Massless Dirac fermions in potassium-doped few-layer black phosphorus

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Thin flakes of black phosphorus (BP) are a two-dimensional (2D) semiconductor whose energy gap is predicted being sensitive to the number of layers and external perturbations. Very recently, it was found that a simple method of potassium (K) doping on the surface of BP closes its band gap completely, producing a Dirac semimetal state with a linear band dispersion in the armchair direction and a quadratic one in the zigzag direction [1]. Here, based on first-principles density functional calculations, we predict that beyond the critical K density of the gap closure, 2D massless Dirac fermions (i.e. Dirac cones) emerge in K-doped few-layer BP, with linear band dispersions in all momentum directions, and the electronic states around Dirac points have chiral pseudospins and Berry's phase [2]. These features are robust with respect to the spin-orbit interaction and may lead to graphene-like electronic transport properties with greater flexibility for potential device applications.

References

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