Trapping and annihilation of excitons in large area monolayer WS_2: an ultrafast spectroscopic insight

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Abstract Two-dimensional Transition metal dichalcogenides (TMDCs) belong to a new class of semiconducting material having distinct properties including large exciton binding energy and valley-contrasting physics, which are beneficial for variety of optoelectronic applications [1,2]. The large area monolayer TMDCs could be useful to design mechanically flexible optoelectronic devices. Monolayer TMDCs grown by chemical vapor deposition (CVD) often include certain type of defect states that dramatically influence the carrier dynamics [3]. In 2D TMDCs, bound excitons can also undergo annihilation after transient injection of high charge carrier density [4]. Herein, we have demonstrated how ultrafast spectroscopy can capture the signature of carrier trapping and exciton-exciton annihilation (EEA) in large area WS_2 monolayer [5]. By monitoring the transient optical response probed at an energy below the band gap, exciton trapping by defects has been identified in monolayer WS_2 (figure 1). The first order recombination of exciton transforms to second order Auger recombination (EEA) at a high pump fluence. Our results demonstrate how ultrafast trapping of excitons play a significant role in carrier relaxation in CVD-grown large area TMDCs and open up the way to utilize such material in optoelectronic devices.

References

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Figures

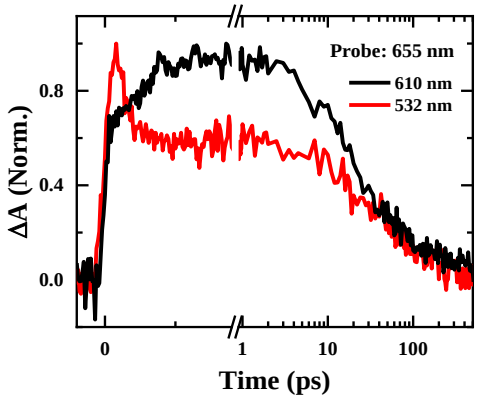

Figure 1: TA kinetics of monolayer WS_2 measured at 655 nm with excitation wavelengths of 532 nm (red) and 610 nm (black).