Oral

ELECTRONIC CONFINEMENT AND COHERENCE IN PATTERNED EPITAXIAL GRAPHENE

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Utrathin epitaxial graphite grown on single-crystal silicon carbide is a promising new two-dimensional electronic material [1-6] showing properties of electronic coherence and quantum confinement at the micron scale well above 4K [1].

Ultrathin graphite layers are grown epitaxialy on millimeter size commercial single-crystal silicon carbide by thermal decomposition in vacuum at high temperature. Epitaxial graphene layers have a structural coherence of a fraction of a micron at least, as shown in detailed structure and composition studies (Auger electron spectroscopy, low energy electron diffraction, X-ray diffraction, transmission electron microscopy, atomic force microscopy, electrostatic force microscopy, scanning tunneling microscopy and tunneling spectroscopy).

Magnetotransport measurements (Shubnikov-de-Haas oscillation) show that the transport properties are dominated by the highly doped graphene layer at the silicon carbide interface. They reveal the Dirac nature of the charge carriers (the energy is proportional to the velocity), as predicted for a single graphene layer, and as recently observed mechanically-exfoliated graphene layers. The properties of Dirac fermions (which are also responsible for transport in carbon nanotubes) can be conveniently explored in epitaxial graphene.

The material can be easily patterned into submicron structures using standard microelectronics lithography techniques. Patterned structures show two-dimensional electron gas properties with long phase coherence lengths l_Φ , even at relatively high temperatures (l_Φ beyond one micron at 4K, and ~500nm at 58K) and mobilities exceeding 2.5 m^2/Vs. The elastic scattering lengths are determined primarily by the micron-scale sample geometry. The magnetoresistance reveals signatures of quantum confinement of electrons in micron wide ribbons at 4K and above. Unusual phase transitions are also observed.

References:

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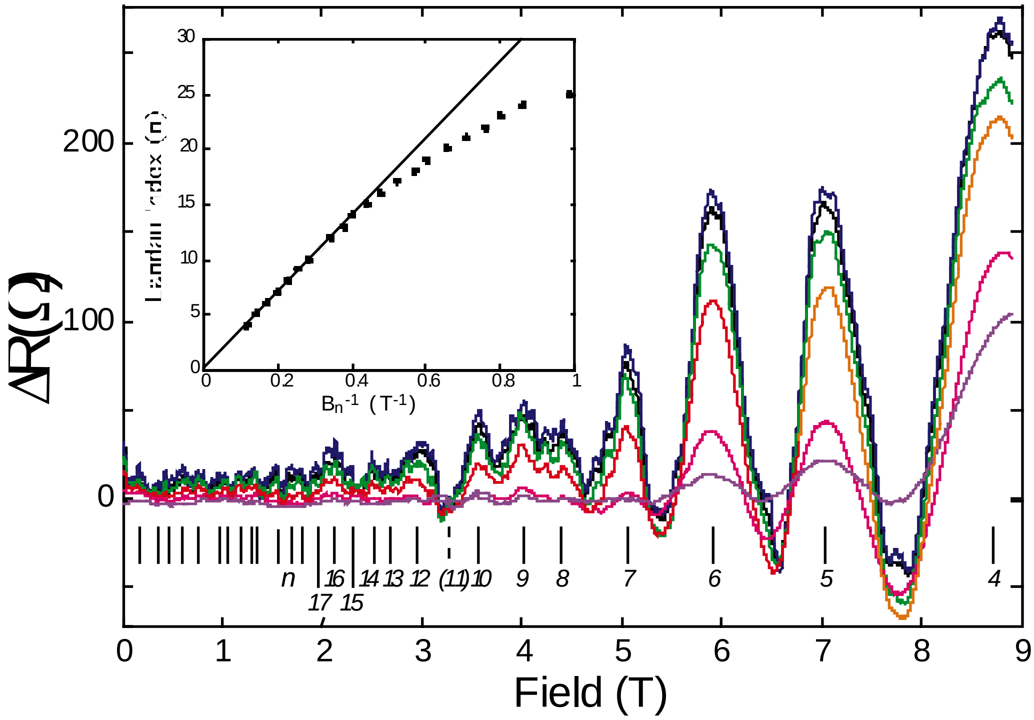

Figure1 : Magnetoresistance (smooth line subtracted) for temperature 4K to 58K showing the Shubnikov de-Haas oscillations in a ribbon 0.5µmx6µm. Landau levels n are indicated and labeled. Inset : Landau level indexes plotted as a function of inverse magnetic field. The slope of the line gives the carrier density (ns=3.4 $10^{12}cm^{-2}$) and the intercept at zero is consistent with the Berry phase $\Phi=\pi$ of graphene. The deviation from linearity indicates confinement in the ribbon, which becomes important when the cyclotron diameter increases at large 1/B. The fluctuations superimposed on the smooth magnetoresistance oscillations are reproducible universal conductance fluctuations, which indicate the long phase coherence length of the system.