Enhanced photocurrent generation in twisted bilayer graphene

With the support by the National Natural Science Foundation of China, the National Basic Research Program of China, and Beijing Municipal Science and Technology Commission, the research team led by Prof. Liu Zhongfan (刘忠范) and Prof. Peng Hailin (彭海琳) at the Center for Nanochemistry, College of Chemistry and Molecular Engineering, Peking University, developed a high-performance photodetector consisting of twisted bilayer graphene (tBLG), which was published in *Nature Communications* (2016, 7: 10699).

Graphene with ultra-high carrier mobility and ultra-short photoresponse time has great potential in ultrafast photodetection. However, a photodetector consisting of graphene monolayer exhibits relatively low photoresponsivity. To address this problem, Prof. Liu's team developed a chemical vapor deposition (CVD) method to fabricate tBLG, a stack of two graphene monolayers with an interlayer twist angle (θ), and then demonstrated the first realization of tBLG-based photodetection with a prominently enhanced photoresponsivity (~80 folds compared with monolayer graphene).

To unravel the unique electronic structure of tBLG, they have cooperated with Prof. Yulin Chen's team at Oxford University and successfully preformed spatially resolvedangle-resolved photoemission spectroscopy (ARPES) on CVD-grown tBLG samples with different θ. Their observations revealed the emergence of θ-dependent van Hove singularities (VHSs) in density of state (DOS) of tBLG, which leads toa strong light—matter interaction and abnormal θ-dependent optoelectronic properties. CVD-grown tBLG crystals were then fabricated into photodetectors and showed a ~6.7 folds enhanced photocurrent if the value of incident photon energy matched the energy interval of the two VHSs in tBLG. The researchers further demonstrated that the performance of tBLG photodetectors can be further improved by ~80 folds compared with monolayer graphene after integrating metallicplasmonic structure in the device. This study provides important insight for designing next-generation photodetectors.

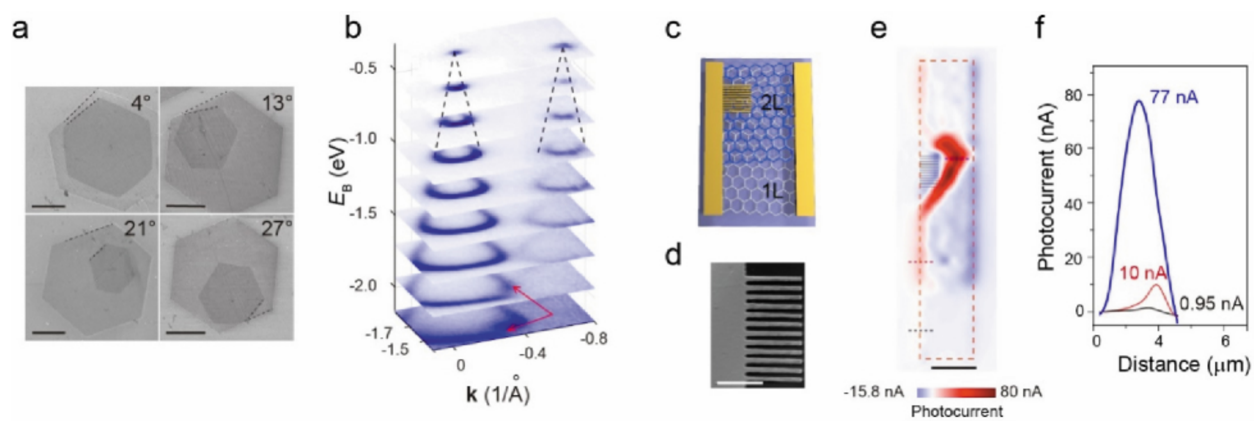

Figure (a) Scanning electron microscopy (SEM) images of tBLG domains with different twist angles on SiO_2/Si. (b) ARPES spectra of tBLG. (c) Schematic illustration of the detector. The channel comprises graphene monolayer domain (1 L) and tBLG domain (2 L). The electrode is integrated with metallic plasmonic structure. (d) SEM image of the plasmonic structure in (c). (e) Scanning photocurrent image of the photodetector with 532 nm focused laser (30 μW) as exciting light. (f) Line-scanning photocurrent of the photodetector. The blue, red and black curves correspond to photocurrent distributions along the tBLG near figure structure, tBLG and graphene monolayer, which are labelled by blue, red and black dashed lines in (e). Scale bar: 1 μm (plasmonic structure in d). Scale bars, 5 μm (others).