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Optical Generation of High Carrier Densities in 2D Semiconductor Hetero-Bilayers

Abstract:
Controlling charge density in two dimensional (2D) materials is a powerful approach for engineering new electronic phases and properties. Such control is traditionally realized by electrostatic gating. Here, we report an optical approach for generation of high carrier densities utilizing transition metal dichalcogenide hetero-bilayers, $WSe_2/MoSe_2$, with type II band alignment. By tuning the optical excitation density above the Mott threshold, we realize the phase transition from interlayer excitons to charge-separated electron/hole plasmas, where photoexcited electrons and holes are localized to individual layers. Remarkably, high carrier densities up to $4x10^{14}$ cm^{-2} can be sustained under both pulsed and continuous wave excitation conditions. These findings open the door to optical control of electronic phases in 2D hetero-bilayers.

Figures

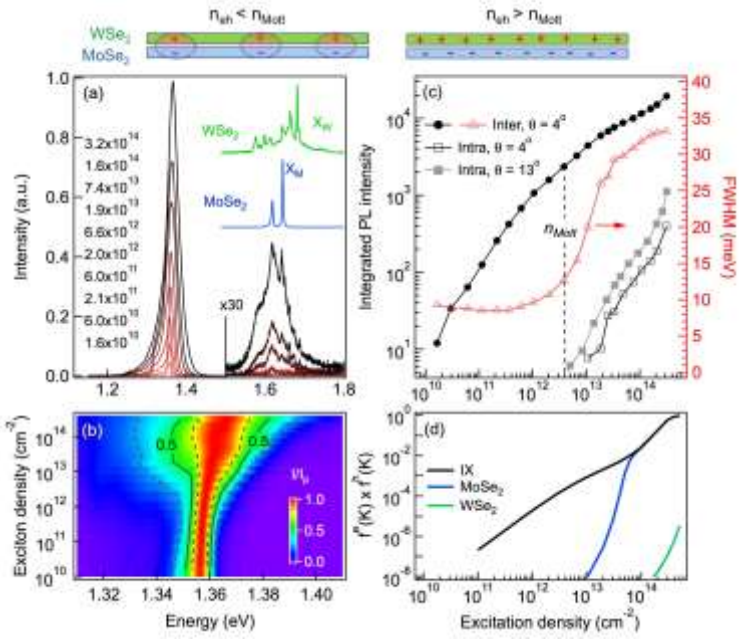

Figure 1: Excitation density dependent photoluminescence (PL) and Mott transition in the $WSe_2/MoSe_2$ hetero-bilayer.