Abstract Submitted
for the NWS15 Meeting of
The American Physical Society

Ultrafast Carrier Dynamics in Single-Crystal Two-Dimensional $CuInSe_2$ Nanosheets XIN TAO, ELHAM MAFI, YI GU, Washington State University — Recently, two-dimensional (2D) layered materials beyond graphene are being extensively studied. In particular, the excitonic effects due to the decreased dielectric screening in 2D materials contributes significantly to the enhanced optical absorptions, which motivates the explorations of more "conventional" semiconductors in the 2D form for solar cell applications. One material of interest is $CuInSe_2$, with $CuInSe_2$-based solar cells among the most efficient thin-film technologies. Here, we report, for the first time, the synthesis of single-crystal $CuInSe_2$ nanosheets with the thickness on the nanoscale by solid-state chemical reaction. Carrier dynamics was studied via the measurements of the transient optical reflectivity using an optical pump-probe technique. Hot carrier cooling was suggested to dominate the carrier dynamics within a few ps following the optical excitation. The hot carrier diffusion coefficient was obtained by spatially resolved pump-probe measurements. The dependence of the hot carrier diffusion coefficient on the nanosheet thickness provides insight into the limiting mechanisms of hot carrier transport, and can be used to gauge the possibility of efficient hot carrier collection in nanostructured $CuInSe_2$ solar cells.

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Date submitted: 14 Feb 2015 Electronic form version 1.4