Poster-1-38

Quenching of the band gap of 2D semiconductors with a perpendicular electric field

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The electronic band structure of atomically thin semiconductors can be tuned by the application of a perpendicular electric field. The principle was demonstrated experimentally shortly after the discovery of graphene by opening a finite band gap in graphene bilayers [1], which naturally are zero-gap semiconductors. So far, however, the same principle could not be employed to control a broader class of materials, because the required electric fields are beyond reach in current devices. To overcome this limitation, we have realized double ionic gated transistors that enable the application of very large electric fields, due to the much larger geometrical capacitance achieved in these devices compared to those based on solid state dielectrics. Using these devices, we show that the band gap of few-layer semiconducting transition metal dichalcogenides, from bilayer to heptalayer WSe_2, can be continuously suppressed from 1.6 eV to zero [2]. Our results illustrate an unprecedented level of control on the band structure of 2D semiconductors and envision the possibility to realize novel experiments, such as bias tuning of a topological state.

[1] See, for instance, Oostinga, J. B et al. Gate-induced insulating state in bilayer graphene devices. Nature Materials 7, (2008) and Y. et al. Direct observation of a widely tunable bandgap in bilayer graphene. Nature 459, (2009).

[2] Quenching the bandgap of two-dimensional semiconductors with a perpendicular electric field. Nature Nanotechnology, (2022).