Towards a graphene-based Quantum Resistance Standard for metrological applications

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Since the changes brought by the Système International d'unités (SI) in 2018, the basic units of measurement are redefined from universal constants of nature. Specifically, redefinitions for the mass (kg) and current (A) in this new quantum SI are obtained from the relation between Planck's constant (h) and the electron charge (e). The Quantum Hall Effect[1] (QHE) is a quantum macroscopic phenomenon in 2DEG systems where, in the presence of high magnetic fields, the Hall resistance is quantized in multiples of h/e^2. Nowadays the QHE in AlGaAs/GaAs heterostructures is used as the quantum resistance standard (QRS) defining the relation between e and h with extremely high precision. Recently, it has been shown that the electronic properties of single layer graphene[2] (SLG) allow the observation of the QHE in more relaxed experimental conditions (temperature, magnetic field and current) as compared to AlGaAs/GaAs making graphene an attractive candidate for the development of QRS that could have a broader use beyond national metrology institutes[3]. However, one disadvantage of graphene is its susceptibility for degradation with time. We have fabricated epitaxial SLG Hall bars and characterized the electronic transport and QHE as a function of temperature. We have performed preliminary studies of aging effects when the devices are stored in vacuum for a long time.

References

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Figures

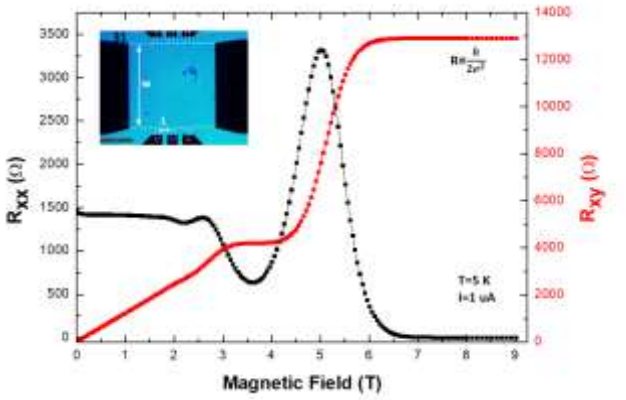

Figure 1: Quantum Hall effect in graphene at 5 K, 1 μA. Insert: Optical image of graphene Hall bar.