Femtosecond dynamics of exciton and structure in 2H-$MoTe_2$

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Van der Waals (vdW) layered materials have great potential for optoelectronic devices, such as photodetectors, photovoltaics with efficient power conversion, and high-speed memory/switching devices [1-3]. Reduced dimensionality in the vdW layered materials provides strong Coulomb interaction with a large exciton binding energy of about 0.3~1 eV in a monolayer although these values are scaled down to less than 0.1 eV by charge screening in thin film. Here, we will discuss the photoexcited excitons and structure dynamics of 2H-$MoTe_2$ by using femtosecond pump-probe spectroscopy. When photoexcited charge carrier density in the vdW layered material is sufficiently low, exciton-exciton scattering prevails over exciton-phonon scattering which makes efficient carrier multiplication phenomena more competitive with other relaxation pathways due to the strong Coulomb coupling (Fig. 1a) [4]. When the carrier density is over 10^{14} cm^{-2} per monolayer, the structural deformation from semiconducting to metallic phases occurs (Fig. 1b). This phase transition is fully reversible within a picosecond via light control.

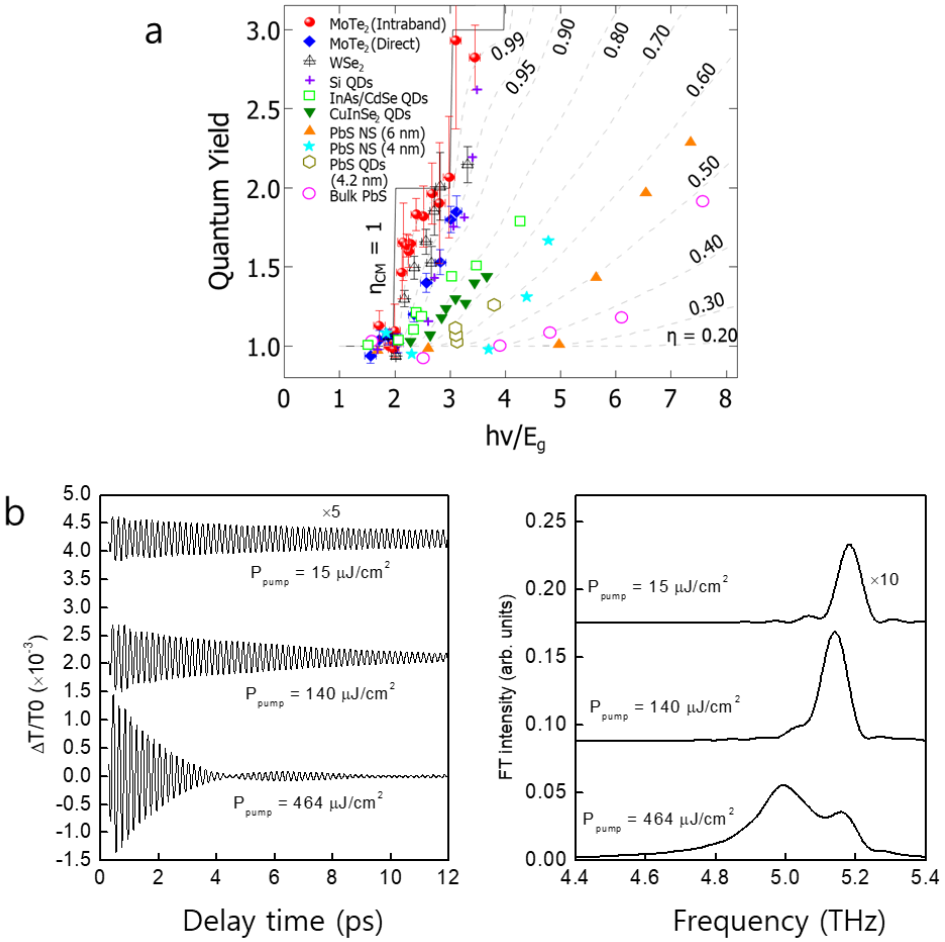

Fig. 1. (a) Carrier multiplication conversion efficiency in various nanostructure including 2H-$MoTe_2$. (b) Coherent phonon oscillations and Fourier transformation spectra with different pump fluence.

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