Band structure sensitive photoresponse in twisted bilayer graphene proxtimitized with WSe_2

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The ability to tune the twist angle between different layers of two-dimensional (2D) materials has enabled the creation of flat bands artificially, leading to exotic quantum phases. An emerging direction in this field is twisted bilayer graphene (tBLG) van der Waals coupled to a layer of semiconducting transition metal dichalcogenide, such as WSe_2, which leads to unique electronic and structural properties arising from moir´e superlattice potential, proximity-induced spin-orbit interaction, etc. Although different transport measurements have shed light on the rich-phase diagram of WSe_2/tBLG devices, understanding light-matter interaction in such systems remains elusive. Here we have leveraged WSe_2/tBLG heterostructure to perform photoresponse measurements, where the mis-orientation angle of the tBLG layer was chosen to lie close to the magic angle of 1.1°. Our experiments show that the photoresponse is extremely sensitive to the band structure of tBLG. We demonstrate that photogating emerges as a primary mechanism for photoresponse in the tBLG layer prevailing above the moir´e band edge. In contrast, strong suppression of photoresponse is observed as the Fermi level is tuned inside moir´e flat bands at low temperatures. Our observations suggest that the screening effects from moir´e flat bands strongly affect the charge transfer process at the WSe_2/tBLG interface, which is further supported by time-resolved photo-resistance measurements. With the enhanced photo responsivity arising from the photogating effect, our device architecture opens up new possibilities to optoelectronically probe the rich physics of WSe_2 proximitized tBLG.