Charge transport in narrow graphene devices

José M. Caridad[1]
S.R. Power[1,2,3], M. Lotz[1], A. Shylau[1], J.D. Thomsen[1], L. Gammelgaard[1], T.J. Booth[1], A.P. Jauho[1] and P. Bøggild[1]

[1]*Center for Nanostructured Graphene (CNG), DTU Nanotech, Technical University of Denmark, 2800 Kongengs Lyngby (Denmark)*
[2]*Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC and the Barcelona Institute of Science and Technology, Campus UAB, Bellaterra, 08193 Barcelona (Spain)*
[3]*Universitat Autònoma de Barcelona, 08193 Bellaterra (Cerdanyola del Vallès) (Spain)*

jcar@nanotech.dtu.dk

For narrow, gated graphene devices, the agreement between experimental data and theoretical predictions is continuously challenged by edge disorder [1,2]. These detrimental effects have a profound impact on the device transport characteristics, making obscure the observation of theoretically predicted properties in pristine systems. An important prediction which has so far eluded experimental verification is the large accumulation of charge at the borders of narrow, gated graphene nanostructures due to the electrostatic coupling (Figure 1) of graphene charge carriers to the gate electrode. Such inhomogeneous charge distribution is able to alter the transport properties of the device in the quantum Hall regime, giving rise to an increase in conductance and a suppression of quantization. [2-4]

We present a systematic study on the charge transport in narrow, gated graphene devices with different degrees of edge disorder [2]. We demonstrate that devices with low edge disorder show the predicted increased conductance with suppressed quantization in the quantum Hall regime. This result is in marked contrast with devices having rougher edges, exhibiting a quantized conductance instead. Our results emphasize the importance of both device geometries and processing methods when studying the electronic properties of nanostructures made from two-dimensional crystals.

References

[1] B. Terrés et al. *Nature Comm.* **7**, 11528 (2016).

[2] J.M. Caridad et al. *Nature Comm.* **9**, 659 (2018).

[3] A.A.Shylau, et al . *Phys. Rev. B*, **82**, 121410 (2010)

[4] P. Silvestrov et al. *Phys. Rev. B*, **77**, 155436 (2008)

Figures

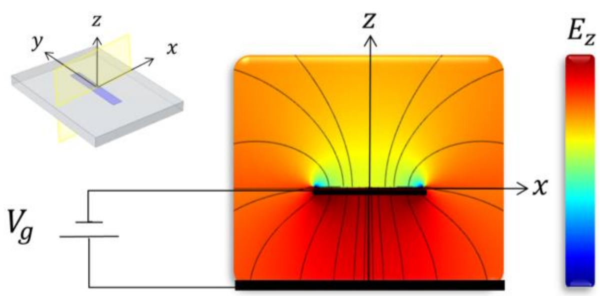

Figure 1: *Calculated electric field E_z across a narrow, back-gated (V_g) graphene nanostructure (plane y=0) .*

Inset (top-left): schematic of the considered device geometry (ribbon).