Excitons in $MoS_2/MoSe_2/MoS_2$ trilayer

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In this talk I will discuss the optical properties of excitons in tri – layer transitions metal dichalcogenides (TMDC).

First, I will demonstrate a novel approach to neutralize the intrinsic defects of CVD-grown TMDCs, using flake transfer tools routinely employed in the fabrication of van-der-Waals heterostructures. We investigate the optical properties of trilayer stacks composed of external MoS_2 flakes as capping layers and an internal $MoSe_2$. Remarkably, this fabrication approach strongly suppresses the localized exciton emission in $MoSe_2$ yielding a low temperature PL comparable to that observed in mechanically exfoliated. This striking result can be understood from density functional theory, which suggests that the more reactive MoS_2 donates chalcogen atoms to heal vacancy defects in $MoSe_2$. Our results pave the way for the production of large area high quality TMDCs. Furthermore, the investigation of the charge transfer between the $MoS_2/MoSe_2$ layers allows us to demonstrate a novel way to introduce the valley polarization in $MoSe_2$. Tuning the excitation laser to the A-exciton resonance of the larger band gap MoS_2 leads to a considerable charge transfer towards lower band gap $MoSe_2$. Our results show that spin of the hole is conserved during charge transfer leading to non-zero steady state valley polarization in $MoSe_2$ [1-2]. Furthermore, I will discuss optical properties of the long lived inter-layer exciton formed between the $MoSe_2$ and MoS_2 monolayers. Under circularly polarized excitation, the inter-layer exciton emission is intriguingly counter polarized. Such an effect has never been observed previously [3]. Finally, I will demonstrate the results of the magneto-photoluminescence spectroscopy, which give a deeper insight into the valley polarization and depolarization mechanisms of interlayer excitons [4].

References:

[1] A. Surrente, PP et al Nano Letters **17**, 4130 (2017)

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