Broadband Photodetection with Graphene Devices

Michael S. Fuhrer[1,2], Jun Yan[1,2], Xinghan Cai[1,2], Myoung-Hwan Kim[1,2], Jennifer A. Elle[1,3], Andrei B. Sushkov[1,2], Greg S. Jenkins[1,2], Howard M. Milchberg[1,3] and H. Dennis Drew[1,2].

[1]Department of Physics, [2]Center for Nanophysics and Advanced Materials, and [3]Institute for Research in Electronics and Applied Physics, University of Maryland, College Park, MD 20742-4111, USA
mfuhrer@umd.edu

Graphene's unique massless, gapless bandstructure gives rise to strong, broadband interactions with light. We report on two different broadband (THz to visible) photodetectors using graphene. The first photodetector exploits the gate-tunable bandgap of bilayer graphene to produce a temperature-dependent resistivity, allowing bolometric detection at temperatures of 5-20 K of visible (1.88 eV), near infrared (1.2 eV), and mid-infrared (0.12 eV) radiation, and/or electrical joule heating[1]. The large heat resistance between electrons and phonons in graphene due to the weak electron-acoustic phonon interaction is directly measured. A near infrared (1.2eV) excitation pump-probe study verifies the intrinsic electron-acoustic phonon energy relaxation time on order 1 ns which promises device operation to gigahertz frequencies. Optimized graphene hot electron bolometers could compare favorably to traditional silicon bolometers and superconducting transition edge detectors in noise equivalent power, speed, and sensitivity. The second photodetector extends the known photovoltaic effect at graphene-metal junctions to the THz regime by coupling an appropriate antenna structure to graphene through dissimilar metal electrodes which allow rectification of the THz signal to produce a dc photocurrent[2]. Detection of 3 THz radiation at room temperature is demonstrated, and the possibility of plasmon-enhanced detection will be discussed.

References

[1] J. Yan, M.-H. Kim, J.A. Elle, A.B. Sushkov, G.S. Jenkins, H.M. Milchberg, M.S. Fuhrer, and H.D. Drew, arXiv:1111.1202.

[2] X.H. Cai, A.B. Sushkov, G.S. Jenkins, M.S. Fuhrer, and H.D. Drew, in preparation.