Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Time-resolved photocurrent generation in graphene $p-n$ junctions; probing $e-h$ relaxation dynamics near the Fermi level MATT GRAHAM, SU-FEI SHI, DANIEL RALPH, JIWOONG PARK, PAUL MCEUEN, Kavli Institute at Cornell for Nanoscale Science — In this contribution we probe the relevant timescales associated with photocurrent generation by optically exciting graphene at a $p-n$ junction defined by electrostatic gates. Time-resolution of the optical and electrical response are obtained by simultaneous collection of transient photocurrent and transient absorption using a two-pulse correlation approach with 160 fs resolution. The transient absorption signal decays biexponentially in the $p-n$ junction at 0.26 and 2.2 ps; timescales similar to those recently established for hot electron and hot optical phonon cooling in graphene sheets. By contrast, we find transient photocurrent decay signal is surprisingly slow, with tails extending for 100s of ps. At 10 K, the rate coefficient for transient photocurrent decay is 2.7 ± 0.6 ps^{-1}nA^{-1}, and it increases monotonically tenfold upon warming to room temperature. We attribute the stark difference in the transient photocurrent and absorption kinetics to a photocurrent response that is sensitive to recombination processes that are occurring well below optical excitation energies, near the Fermi level. Combining the measurements, transient photocurrent alongside the well-studied transient absorption allows us to construct a rough timeline of events associated with photocurrent production at a graphene $p-n$ junction.

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Date submitted: 11 Nov 2011 Electronic form version 1.4