PFM and s-SNOM imaging of minimally-twisted double bilayer graphene: moirés, domain walls and solitons

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Twisting graphene-based heterostructures results in local atomic reconstructions which have large consequences in terms of local and global electronic and optical properties [1]. At small twist angle, the moiré superstructure relaxes by forming domains with homogeneous atomic ordering, separated by domain walls (DWs), which play a major role in the observed local and global properties. In addition, other DWs can be observed, called solitons, analogous to dislocations in the crystal [2-4]. Topologically protected edge channels in the valley quantum Hall regime have been observed at the edge of such DWs in bilayer graphene [2]. In this study, we have characterized the DWs superlattices in twisted double bilayer graphene at very small twist angle by piezoresponse force microscopy (PFM) and scattering-type scanning near-field optical microscopy (s- SNOM) in the mid-infrared range (9 µm - 10.6 µm). These two techniques provide complementary information. PFM imaging (Fig. 1a) mainly reveals a contrast related to DWs, via flexoelectric effects, bond tensions and atomic orbital alterations. SNOM imaging (Fig. 1b) provides information on local optical conductivity changes within the domains (corresponding to different local stacking) and to the generation of plasmons launched by the tip and reflected at the walls. We also observe solitons that can be manipulated (moved, wiped out) via the action of the tip.

References

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Figures

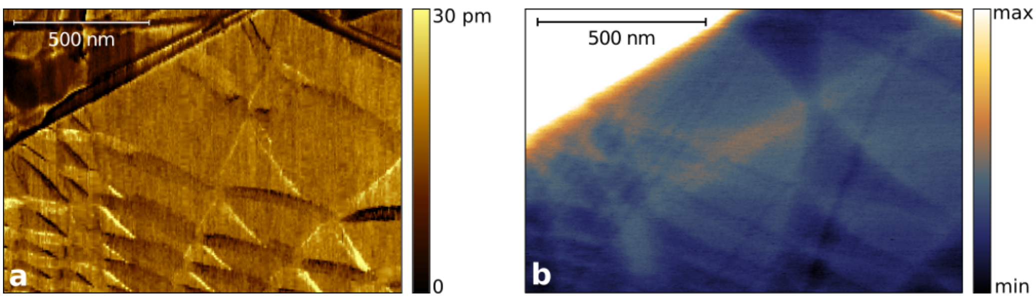

Figure 1: Imaging of twisted double bilayer graphene moiré (a) with PFM microscopy, and (b) with s-SNOM (the signal is demodulated at the 4th harmonic of the lever resonance frequency, illumination at 10.6 µm).