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Valley and spin transport and magnetoresistance in a borophene monolayer

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Abstract

In this paper, we investigate the spin and valley transport of electrons through a ferromagnet-normal-ferromagnet junction in a 8-pmmn borophene monolayer. A gate voltage is applied to the normal region and an exchange magnetic field is applied to both sides of this region through the ferromagnetic substrate. The exchange field breaks the spin degeneracy and results in spin polarization. On the other hand, the gate voltage induces valley polarization in the system. The valley polarization induced by the gate voltage is due to the presence of tilted and anisotropic Dirac cones in the borophene structure. While in materials such as graphene with isotropic cones, the gate voltage cannot induce valley polarization and strain must be applied to the system. Our proposed system can act as a perfect valley and spin filter such that the filtration characteristic can be controlled by changing the Fermi energy and gate voltage. It is observed that if the length of the normal region is greater than a certain limit, perfect valley polarization occurs. According to the results, this system can be used in borophene-based electronic and spintronic devices. The investigation of magnetoresistance is another study that has been conducted, and indicates the potential capability of this material in the fabrication of spin memories.

Keywords: Borophene monolayer, Quantum transport, Nanoelectronic devices, Spin and valley filters, Magnetoresistance

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