

Large Magnetoresistance of a Dilute 2DHG in p -Si/SiGe/Si in a Parallel Magnetic Field

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DC and AC conductivity of a dilute ($p=8.2 \cdot 10^{10} \text{ cm}^{-2}$) two-dimensional (2D) hole gas were studied at the DC field facility of the NHMFL by the conventional direct current method and surface acoustic wave technique respectively. The experiments were performed on p -Si/SiGe/Si heterostructures in the temperature range of 0.3–2 K in the magnetic fields of up to 18 T, parallel to the 2D channel at two orientations of the in-plane magnetic field B_{\parallel} against the current I : $B_{\parallel} \parallel I$ and $B_{\parallel} \perp I$. An in-plane magnetic field induces a giant positive magnetoresistance with no sign of saturation in the studied heterostructures with the thickness of about 30 nm. When the magnetic field rises up to 18 T, the resistivity ρ_{xx} in this sample increases significantly and changes by more than three orders of magnitude, while in the sample with $p=1.6 \cdot 10^{11} \text{ cm}^{-2}$ the magnetoresistance increase is just several times in the same field range (see Fig.1). The resistance depends on the current orientation with respect to the in-plane magnetic field. At $B=18 \text{ T}$ and $T=0.3 \text{ K}$ the resistivity ratio $(\rho_{xx}^{B \perp I})/(\rho_{xx}^{B \parallel I})$ equals 3. In low magnetic fields $\Delta\rho_{xx}/\rho_0 \propto B^2$ and the temperature dependence of ρ_{xx} demonstrates the metallic characteristics $d\rho_{xx}/dT > 0$. However, at $B=7.2 \text{ T}$ the derivative $d\rho_{xx}/dT$ reverses the sign. It could be interpreted as a magnetic field suppression of the metallic state. At $B \approx 13 \text{ T}$ there is a transition from the dependence $\ln(\Delta\rho_{xx}/\rho_0) \propto B^2$ to the dependence $\ln(\Delta\rho_{xx}/\rho_0) \propto B$. The observed effects can be explained by the influence of the in-plane magnetic field on the orbital motion of the charge carriers in the quasi-2D system with a finite thickness of the 2D layer.

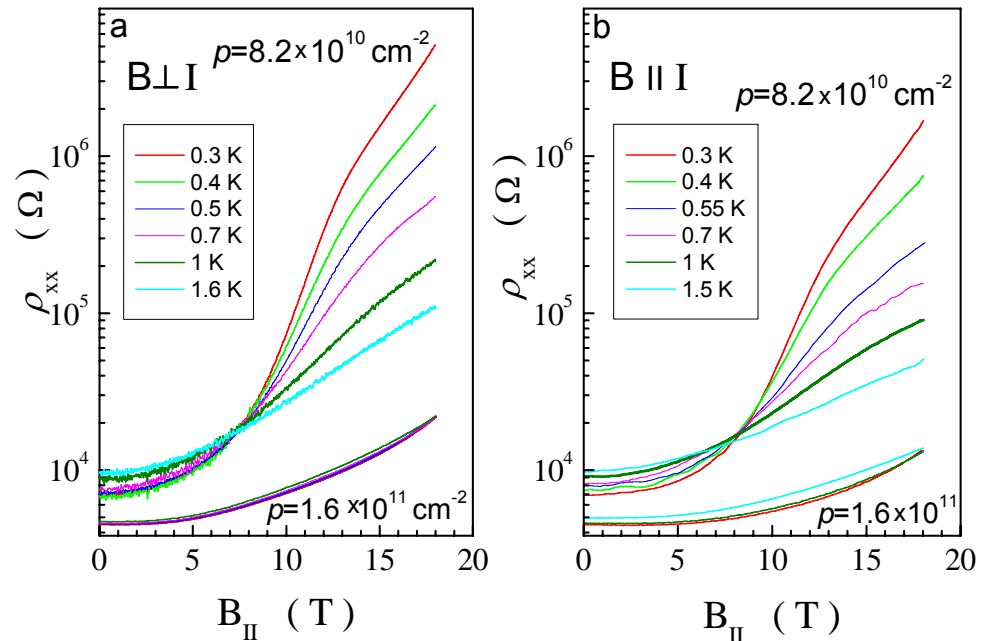


FIG. 1. Magnetoresistance ρ_{xx} versus B_{\parallel} parallel to the 2D channel plane for the samples with $p = 8.2 \cdot 10^{10} \text{ cm}^{-2}$ and $p = 1.6 \cdot 10^{11} \text{ cm}^{-2}$ with two B -to- I orientations: (a) $B \perp I$ and (b) $B \parallel I$.

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