Interface Modulated Interlayer Excitons in Large-Area CVD-Grown Vertical MoS_2/WS_2 Heterostructures

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Understanding how interfacial quality governs exciton localisation and hybridisation is central to excitonic engineering in van der Waals heterostructures. Here, we report two single-step chemical vapour deposition growth routes for large-area (up to ≈600 μm), continuous MoS_2/WS_2 heterostructures, enabling a systematic comparison of excitonic behaviour across contrasting interface qualities. Photoluminescence (PL) studies, supported by ultra-low frequency Raman spectroscopy, reveal two distinct interlayer exciton (ILE) regimes governed by interface disorder and interlayer coupling. Contrasting behaviour in the temperature-dependent PL is observed for the two samples, indicating the important role of the interface quality. Modulating the interface changes the excitonic nature from defect-trapped ILE to delocalized ILE stabilised by strong interlayer coupling. By distinguishing defect-trapped and free ILEs through their thermal evolution, this work establishes PL as a sensitive probe of interface quality. It demonstrates scalable interface-driven excitonic engineering in MoS_2/WS_2 heterostructures.

References

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Figures

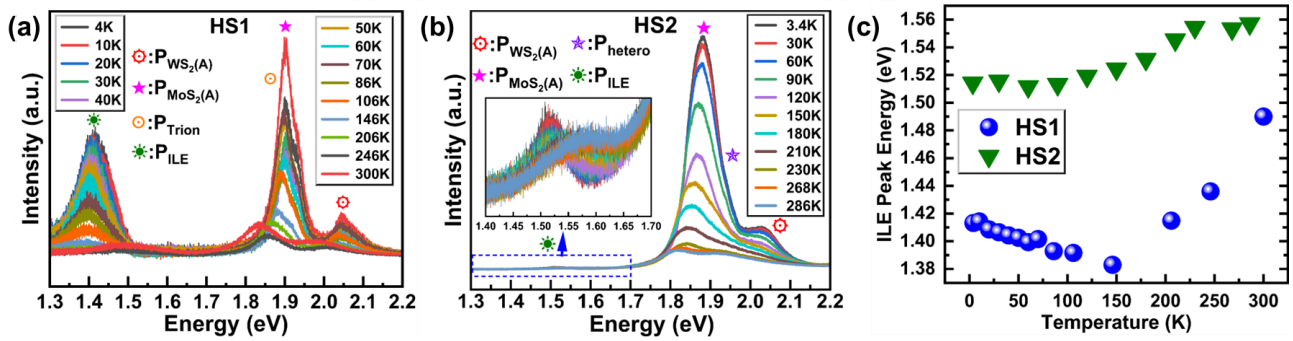

Figure 1: (a, b) Temperature-dependent PL spectra of weakly coupled (HS1) and strongly coupled (HS2) MoS_2/WS_2 heterobilayers, respectively. (c) Temperature evolution of ILE showing a pronounced red-to-blue shift in HS1, in contrast to a purely monotonic blueshift in HS2.