Intersubband scattering in modulation-doped Si two-dimensional electron gases

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A bilayer of modulation doped two-dimensional electron gas (2DEG) is of great interest to probe Coulomb drag. For bottom-doped Si 2DEGs, impurity scattering due to poor phosphorus (P) turn-off results in low carrier mobility. Here we demonstrate a record-high electron mobility of 470,000 cm²/V-s at 0.3 K in a bottom-doped 2DEG, comparable to that in top-doped structures. The power-law exponent of mobility vs. density was also evaluated for different P turn-off slopes. With fast turn-off, the power is 1.5, indicative of dominant remote doping scattering. The power decreases with slower P turn-off due to the enhanced scattering from the segregated P atoms.

Further, for the first time, we report the second subband occupancy and intersubband scattering in a single Si quantum well, supported by the Shubnikov-de Haas oscillation data.