Parallel transport and layer-resolved thermodynamic measurements in twisted bilayer graphene

Giulia Piccinini[1,2]

V. Mišeikis, K. Watanabe, T. Taniguchi, C. Coletti, S. Pezzini

[1]*NEST, Scuola Normale Superiore, Piazza San Silvestro 12, 56127 Pisa, Italy*
[2]*Center for Nanotechnology Innovation @NEST, Istituto Italiano di Tecnologia, Piazza San Silvestro 12, 56127 Pisa, Italy*

giulia.piccinini@sns.it

Abstract

We employ dual-gated 30°-twisted bilayer graphene (30TBG) [1] (Figure 1(a)) to demonstrate simultaneous ultra-high mobility and conductivity, unattainable in a single-layer of graphene [2]. Thanks to low-energy interlayer decoupling and high device quality, we show that 30TBG replicates the transport properties of two pristine single-layer graphene sheets conducting in parallel, with a gate-controlled carrier distribution. The individual carrier density in the layers are obtained by electrostatic modelling the gated TBG system. Based on the parallel transport mechanism, we then exploit the effective electronic decoupling of large-angle TBG to introduce a method for *in situ* measurements of the chemical potential (*μ)* of the two layers. In particular, by keeping one of the layers charge-neutral, it is possible to probe *μ* in the other one with a resolution in the meV range (comparable to hBN-spaced structures [3]) (Figure 1(b)). This twist-enabled approach, neither requiring a dielectric spacer, nor separate contacting, has the potential to greatly simplify the measurement of thermodynamic quantities in graphene-based systems of high current interest.

References

[1] S. Pezzini et al., Nano Lett., vol. 20, no. 5 (2020) 3313–3319
[2] G. Piccinini et al., submitted for publication
[3] J. M. Park et al., Nature, 592 (2021) 43–48

Figures

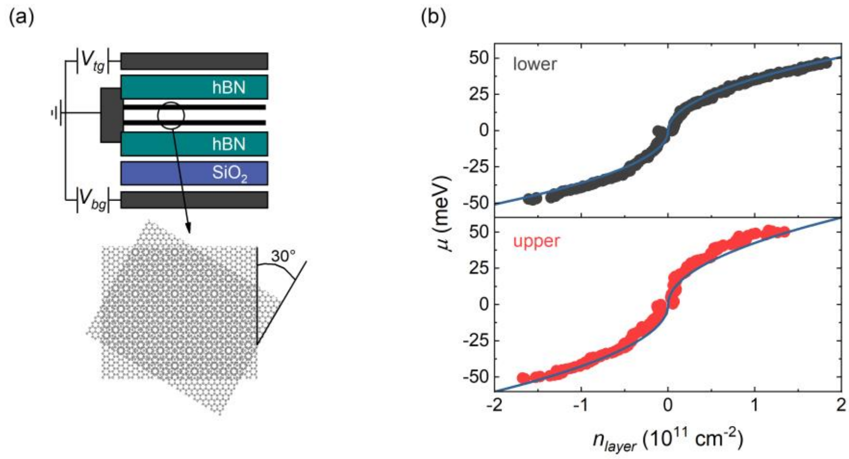

Figure 1: (a) Schematics of the lateral section of the investigated device. CVD-grown 30°-twisted bilayer graphene is encapsulated between hBN flakes. (b) Experimentally measured chemical potential as a function of the carrier density for the two graphene layers (black and red circles). The blue lines are fits to the Dirac dispersion.