High room temperature valley polarization in WS_2/Graphite

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Transition metal dichalcogenide (TMD) monolayers (1L) in the 2H-phase are 2D-semiconductors with two valleys in their band structure that can be selectively populated using circularly polarized light [1-3]. The role of the substrate for 1L-TMDs is an essential factor for the optoelectronic properties and for achieving a high degree of circular polarization at room temperature [4]. In this work, we investigate the room-temperature (RT) valley polarization of monolayer WS_2 on different substrates. The degree of polarization of photoluminescence in excess of 27% is found from neutral excitons in 1L-WS_2 on graphite at RT under on-resonance excitation. Using the photochlorination process [5], we modulate the polarization of the neutral exciton emission continuously from 27% to 38% for 1L-WS_2/Graphite. We show that valley polarization strongly depends on the interplay between the doping and the choice of the supporting layer of TMDs. Time-resolved PL measurements, corroborated by a rate equation model accounting for the bright exciton population in the presence of a dark exciton reservoir, support our findings. These results suggest a pathway towards engineering valley polarization and exciton lifetimes in TMDs, by controlling carrier density and choice of substrate.

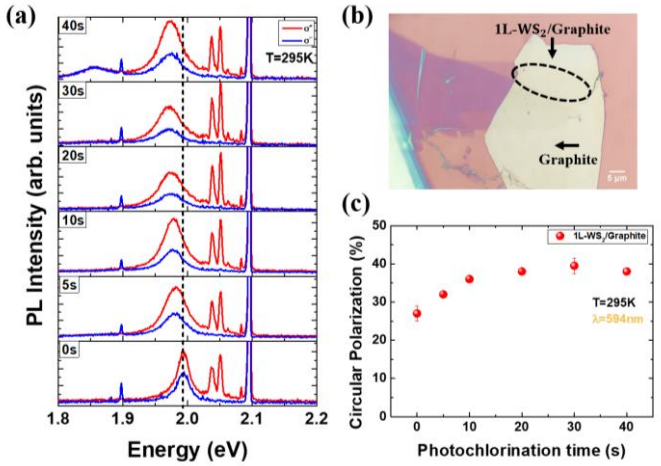

Figure 1: (a) Room temperature photoluminescence spectra of 1L-WS_2/Graphite analyzed for positive (σ+: red solid line) and negative (σ–: blue solid line) helicity as a function of photochlorination time (b) Microscope image of the monolayer 1L-WS_2/Graphite. (c) Circular Polarization of 1L-WS_2/Graphite as a function of photochlorination time.

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