Breakdown of Quantum Hall Effect in Graphene

C. Yanik, A. G. Demirkol, C. Celebi and **I. I. Kaya**

Faculty of Engineering and Natural Sciences, Sabanci University, Istanbul 34956, Turkey

The breakdown of the quantum Hall effect is observed as the abrubt change in the longitudinal resistance by several orders of magnitude with an associated loss in quantization of Hall voltage. Breakdown limits the accuracy of the existing resistance standard. Graphene is a new material system that allows the quantization of the Hall resistance upto the room temperature, hence a good candidate for being used as a high precision metrological characterization. The uncertainity in the resistance quantum measured in graphene rapidly improved in the last couple of years to 3 pbb in epitaxial graphene[3]. Sufficiently high breakdown currents and low contact resistances are needed to obtain such high accuracy in determining the resistance quantum.

In this work, we report experimental results on the breakdown of quantum Hall effect in graphene. The devices were fabricated on mechanically exfoliated graphene. Single layer, bilayer and a few layer graphene sheets are transferred onto SiO_x substrate where Raman spectroscopy is used to identify the number of graphene layers. Devices were patterned by optical and electron beam lithography. Samples typically exhibit immediate onset of the longitudinal resistance while the Hall plateaus can endure to much higher currents. We elaborate on the physical phenomena underlying this unique behavior in the breakdown of the quantum Hall effect and its possible implications on the improvement of the accurate determination of the plateau levels.

[1]Tzalenchuk, A. *et al.* Nature Nanotech. 5, 186–189 (2010).