2D Metal-insulator transition behavior in a high mobility strained Si quantum well

K. LAI, D.C. TSUI, S. LYON, Princeton Univ., W. PAN, Sandia Natl. Labs, M. MUHLBERGER, F. SCHAFFLER, Univ. Linz — The apparent metal-insulator transition is observed in a high quality two-dimensional electron system (2DES) in the strained Si quantum well of a Si/Si$_{1-x}$Ge$_x$ heterostructure with mobility $\mu = 1.9 \times 10^5$ cm$^2$/Vs at $n = 1.45 \times 10^{11}$ cm$^{-2}$. The critical density $n_c$, where the thermal coefficient of low T resistivity changes sign, is $0.32 \times 10^{11}$ cm$^{-2}$, much smaller than the $n_c$ of $\sim 0.8 \times 10^{11}$ cm$^{-2}$ seen in clean Si-MOSFET’s (usually with a peak $\mu \sim 4 \times 10^4$ cm$^2$/Vs). This result is consistent with previous observations in the GaAs systems that $n_c$ decreases with increasing 2DES quality. Moreover, in low n range, for $0.27 \times 10^{11}$ cm$^{-2} < n < 0.35 \times 10^{11}$ cm$^{-2}$, close to the transition region, the conductivity increases roughly linearly with $T$ around the Fermi temperature and, surprisingly, all the curves of different densities are parallel to each other for $T > 1.2K$. In the higher density range where the 2DES shows metallic-like behavior, the in-plane magnetoresistance $\rho(B)$ first increases $\sim B^2$ and then saturates to a finite value $\rho(B_C)$ for $B > B_C$. The full spin-polarization field $B_C$ decreases monotonically with $n$ but appears to saturate to a finite value as $n \rightarrow 0$. We find $\rho(B_C)/\rho(0) \sim 1.8$ for all the densities ranging from $0.35$ to $1.45 \times 10^{11}$ cm$^{-2}$ and, when plotted versus $B/B_C$, collapse onto a single curve.

Keji Lai
Princeton Univ.

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