Optical Absorption Spectroscopy of Exfoliated Few Layer $PtSe_2$

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Two-dimensional Transition Metal Dichalcogenides are promising candidates for optoelectronics thanks to their large electronic mobility and strong light-matter coupling. Among them, PtSe2 thin films are of particular interest because of their outstanding bandgap tunability starting from 1.2 eV for one monolayer and vanishing as the number of layers increases [1]. This property makes them especially suitable for wide-range near-infrared to visible ultrafast photodetectors and telecom optoelectronics. PtSe2 thin films are manufactured using several growth methods, where material purity is sought to achieve ultimate device performances [2-4]. However, intrinsic $PtSe_2$ optical absorption mechanisms remain elusive, as an apparent optical bandgap (of about 0.5 eV for thick samples) can be observed regardless of the semiconductor or semimetallic nature of the film. In this talk, I will present an extensive 0.8 – 3.0 eV optical absorption study performed on superior quality gold-assisted mechanically exfoliated $PtSe_2$ flakes [5]. A comparison to DFT calculations allows us to shed light on the intrinsic in-gap absorption mechanism responsible for a strong absorption tail (figure 1) and the creation of an effective optical bandgap.

References

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Figures

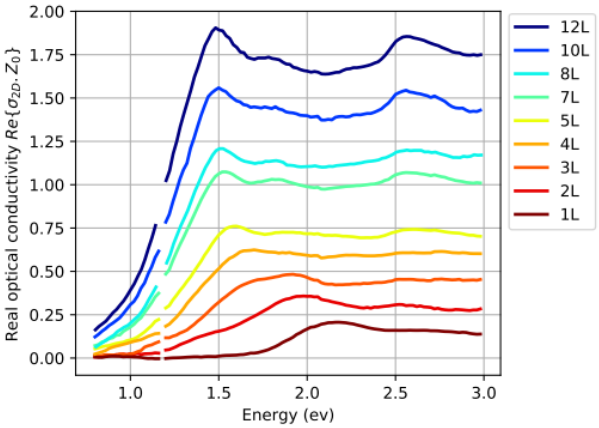

Figure 1: Optical spectroscopy of monolayer to quasi-bulk 12-layers exfoliated PtSe2. The high-energy plateau of the 2D real sheet conductivity $Re\{\sigma_{2D}.Z_0\}$ (with Z_0 the impedance of vacuum) scales with the number of layers. While 2D confinement explains the redshift of the peaks position with the thickness, a non-trivial and intrinsic mechanism is responsible for the slowly decaying low-energy absorption tail.