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Optical Transitions and Valley Polarization in 2D Transition Metal Dichalcogenides

Two dimensional (2D) materials derived from Transition Metal Dichalcogenides (TMD) offer a new platform for exploring new physics and for the development of new device concepts such as 'Valleytronics'. The field 'Valleytronics' is based on controlling the population of charge carriers in the local conduction/valence band (Valleys) in order to tune the charge transport properties. The key material features enabling the selective population of valley states including the direct band gap, strong spin orbit coupling and breaking of spatial inversion symmetry [1]. In addition to the intrinsic materials properties, the extrinsic properties such as the ratio between the neutral and charged excitons, generation/recombination of excitations and layer interfaces could also play a role. In this talk, our efforts to understand the optical properties of mono to few layers of WSe2 and WS2 flakes will be presented. The experimental techniques such as micro-Raman spectroscopy, Photoluminescence and Circular dichroic photoluminescence spectroscopy methods were used to understand different optical transitions and degree of valley polarization. The thin layers were prepared using mechanical exfoliation technique and the number of layers was confirmed using Raman/photoluminescence spectra (shown in Figure 1). The low temperature photoluminescence studies were used to identify the nature of various excited states and to understand their recombination pathways. The degree of valley polarization in WSe_2 and WS_2 layers were studied using customized circular dichroic photoluminescence spectroscopy at low temperature and the key results obtained from our studies will be discussed in detail.

References

[1] A. M. Jones, H. Yu, N. J. Ghimire, S. Wu, G. Aivazian, J. S. Ross, B. Zhao, J. Yan, D. G. Mandrus, D. Xiao, W. Yao and X. Xu, Nat. Nanotechnol., 8, (2013), 634.

Figures

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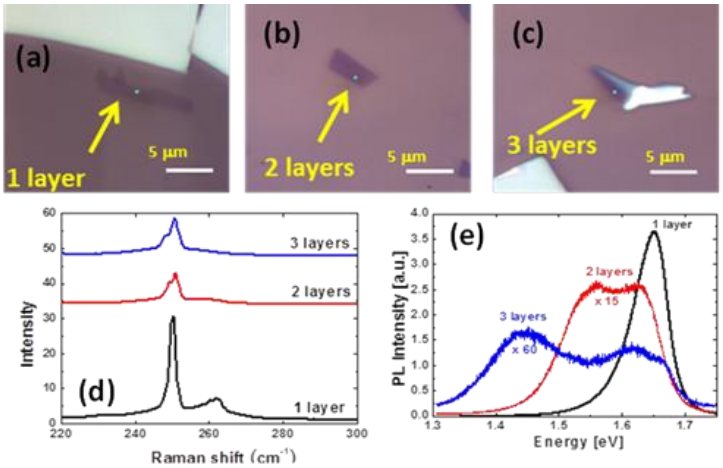

Figure 1. (a-c) Optical microscopy image of exfoliated WSe_2 flakes on SiO_2/Si; (d) Raman spectra of 1, 2 and 3 layers of WSe_2. (e) Photoluminescence spectra for 1-3 layers