Pronounced Half-Integer Quantum Hall-Effect on Epitaxial Graphene up to 70K

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Introduction
Recent reports of large-area epitaxial graphene by thermal decomposition of SiC wafers have provided the missing pathway to a viable electronics technology.\textsuperscript{1-5} An interesting question that remains to be addressed is whether the electrical properties of epitaxial graphene on SiC are essentially same as those in exfoliated graphene films.\textsuperscript{5-7} For example, the well-known quantum Hall-effect (QHE), a distinguishing feature of a 2D electronic material system, is just beginning to be discovered in epitaxial graphene.\textsuperscript{8-10} We report on the observation of the QHE in gated epitaxial graphene films on SiC (0001), along with pronounced Shubnikov-de Haas (SdH) oscillations in magneto-transport. The last QH plateau is especially pronounced, even at temperatures as high as 70K, reaching the temperature limit of the present experimental setup.

Results and Discussion
Figure 1 shows the Hall resistance and magneto-resistance measured at T=0.8K with floating gate bias. The horizontal dashed lines correspond to $\hbar/(4n+2)e^2$ values. The QHE of the electron gas in epitaxial graphene shows one quantized plateau and two developing plateau in $R_{xy}$, with vanishing $R_{xx}$ in the corresponding magnetic field regime. Figure 2 shows the temperature dependence of $R_{xx}$ at $V_g=-5V$. Pronounced SdH minimum remain up to 70K. Figure 3 shows the Temperature dependence of $R_{xy}$ at $V_g=-5V$. A pronounced n=0 QH plateau remains up to 70K. Experiments were performed using SCM-2 at NHMFL, Tallahassee, FL.

Conclusions
In conclusion, a high-$\kappa$ gate stack on epitaxial graphene is realized by inserting a fully oxidized nanometer thin aluminum film as a seeding layer followed by an atomic-layer deposition process. The electrical properties of epitaxial graphene films are sustained after gate stack formation without significant degradation. At low temperatures, the QHE is observed in epitaxial graphene on SiC (0001), along with pronounced SdH oscillations. This quantum experiment confirms that epitaxial graphene on SiC (0001) shares the same relativistic physics as the exfoliated graphene.

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References