Spin Filtering in Zigzag Graphene Nanoribbons Using 7-5 Defects

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Electrons carry both charge and spin. The processing of information in conventional electronic devices is based only on the electronic charge. Spin electronics, or spintronics, uses the spin of electrons as another degree of freedom [1]. Materials with zero band gap form the basis for spintronic devices and show superior performance in comparison with non-zero band gap materials [1]. Graphene, a zero band gap material, has attracted considerable attention from the scientific community due to its excellent electronic, optoelectronic, and spintronic properties.

A graphene layer can be patterned with zigzag edges on both sides, known as zigzag graphene nanoribbon (ZGNR). In ZGNRs edge states are ferromagnetically ordered, however, opposite spin orientation across the ribbon results in zero total spin [2]. Ideal ZGNRs are inefficient spin injectors due to symmetric edge states with opposite spin orientation [3]. To break this symmetry and obtain a net spin injection one can apply a large transverse electric field [2]. Alternatively, edge imperfections, such as vacancies, can be employed to obtain a finite spin conductance in ZGNRs [3].

In this work we show that edge reconstructed ZGNRs by 7-5 defects, which have been observed experimentally [4], have a finite spin conductance and show spin filtering behavior (see Fig. 1). In such structures, zigzag edges can be reconstructed to armchair type by 7-5 defects. Therefore, interesting mixed spin properties can be observed in such structures, which result in excellent spin filtering, see Fig.1 (right). The electronic band structures are obtained from ab initio pseudo-potential spin density functional theory with relaxed atomic positions. These properties are investigated for various ZGNR indices and similar results are obtained. The proposed structure can be used as an excellent spin injector and filter in spintronic applications.

References:

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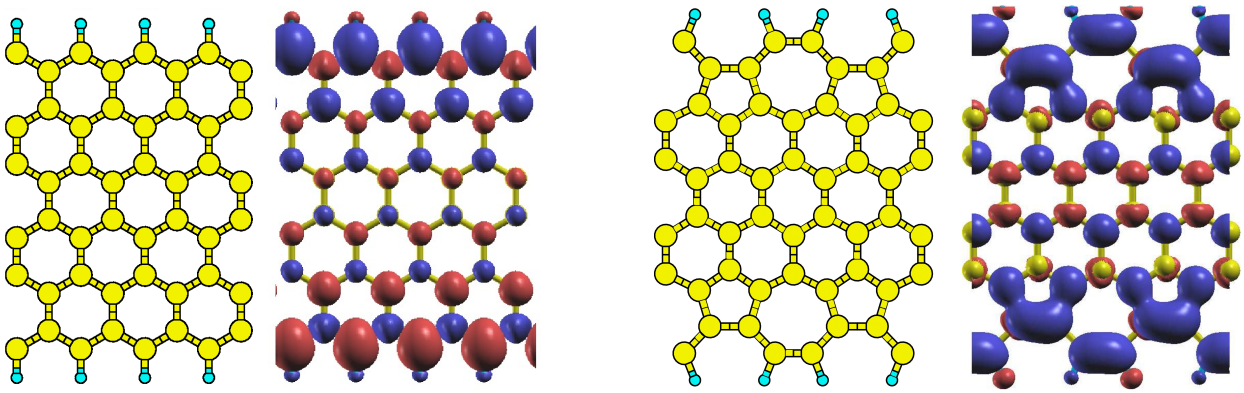

Fig. 1: Spin filtering in an edge-reconstructed 6-ZGNR with 7-5 defects.