Photoconductivity multiplication in semiconducting few-layer $MoTe_2$

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Abstract

In conventional semiconductors, the excess energy of photogenerated charge carriers beyond the bandgap is lost as heat on a sub-ps time scale via efficient inelastic carrier-phonon scattering. Such ultrafast hot carrier relaxation leads to a >30% efficiency reduction of photovoltaics within the Shockley and Queisser framework [1]. The optical generation of multiple pairs of electrons and holes in semiconductors by a single energetic photon, a process known as carrier multiplication (CM), represents one of the recently proposed solutions to circumvent energy losses [2,3].

This talk will report our recent observation of efficient photoconductivity multiplication in multi-layered semiconducting molybdenum tellurium ($MoTe_2$). The high-efficiency process is a direct consequence of an efficient steplike carrier multiplication with near-unity quantum yield and high carrier mobility [4]. This photoconductivity multiplication is quantified using ultrafast, excitation-wavelength dependent photoconductivity measurements employing contact-free terahertz spectroscopy. Our data suggest that free charge carriers, rather than bound electron-hole pairs (*i.e.*, excitons), are involved in the CM process via impact ionization. The photocurrent multiplication, in conjunction with its narrow bandgap (~1 eV) and high charge carrier mobility (~ 50 $cm^2/(V\cdot s)$), makes $MoTe_2$ a promising candidate for hot carrier-related optoelectronics.

References

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Figures

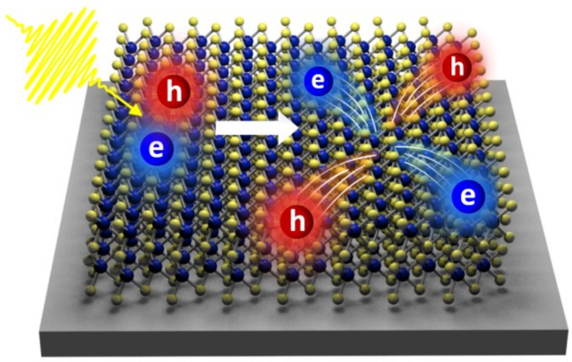

Figure 1: Schematic of photoconductivity multiplication in 2H-$MoTe_2$ following optical excitations.