Near-field study of twisted bilayer graphene from small angles to magic angle

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Twisted BiLayer Graphene (TBLG) has recently attracted a lot of interest, mostly due to the discovery of electronic correlated phases [1-2], when the twist angle is close to the magic value of ≈1.05°. Here we report the study of TBLG samples at different angles ranging from very small angles to close to magic angle using mid-infrared and TeraHertz near field photocurrent measurements and scattering-type Scanning Near Field Optical Microscope (s-SNOM).
At small angles (<1°) TBLG forms a lattice of alternating regions with AB and BA stacking separated by domain walls. This structure can be unveiled using near-field photocurrent images [3-4]. We interpret the obtained images in terms of a spatially varying Seebeck coefficient and compare our results with similar measurements made on isolated domain walls in bilayer graphene and with a theoretical model based on the local sheet alignment.
We also analysed TBLG samples at angles close to the magic angle using s-SNOM with the aim of studying the presence of collective modes coupled to the charge density (plasmons). Here, the main finding is the presence, even at charge neutrality, of localized patches that act as cavities for collective modes with a well-defined gapped linear dispersion [5]. We interpret this result in terms of a local change of the inter-layer tunnelling amplitude in the regions of local AA stacking [6].

References

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[2] Y. Cao et al. Nature, **556** (2018) 80.
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[6] P. Novelli et al. Phys. Rev. B, **102** (2020) 125403.

Figures

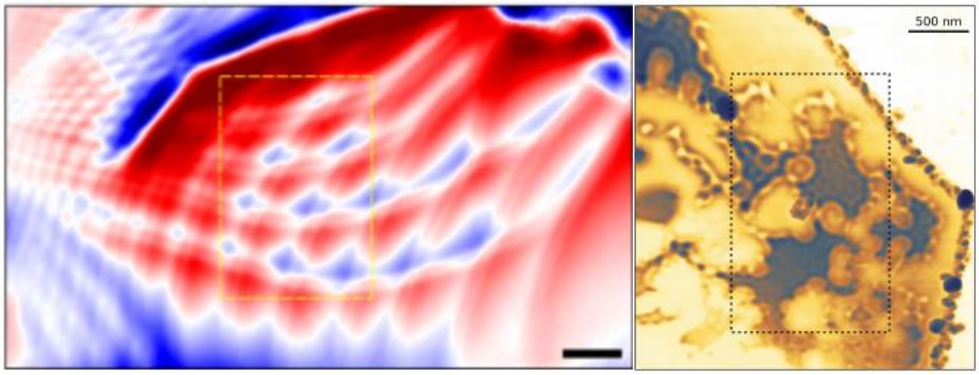

Figure 1: (left) Photocurrent map generated by the moiré pattern of small-angle TBLG, measured at carrier density n ~ 1 × 10^{12} cm^{-2} with an excitation energy of 188 meV. Length of scale bar: 500 nm. (right) Image of the nearfield scattering amplitude in a TBLG sample with twist angle ≈1.35°. Propagating collective excitations are visible in certain areas as periodic interference fringes. The illumination photon energy is 219 meV.