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Charge-transfer-induced hot carriers in MoS_2/graphene heterostructure

Owing to hot phonon bottleneck effect combining with ultrahigh carrier mobility, graphene has been emerging as potential platform for hot carrier applications such as photo-thermoelectric detectors and hot carrier solar cells. However, carrier life time in a picosecond of graphene significantly limits its hot carrier extraction. By combining graphene and MoS_2 in a heterostructure, carrier lifetime in graphene of the heterostructure can be enhanced four times in comparison to that of pristine one, which is determined by using near infrared transient transmittance spectroscopy. The longer life time of carriers in graphene is attributed to an increase in its photogenerated carrier density via photo-induced charge and energy transfer from MoS_2. The photo-induced charge and energy transfer from MoS_2 to graphene is observed by simultaneously measuring photocurrent in graphene and photoluminescence of MoS_2 as varying gate bias. In addition, the charge and energy transfer from MoS_2 to graphene is manifested in visible transient transmittance spectra of MoS_2 with a reasonable reduction of A-exciton decay time for MoS_2 of heterostructure in comparison to bare MoS_2. This is report shed the window for utilizing heterostructure of graphene/transition metal dichalcogenides for hot carrier device applications.

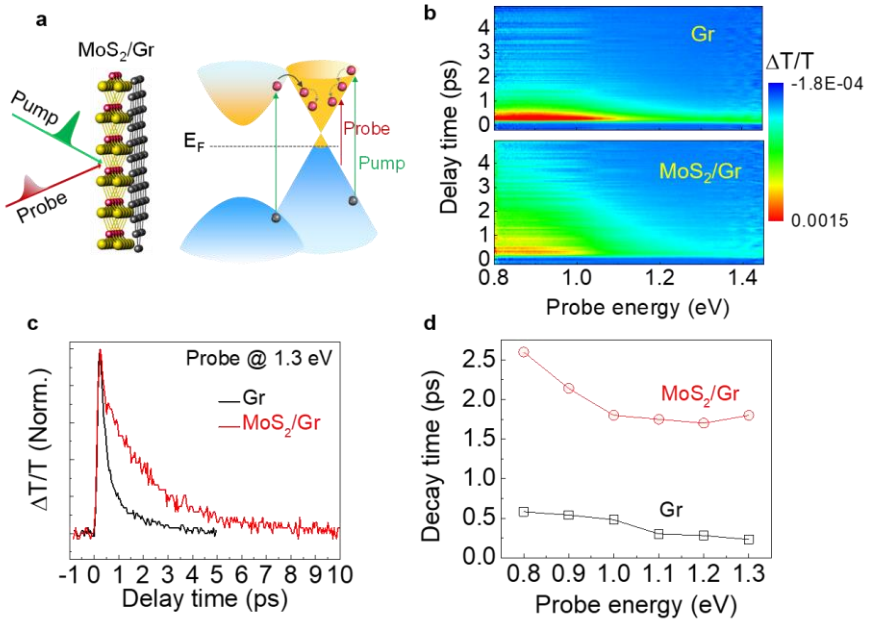

Figure 1: (a) (**a**) Schematic illustration of NIR TA measurement. (**b**) TA map as a function of pump-probe delay time and probe energy with pump-photon energy of 2.33 eV for pristine Gr (top panel) and MoS_2/Gr heterostructure (bottom panel). (**c**) Transient absorption dynamics for Gr (black) and MoS_2/Gr (red) at probe energies of 1.3 eV. (**d**) Probe energy dependent of decay time for Gr (black) and Gr/MoS_2 (red).