Selective control and anisotropic dynamics of non-degenerate excitons in atomically-thin ReS_2

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Recently, two-dimensional group VII transition metal dichalcogenides (TMDs) such as ReS_2, $ReSe_2$ have attracted a lot of attention from many researchers because of their distinctive in-plane anisotropic optical and electrical properties, whereas group VI TMDs exhibit isotropic transport and linear optical properties [1,2]. Remarkably, since their anisotropic optical behaviours are originated from energetically non-degenerate two exciton states where each exciton state has different polarization dependence, the anisotropic nature of group VII TMDs is different from other anisotropic materials (such as black phosphorus and carbon nanotubes). Therefore, VII TMDs are promising materials for ultrafast anisotropic excitonic optical modulators or switches with an energy-selectivity.

In this work, we manipulate and explore energetically non-degenerate anisotropic exciton states in few layer ReS_2, using polarization controlled optical pump-probe spectroscopy [3]. Frist, we selectively control the energetically non-degenerate exciton state using optical Stark effect by tuning pump polarization, where pump energy is lower than both exciton states (fig.1). Second, anisotropic two excitons dynamics are investigated by manipulating probe polarization, where pump energy is higher than both exciton states (fig.2). These results provide a foundation for energy-selective control of exciton states.

References

[1] S. Tongay et al., Nature Comm., 5 (2014) 3252.

[2] O. B. Aslan et al., ACS Photonics, 3 (2016) 96-101.

[3] Sim et al., Nature Comm., 7 (2016) 13569.

Figures

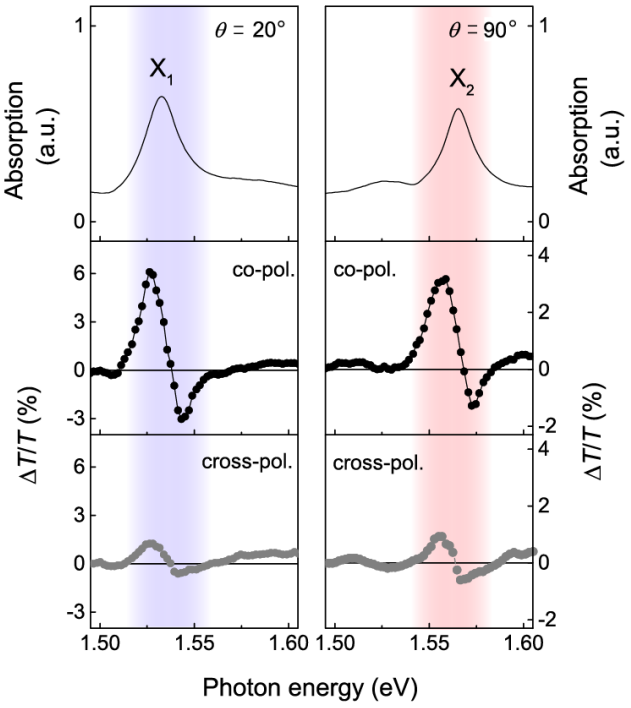

Figure 1: Exciton-selective optical Stark effect controlled by linear light-polarization in few layer ReS_2.

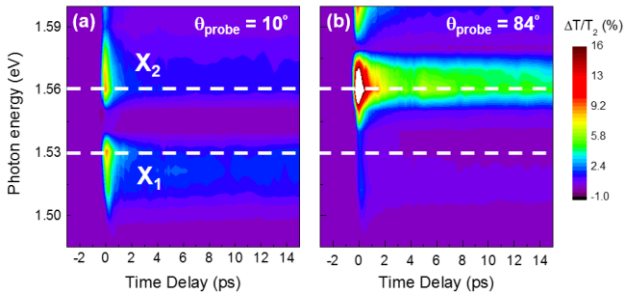

Figure 2: Transient differential transmission spectra in few layer ReS_2 with probe polarization of (a) 10 ° and (b) 84 ° with respect to b-axis.