Department of Materials Science and Engineering Seminar Series 2025

Strain and Interaction Phenomena in Two-Dimensional Crystals

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Date and time: Thursday, 12 Nov, 4:00-6:00pm

Venue: S9, Level 9 Conference room

Abstract

Moiré superlattices formed by stacking two-dimensional (2D) materials with relative twist angles and/or lattice mismatches exhibit rich emergent physical phenomena. Strain provides an additional degree of freedom for manipulating their structures and properties, yet experimental strain engineering of moiré superlattices remains challenging.
In this work, fabrication and strain-engineering techniques are improved for atomically thin graphene and hexagonal boron nitride (hBN) moiré superlattices. Raman spectroscopy is employed to characterize strain in graphene, while atomic force microscopy (AFM) is used to investigate moiré structures.

The scanning moiré fringe (SMF) method is extended to graphene-hBN moiré superlattices using AFM. SMFs magnify local variations in moiré period and orientation, revealing underlying strain and twist-angle variations. This enables rapid visualization of structural inhomogeneity and identification of local distortions over micrometre-scale areas, making SMFs a potential useful tool for studying strain and interactions in 2D crystals.

The effects of unintentional strain on atomically thin graphene-hBN moiré superlattices are investigated. Unintentional strain produces diverse in-plane moiré geometries. In addition, enhanced out-of-plane moiré corrugation is observed with fewer supporting layers at comparable moiré periods.

Furthermore, the effects of intentionally applied strain are investigated. Tensile strain is observed to improve the structural homogeneity of moiré superlattices. A distinct morphology, termed non-moiré buckling, is also investigated. Its suppression under tensile strain and reappearance after strain release provide strong supporting evidence for its association with compressive strain.

These findings advance the understanding of strain-induced structural responses in 2D heterostructures and provide insights into the characterization and strain engineering of moiré superlattices.

Biography

Chen Hengrui received his BSc degree from Nanjing University of Science and Technology and his MSc degree from Southeast University. He pursued his PhD at the National University of Singapore (NUS), where he was supervised by Assistant Prof. Colin Robert Woods during the first two years of his doctoral studies. He is currently conducting his research and completing his PhD in the group of Prof. Konstantin Sergeevich Novoselov at NUS.

Please join us!

HOST: Asst. Prof Zhao Ming