Abstract Submitted
for the MAR10 Meeting of
The American Physical Society

Electric-Field Induced Semimetal-to-Metal Transition in Few-Layer Graphene RICHARD S. THOMPSON, YI-CHEN CHANG, GERD BERGMANN, JIA G. LU, University of Southern California — An electric-field induced semimetal-to-metal transition is observed in five-layer graphene produced by the peeling process based on the temperature dependence of the resistance for different applied gate voltages. For small gate voltages the resistance decreases with increasing temperature due to the increase in carrier concentration resulting from thermal excitation of electron-hole pairs, as characteristic of a semimetal. For large gate voltages excitation of electron-hole pairs is suppressed, and the resistance increases with increasing temperature because of the decrease in mean free path due to electron-phonon scattering, characteristic of a metal. The electron and hole mobilities are almost equal, so we have approximate electron-hole symmetry. The data are analyzed according to theoretical models for few-layer graphene. The simplest model used has two overlapping bands with quadratic energy-versus-momentum dispersion, a conduction band and a valence band. The energy range of the overlap is of the order of 20 meV in order to fit the residual resistance at low temperatures at zero gate voltage. The fitting at low temperatures is improved by adding a second pair of quadratic bands that just touch with zero overlap. Finally, the addition of a pair of touching Dirac bands with linear dispersion is considered, but shown to be unimportant due to the low density of states in the Dirac bands.

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Date submitted: 19 Nov 2009 Electronic form version 1.4