TMD assembly films. (b) SEM image of assembled pure MoS_2 film. (c) TEM cross section image of vertical MoS_2/WS_2 film. (d) STEM image of lateral heterostructured MoS_2/WS_2 film.

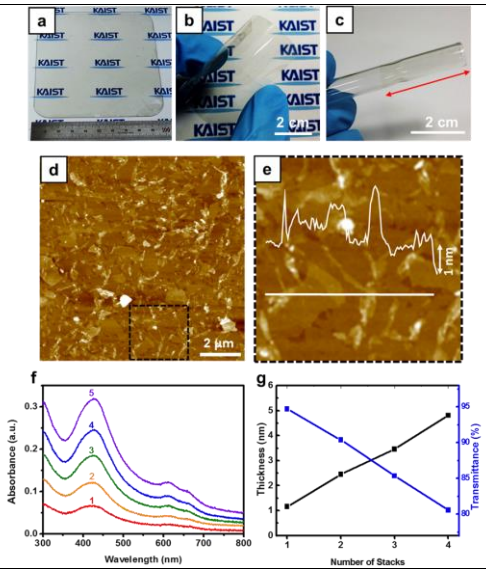

Figure 2: MoS_2 films transferred onto (a) 10 cm glass, (b) flexible PET film and (c) curved glass pipet. (d) AFM image of a MoS_2 thin film. (e) Magnified AFM image. (f) UV-vis Absorbance spectra at various number of stacks. (g) Film thickness and transmittance at 550 nm plotted against the number of layer stacks.