Impact of twist angle and folds on the thermoelectric properties of graphene

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Due to its unique electronic properties, graphene is an ideal material for studying thermoelectricity in 2D geometry. Previous studies focused on thermoelectric effects caused by flake edges, grain boundaries and carrier density fluctuations[1,2]. However, graphene folds and twist angle have received less attention. Since these are common features in twisted bilayer graphene (TBG) devices, understanding their effect on the thermoelectric properties is critical for targeted applications. Here, we investigate how the nanoscale thermoelectric properties of graphene are affected by folds and twist angle using scanning photocurrent microscopy. The measurement system is based on a scanning near field optical microscope (s-SNOM) with an external amplification circuit, enabling the measurement of photocurrents, SNOM response and topography simultaneously. Our results demonstrate that folds and monolayer-TBG boundaries generate strong photocurrent, implying significant changes in Seebeck coefficient across these features. We also observe large photocurrents near the device contacts, as reported previously[3]. Interestingly, applying back gate voltages has a markedly different effect on photocurrent patterns for monolayer and TBG. Random fluctuations in photocurrent, often attributed in the literature to charge puddles, are much stronger in monolayer graphene than in TBL, which has not been reported previously. These observations provide new insights into the features affecting thermoelectricity in graphene devices.

References

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[3] T. Mueller, F. Xia, M. Freitag, J. Tsang, and Ph. Avouris. Phys. Rev. B 79 (2009) 245430-36.

Figures

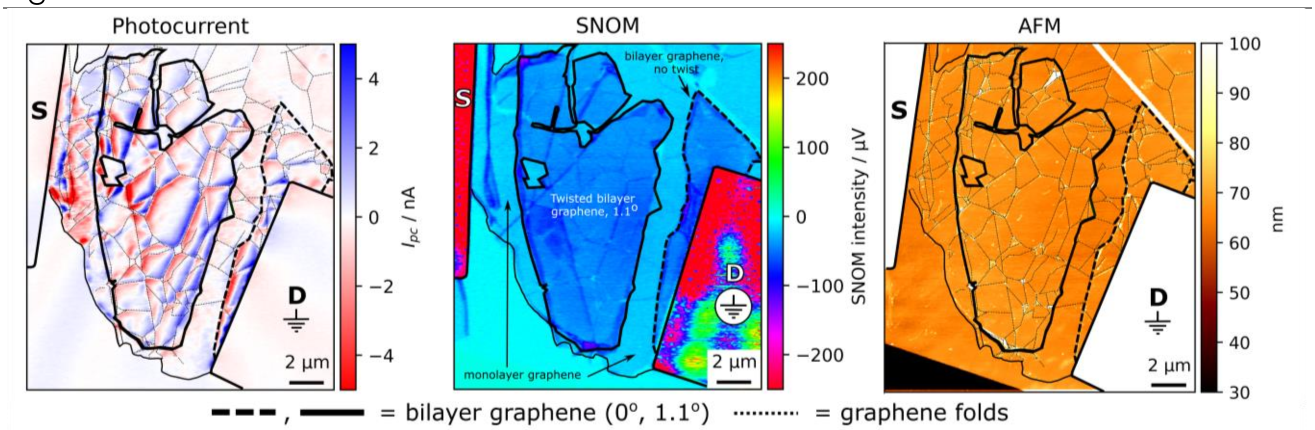

Figure 1: Photocurrent, SNOM response and topography of a monolayer and TBG device, consisting of two overlapping monolayer graphene flakes. TBG is shown by the darker contrast in the SNOM image. Flake edges and graphene folds are also marked.