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Engineering excitonic properties and valley polarization in transition metal dichalcogenide monolayers[1]

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Binary Transition metal dichalcogenide (TMDC) monolayer (ML) materials MoS2, MoSe2, WSe2, WS2 and MoTe2 share common properties such as a direct optical bandgap, Spin-Orbit splittings of hundreds of meV and coupled spin-valley states. Optical absorption and emission are dominated by robust excitons, whose resonances also strongly influence Raman scattering amplitudes [1] and second harmonic generation efficiency [2]. Important differences in opto-electronic properties between these materials depend on whether the exciton ground state is optically bright or dark. This order will depend on the conduction band Spin-Orbit splitting and the electron-hole Coulomb interaction and will have strong influence on the light emission yield of the TMDC MLs. In this talk we discuss Spin-Orbit engineering in Mo(1-x)W(x)Se2 alloy monolayers [3]. We probe the impact of the tuning of the conduction band Spin-Orbit spin splitting on the bright versus dark exciton population. For MoSe2 monolayers the PL intensity decreases as a function of temperature by an order of magnitude (T=4-300 K), whereas for WSe2 we measure surprisingly an order of magnitude increase. The ternary material shows a trend between these two extreme behaviors. In addition we show a non-linear increase of the optically generated valley polarization as a function of tungsten (W) concentration. Tuning the optical properties in applied external fields will be discussed. [1] G. Wang et al, PRL 115, 117401 (2015) [2] G. Wang et al, 2D Mater. 2 , 045005 (2015) [3] G. Wang et al, Nature Comms. (in press, arxiv 1506.08114)

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