Growth of 2D Transition Metal Dichalcogenide Monolayers, Heterostructures and Their Applications

Prof Lain-Jong (Lance) Li
Prof of Materials Science and Engineering Physical Sciences and Engineering Division, King Abdullah Univ. of Science and Technology, Thuwal, Kingdom of Saudi Arabia

Our recent demonstration in vapor phase growth of TMD monolayers such as MoS2 and WSe2 has stimulated the research in growth and applications (1). The growth mechanism and the orientation control of the 2D flakes will be first discussed. These 2D monolayer building blocks can be used to form p-n junctions. For example, the heterostructures of 2D materials formed by vertical stacking have been realized via transfer of their exfoliated flakes, where their electronic structures are dominated by the stacking orientation and strength of interlayer coupling (2). Another very attractive structure is the lateral heterojunction, where we have demonstrated that the atomically sharp p-n junction exhibits diode properties and a large strain exhibits at the junction region which offers tunability in electronic structures (3).

In addition to the symmetry 2D materials, we have also developed a method that can precisely manipulate arrangement of chalcogenide atoms (S and Se) along the vertical direction of TMD. This new strategy allows us to fabricate a MoSSe Janus structure, where the transition metals are sandwiched by selenium at upmost and sulfur at bottom. Such a Janus 2D monolayer exhibits piezoelectric responses and optical dipole along out-of-plane direction (4).

References