Extremely Low Tunneling Resistance in GaAs 2D-Bilayers, Going Beyond Balanced Densities

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We explore the transport characteristics of bilayered Gallium-Arsenide (GaAs) two-dimensional electron gases (2DEGs) with different barrier widths. Equilibrium resonant electron tunneling is a well-known phenomenon in density balanced bilayered 2DEGs and has successfully been described by considering the conservation of the in-plane electron momenta. Using ion-implanted pinch-off back gates we are able to contact the two layers independently with barrier thicknesses as low as 5 nm. In our samples, we measure a remarkably low tunneling resistance of only a few tens of Ohms in zero magnetic field. For our experiment we force a tunneling current and capture interlayer potential difference as well as the differential conductance. We observe that this low tunneling resistance persists beyond the equilibrium regime, until a critical current is reached, upon which the tunneling resistance increases abruptly. This results in a step-like increase in the interlayer voltage, as seen in Fig. 1 below. Furthermore, we report that this critical tunneling current is sustained in finite perpendicular magnetic fields. As the tunneling resistance increases with magnetic field the critical current and the interlayer voltage step deteriorate. Correspondingly, the critical current decreases and eventually vanishes for increasing temperatures. This behavior is similar to the recently reported electron tunneling through a single localized state in Graphene bilayers [1] and the occurrence of critical tunneling currents at total filling factor ν = 1 [2]. Our current findings hint that the single-particle tunneling model may not be sufficient to describe our results and that correlation effects are also relevant [3].

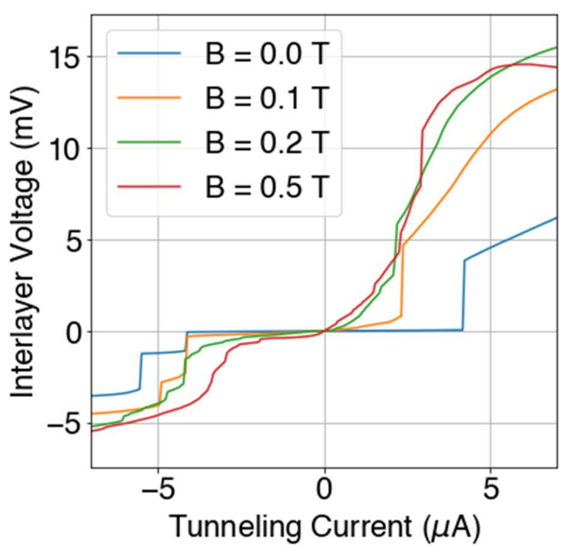

Fig. 1. Distinct interlayer voltage steps for zero and small perpendicular magnetic fields.

References

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