LEEM imaging of the moiré pattern of twisted bilayer graphene.

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The discovery that magic angle twisted bilayer graphene (MABLG) is a superconductor, yielded the promise of exciting new solid state physics, in particular as gating enables exploration of the phase diagram not possible in cuprates [1]. However, the influence of the (in)homogeneity of twist angle, strain and defects in the exfoliated, torn and stacked flakes in transport devices remains an important open question.

Here, we demonstrate that Low Energy Electron Microscopy can directly image MABLG on the full device scale, identifying clean areas of the right twist angle. This has enabled efficient Nano-ARPES measurements confirming the existence of flat conduction bands [2]. Furthermore, we show that direct imaging of the moiré pattern at the magic angle is possible (figure 1) and compare monolayer-on-monolayer to bilayer-on-bilayer graphene. Applying automated stitching to high magnification images, we image the moiré pattern at approximately 2 nm resolution at the full device scale of several micrometers. Using this data, local variations in twist angle and strain are extracted from the moiré pattern by geometric phase analysis [3]. We observe large areas of homogeneous twist angle, but also folds, forming the main type of defects, separating areas of different twist angle. In contrast, layer count boundaries are observed to exist with no influence on twist angle and phase of the moiré pattern. The direct observability of these properties establishes the application of LEEM to this field of physics.

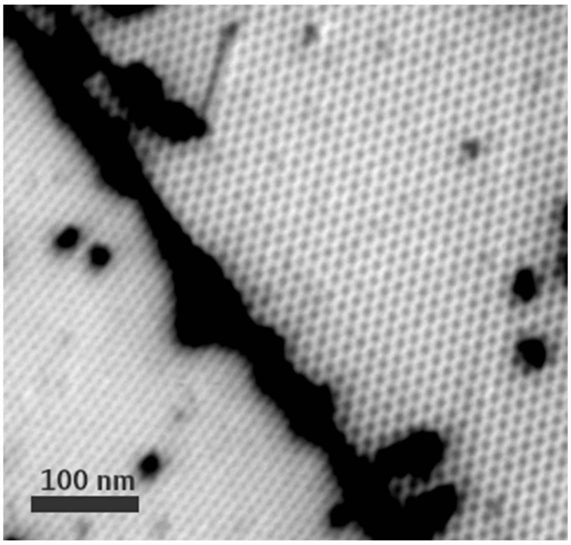

Figure 1. LEEM image at a landing energy of 16.5eV of twisted bilayer-on-bilayer graphene, showing the moiré of two slightly different twist angles at both sides of a fold.

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References
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