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Application Note

nanoARPES on Functioning and Tunable Devices with a DA30-L

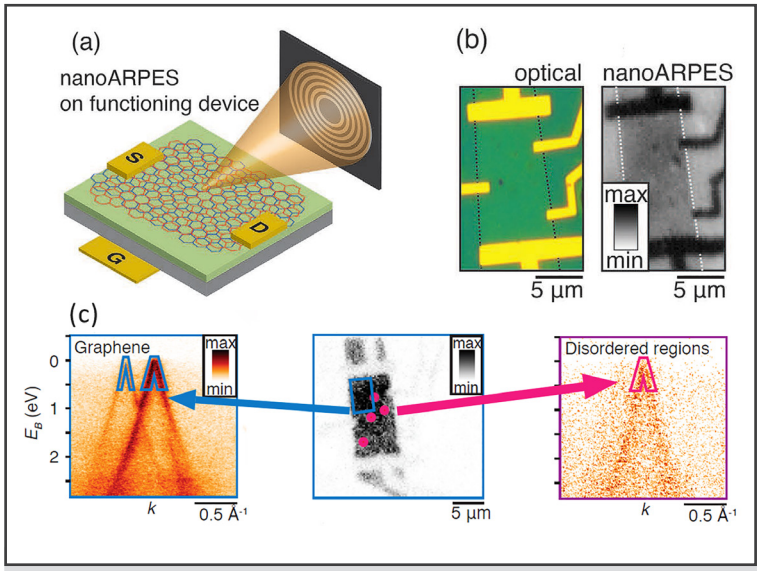
In their recent paper, A. J. H. Jones and S. Ulstrup et al. explore engineering properties of quantum materials by placing a singularity of the density of states near the Fermi energy. Using ebeam lithography for structuring and formation of electrical contacts, a device consisting of twisted bilayer graphene (twBG) on a stack of hBN and graphite was formed. The device was wire bonded to a chip package and introduced to the nanoARPES branch of the I05 beamline at the Diamond light source.

With nanoARPES, such devices in the micrometre scale become accessible and even tiny spatial inhomogeneities the sub-µm domain can be characterised including the twist angle. Given the large twist angle, the mini Brillouin zone of the superlattice is large enough to detect and identify band structure features, specifically the van Hove singularity (vHs) and a small gap. The authors demonstrate how an applied gate voltage can shift this vHs and allows positioning relative to the Fermi energy.

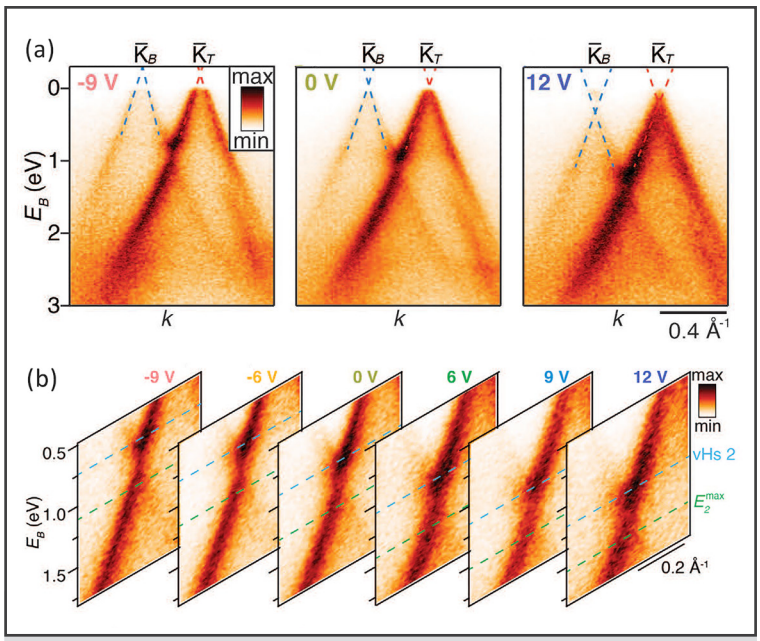
These results encourage further electron transport studies where the vHs energy is tuned with electrical doping in combination with fully resolved (E,k) band structure measurements.

Professor Katoch contributing author stated:
"It is crucial to bridge the gap between the electronic transport and band structure measurements to obtain a comprehensive understanding of electronic properties of emergent quantum materials. In this direction our work provides a deeper insight into the electronic band structure of fully functional mesoscopic sized twisted bilayer graphene device".

About nanoARPES using the DA30-L:
The measurements for this paper were acquired at the I05 beamline at the Diamond light source where a Fresnel zone plate focused 60 eV light down to a 690 nm spot on the sample. A piezo electric stage scanned the sample at 250 nm increments relative to the spot while a DA30-L acquired the photoemission spectra at each position (E, k). The DA30-L deflector mode was used to obtain (E, k_x, k_y)-dependent photoemission intensity.



nanoARPES of twisted bilayer graphene. (a) Overview of the nanoARPES experiment. (b) Device region by optical microscopy (left) and by integrated ARPES intensity (right). (c) Region specific spectra can be extracted and can be used to reconstruct band structure sensitive images. Adapted and cropped from original.



Influence of the gate voltage on the band structure. (a) Influence of gate voltage on the dirac cone positions and (b) the position of the van Hove singularity. Adapted and cropped from original.

Reference:
A. J. H. Jones, S. Ulstrup et al, Adv. Mater. 2020, 32, 2001656,
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