Investigating low-dissipative transport in quantum Hall devices based on graphene grown by CVD on SiC in view of improving the resistance standard

Jérémy Brun-Picard[1],
B. Jouault[2], A. Michon[3], W. Poirier[1], F. Schopfer[1]

[1]Laboratoire National de Métrologie et d'Essais, Trappes, 78190, France
[2]Laboratoire Charles Coulomb, Université de Montpellier 2, CNRS, Montpellier, 34095, FRANCE
[3]Centre de Recherche sur l'Hétéroépitaxie et ses Applications, CNRS, Valbonne, 06560, FRANCE

jeremy.brun-picard@lne.fr

In order to develop a reliable and practical resistance standard, metrologists aim at exploiting the robustness of the quantum Hall effect in graphene, coming from the very large gap between the two first Landau levels. Recent progress have been made by using graphene grown by CVD on SiC: the Hall resistance quantization with an excellent accuracy (below 1 ppb) has been observed in convenient experimental conditions (magnetic field of 3.5 T, temperature of 10 K) much simpler than those required by GaAs/AlGaAs heterostructures [1].
To understand the underpinning physics of these devices, extensive transport measurements have been performed in several samples and by varying the charge density concentration. The expected Efros and Shklovskii model of variable range hopping between counterpropagating quantum Hall edge states give an apparently correct description of the dissipation in some cases [2] (see fig.2) but fails in other ones. Recent efforts have been exerted to identify the key properties of the system graphene/SiC for the observation of the ideal Hall quantization: the signatures of specific disorder (bilayer inclusions and more generically disorder on SiC step edges) have been tracked down to subtle features of the transport in the QHE regime (R_H to R_{xx} coupling notably). As a charge reservoir, the interface layer between graphene and SiC ($(6\sqrt{3} \times 6\sqrt{3}) - R30°$ reconstructed layer), plays a role in the very large magnetic field extension of the R_H plateau. Beyond, its quality/homogeneity seems definitely crucial for quantization quality in general. Finally, even if graphene on SiC has already demonstrated impressive performance as a quantum Hall resistance standard, the question remains to know whether it is the material of choice to go beyond, down to 1 T, for instance.

References

[1] R. Ribeiro-Palau et al., Nature Nanotech., 10, 965 (2015)
[2] F. Lafont, Nature Comm, 6, 6806 (2015)

Figures

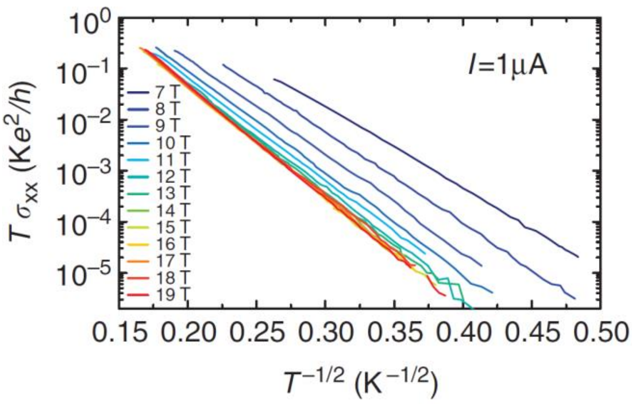

Figure 1: T.σxx as a function of $T^{-1/2}$ in a semi-log scale for magnetic fields from 7 to 19 T and in a temperature range from 4 to 40 K. We expect a linear relation in the case of expected Efros and Shklovskii model of variable range hopping.