Physics Colloquium

Thursday, 18 April 2024 | 17:00 – 18:00, Seminar Room, 3rd floor

Tuning the optoelectronic properties of two-dimensional materials

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ABSTRACT

Monolayers of Transition Metal Dichalcogenides (TMDs) of MX_2 type (M=Mo or W and X=S or Se) exhibit promising potential for future 2D nanoelectronics. We'll present methods for controlling their optical and electronic characteristics through the engineering of their dielectric environment, employing photochemical methods, and applying mechanical strain. We investigated WS_2 monolayers on pre-patterned Si/SiO_2 substrates with cylindrical wells of 3 μm in diameter, analyzing strained and suspended areas. Raman mapping experiments quantify strain, revealing a 10-fold enhanced PL efficiency with strong neutral excitonic emission in suspended areas. TMD optoelectronic properties are chemically controlled by modulating the Fermi level using UV-assisted photochlorination processes [1-3]. Systematic shifts and relative intensities between charged and neutral excitons indicate a controllable decrease in electron density switching WSe_2 from n-type to p-type semiconductor. Investigating isotropic, biaxial strain at room temperature on WS_2 monolayers shows a strong shift ~130 meV/% of strain in neutral exciton emission and a decrease in circular polarization degree [4]. The analysis reveals the interplay of energy and polarization relaxation channels, as well as variations in the exciton oscillator strength affecting the long-range exchange interactions.

[1] I. Demeridou, et al. 2D Mater. **6**, 015003 (2018)
[2] I. Demeridou, et al. Appl. Phys. Lett. **118**, 123103 (2021)
[3] E. Katsipoulaki, et al., 2D Mater. **10**, 045008 (2023)
[4] G. Kourmoulakis, et al., Appl. Phys. Lett. **123**, 223103 (2023)