On demand angle control in van der Waals heterostructures

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Fabricating layered heterostructures from the assembly of layered 2D crystals (so called, van der Waals (vdW) materials) has emerged as a new paradigm in nano-structured materials. One intriguing feature of these hybrid systems is that device characteristics often depend critically on the relative crystallographic orientation between adjacent layers. A well-known example is graphene on boron nitride, where the relative angle between the two materials generates a periodic (Moiré) potential in graphene, strongly modifying its band structure. Experimental studies of these effects however have remained significantly constrained, owing to the inability to precisely control the rotation order. Here we use a new device architecture where the crystallographic alignment between layers can be manipulated *in situ*, while characterizing the electronic response. Variation in the rotational orientation to better than 0.5 degree enable fine tune of the Moiré potential (Fig. 2) and tuning of the transmission between graphene layers by changing the relative orientation of the graphene crystals, Fig. 1. This transmission is characterized by a 60° periodicity corresponding to crystal symmetry with additional sharp decreases around 22° and 39°, which are among the commensurate angles of twisted bilayer graphene.
This new technique allows, for the first time, a systematic experimental exploration in twisted layered structures van der Waals heterostructures and it represents the first demonstration of *in-situ* modification of a 2D crystal band structure by controlled rotation of its angular orientation.

References

[1] T. Chari *et al.*, Nano Letters 16, 4477–4482 (2016).

Figures

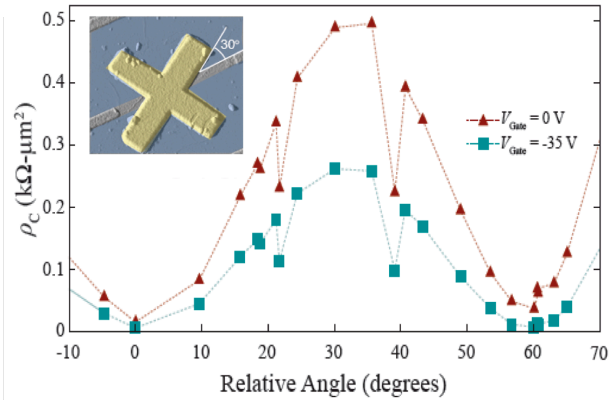

Figure 1: Angular dependence of the resistivity from a graphene layer to graphite.

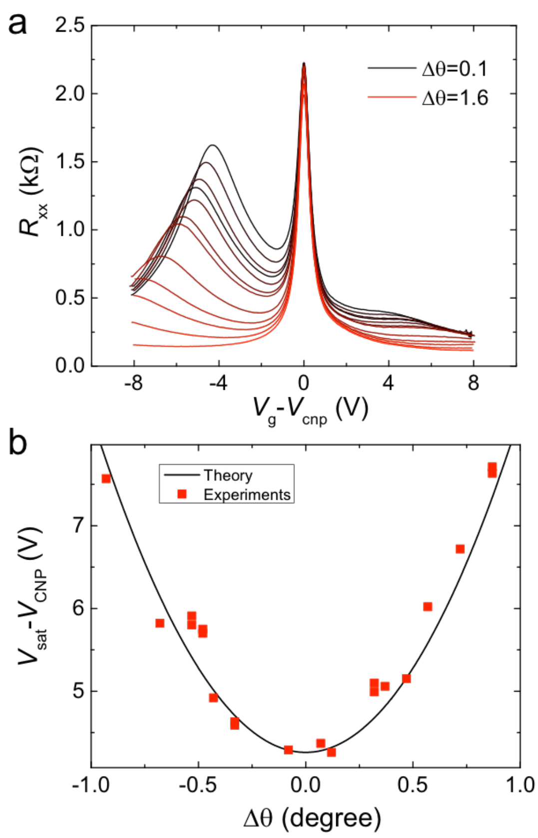

Figure 2: a Variation of the resistance as a function of the back-gate for different layer alignment. **b** Variation of the position of the satellite peak observed in **a** as a function of the angle.