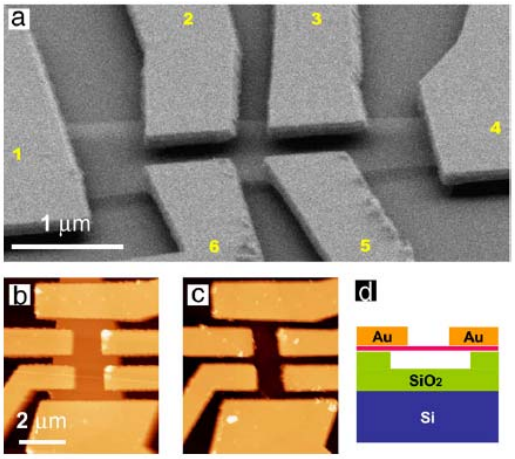
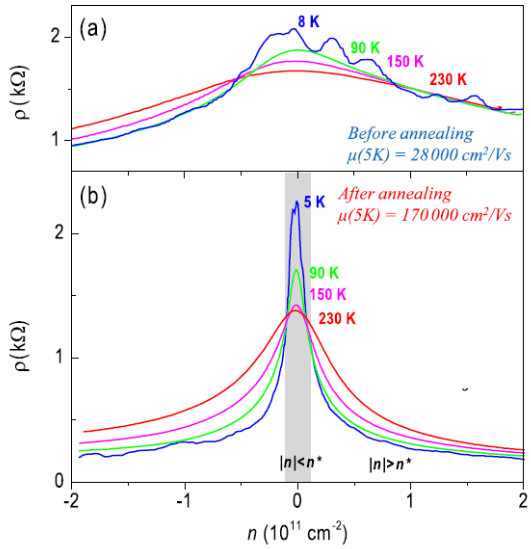
Scientific Accomplishments: Fundamental Nanoscale Phenomena and Processes (PCA 1)

Electrons (and Holes) Move Faster in Graphene than in Any Other Material

Professor Philip Kim at Columbia University and his coworkers set the world record for measured electron and hole mobility at or near room temperature using a suspended and annealed single layer graphene sample. Mobility is a measure of the velocity of electrons (or holes) in a material when driven by a set electric field. Their measured electron and hole mobility of 120 000 cm^2/Vs at temperature of 240 Kelvin and carrier density of 2 x 10^{11} cm^{-2} exceeds that of any other materials studied previously and approaches the intrinsic mobility limit of about 200 000 cm^2/Vs established by Prof. Michael Fuhrer at the University of Maryland in an independent study. This breakthrough could potentially lead to applications in ultrafast electronics.





LEFT: SEM (a) and AFM (b) images of a suspended graphene. (c) AFM image of the device after the measurements with graphene removed. (d) Device schematic side view. Suspended single-layer graphene is shown in pink.
RIGHT:Temperature dependence of resistance of a suspended graphene device before (a) and after (b) current annealing.

1. K.I. Bolotin, K.J. Sikes, Z. Jiang, M. Klima, G. Fudenberg, J. Hone, P. Kim, H.L. Stormer. "Ultrahigh electron mobility in suspended graphene," *Solid State Communications* **146**, 351 (2008).
2. K. I. Bolotin, K. J. Sikes, J. Hone, H. L. Stormer, and P. Kim, "Temperature-Dependent Transport in Suspended Graphene," *Physical Review Letters* **101** (9), 096802 (2008).
3. J. H. Chen, C. Jang, S. Xiao, M. Ishigami, M. S. Fuhrer, "Intrinsic and Extrinsic Performance Limits of Graphene Devices on SiO_2," *Nature Nanotechnology* **3**, 206 - 209 (2008).

Contributing Agency: DOD/ONR