Tuning of quantum interference in top gated graphene

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The chiral nature of quasiparticles in graphene gives rise to a number of peculiar magnetotransport phenomena such as a nonzero Berry phase resulting in half-integer quantum Hall effect and negative magnetoresistance. Quantum interference effects in graphene are nowadays theoretically well understood, based on the interplay between different chirality-breaking scattering mechanisms and dephasing time. From an experimental point of view, in high quality graphene, the low density of short-range scatterers allows the Berry phase to manifest as a Weak Antilocalization (WAL) dip in the magnetoresistance [1]. As the π-phase contribution is averaged out by chirality breaking scattering, enhanced backscattering results in the usual Weak Localization (WL) correction. Essential in driving the transition between WAL and WL regimes is the possibility of tuning the charge density in the graphene monolayer.

The quest for monolithic integration of devices recently moved the interest towards Epitaxial Graphene (EG) on SiC, which has reached high mobility and uniformity on the wafer scale [2]. Despite such interest, the interplay between localization and chirality is still rather unexplored for EG grown on the Si face, where only positive magnetoresistance due to electron localization has been observed so far [3].

We report on quantum interference measurements in top-gated Hall bars epitaxially grown on the Si face of SiC, where the transition from WL to WAL regime was achieved varying the temperature and charge density. We analyzed the relative weight of the scattering mechanisms affecting the conductance in the different density regions. The results stress the role of SiC based devices as a promising technology for graphene coherent electronics.

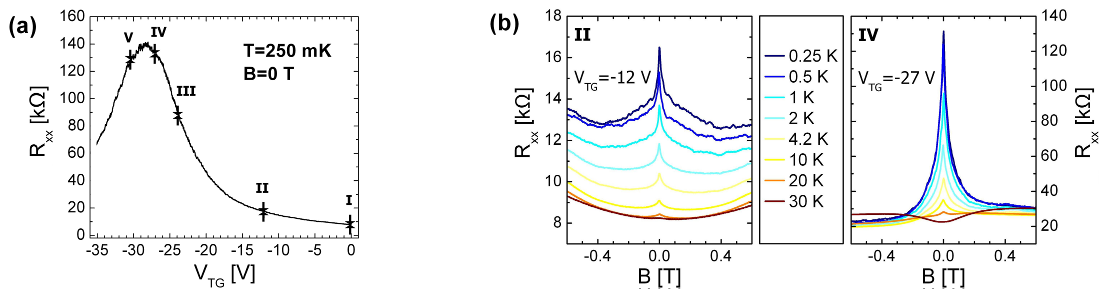

Figure 1: (a) Longitudinal resistance R_{xx} as a function of top gate voltage V_{TG}, showing a maximum at the charge neutrality point. The values of V_{TG} selected for magnetoresistance measurements are indicated. (b) The amplitude of the WL peak decreases as the temperature is increased (point II), evolving into a WAL dip for sufficiently low charge density (point IV).

[1] F. V. Tikhonenko, A. A. Kozikov, A. K. Savchenko, and R. V. Gorbachev, Phys. Rev. Lett. **103**, 226801 (2009).

[2] S. Tanabe, Y. Sekine, H. Kageshima, M. Nagase, and H. Hibino, Phys. Rev. B **84**, 115458 (2011).

[3] S. Lara-Avila, A. Tzalenchuk, S. Kubatkin, R. Yakimova, T. J. B. M. Janssen, K. Cedergren, T. Bergsten, and V. Fal'ko, Phys. Rev. Lett. **107**, 166602 (2011).