30°-Twisted Bilayer Graphene by Hydrogen Intercalation

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Quasi-free-standing twisted bilayer graphene (TBG) with a 30° twist angle is achieved on a 6H-SiC(0001) surface through hydrogen intercalation. Initially, 0°-rotated monolayer graphene is prepared on a zeroth layer graphene (ZLG) using the surfactant-mediated epitaxial growth method [1]. Then, the ZLG is physically and chemically decoupled from the SiC substrate by the intercalation of hydrogen atoms. Since the ZLG is 30°-rotated with respect to the substrate, this process results in a hydrogen-intercalated 30°-twisted bilayer graphene. We performed this process step by step, and investigated the intermediate stages using Low Energy Electron Microscopy and Diffraction (LEEM and LEED), and Angular Resolved Photo-Electron Spectroscopy (ARPES). The measurements confirm the 30°-rotation and the bilayer-stacking configuration of the graphene layers on the surface after the hydrogen intercalation.

For fully exploiting the instrument's spatial resolution, we applied a sophisticated, automatized approach for analyzing LEEM-*IV* data. Subsequent curve clustering allows the identification of homogenous domains on the surface and its illustration as a false-color image. LEED patterns, BF-LEEM images, LEEM-*IV* plots, and false-color images at different stages of intercalation are shown in Fig. 1. We found a continuous evolution of spectral shapes, which reflect the gradual structural transformation of stacked graphene layers at intermediate stages of the hydrogen intercalation.

References:
[1] F. C. Bocquet et al., Phys. Rev. Lett 125 (2020) 106102.

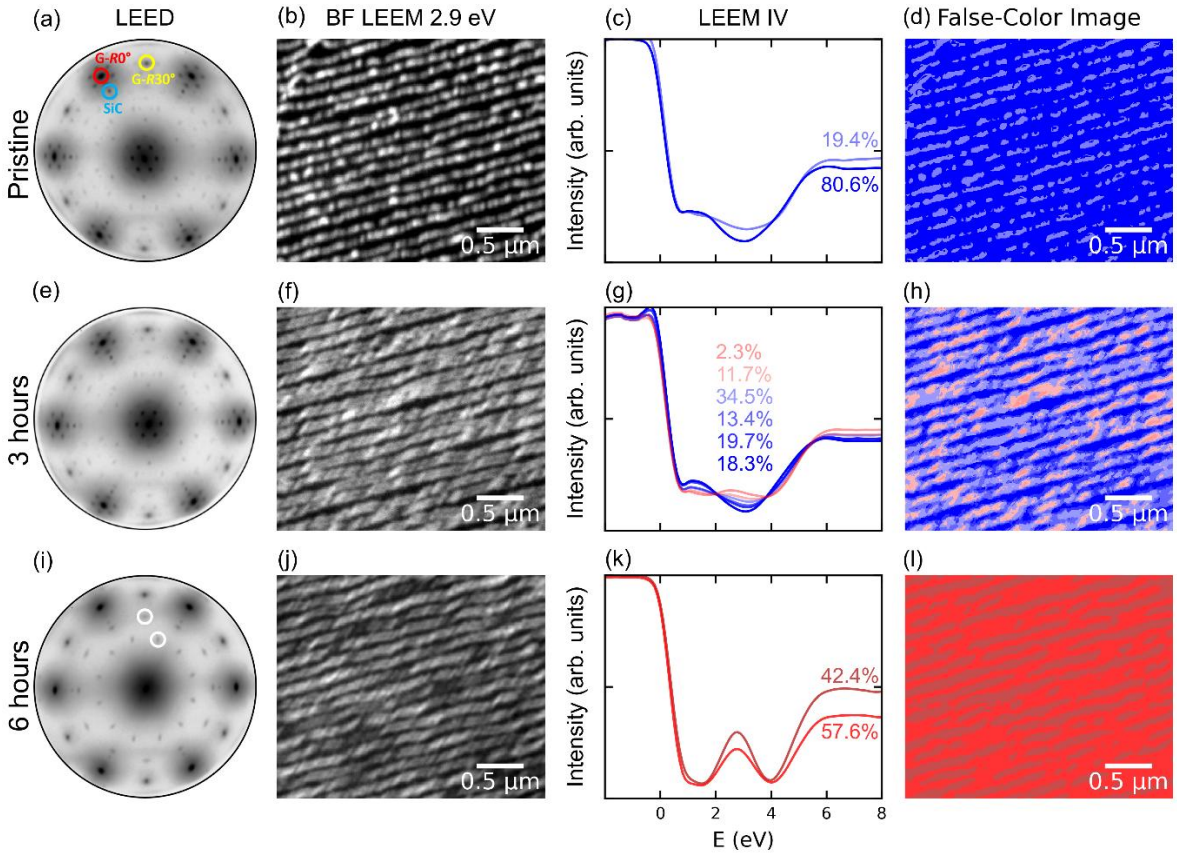

Fig. 1: LEED patterns, BF-LEEM images, average curves of sorted LEEM-*IV* spectra, and false-color images representing the clustering results, obtained from the sample surface at different stages of the hydrogen intercalation. (a,b,c,d) pristine surface, (e,f,g,h) after 3 hours, and (i,j,k,l) after 6 hours.