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Resonant tunneling through twisted black phosphorus homostructures

The advent of atomically thin two-dimensional materials heterostructures open new opportunities for rethinking conventional semiconductors heterostructures devices such as light-emitting diodes[1], quantum well lasers[2], tunneling field-effect transistors[3], resonant tunneling transistors, among many others. Here, we explore electronic transport in homostructures based on anisotropic material, black phosphorus and demonstrate the unprecedented degree of control that the relative staking twist angle between anisotropic layers has on the vertical transport behavior. Interlayer coupling strength between anisotropic layers depends sensitively on the twist angle and subsequently dictates the transport behavior from Ohmic to tunneling. Utilizing high quality homostructures made of orthogonally stacked anisotropic black phosphorus multilayers, we demonstrate resonant tunneling through quantum well states without the need of any physical tunneling materials[4], hence achieving the largest tunneling conductance and peak-to-valley ratio in negative differential resistance characteristics.

References

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Figures

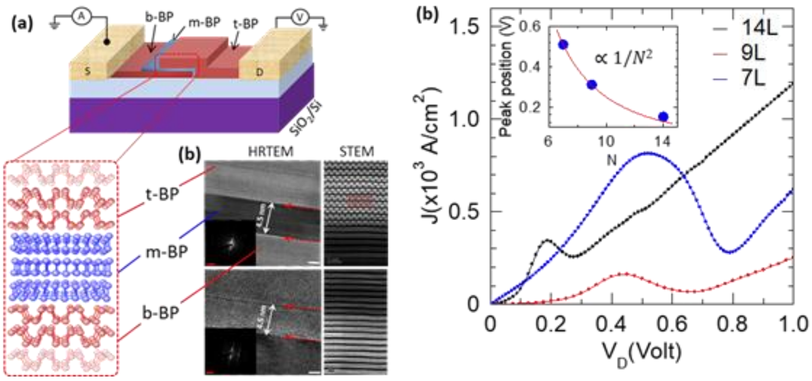

Figure 1: (a) Schematics of the BP trilayer twisted homostructure device and HRTEM/STEM images which reveal (90°) twisted middle layer. **(b)** Resonant tunneling feature as obtained from device shown in (a).

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