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Light polarization and carrier density dependence of photocurrent in few layer graphene and monolayer MoS_2

Helicity dependent photocurrent (PC) in single layer graphene (SLG) has been the subject of intense debate, and was recently ascribed to the photon drag (PDE) and the circular photogalvanic effects (CPGE) [1]. Here we report the experimental determination of the PC response of few layers graphene and 2D semiconductors as a function of light intensity and state of polarization, as well as carrier density and polarity. The bilayer graphene (BLG) data show qualitative features in common with the photocurrent that is expected to arise from the PDE and the CPGE, as seen in SLG except an anomaly which seems to have an origin similar to the CPGE [2]. Also, we present helicity dependent PC data of trilayer graphene (TLG) ABA-stacked (which consists of SLG-like and BLG-like subbands) and ABC-stacked (approximately cubic band dispersion and band gap opening by gating). While the PC due to LPDE of TLG samples are similar to SLG and BLG; we noticed a large enhancement in the PC due to the CPGE of ABC-stacked TLG (~15 pA), while the PC due to CPGE in ABA-stacked TLG is similar to SLG. In addition, we investigated the excitonic physics of monolayer MoS_2 with high valley polarization, by light polarization dependent PC. We demonstrate that large PC dichroism can be achieved, due to the CPGE upon resonant excitations [3]. Also we observed anomalous linear photogalvanic effect in a monolayer MoS_2 sample which could be attributed to spin polarization at the edges. These results highlight the richness of photoresponse in graphene and 2D semiconductors, providing an opportunity to establish light helicity as a means to manipulate the photoconductive behaviour of future 2D optoelectronic devices.

References

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