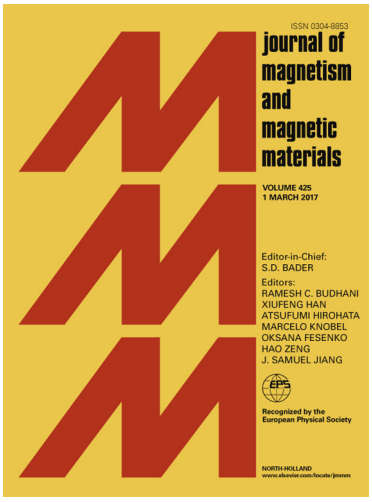

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Spin-dependent electronic transport of a lengthy ladder-like magnetic nanoribbon

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Abstract

We propose a theoretical method based on Green's function technique within the tight-binding approach to consider the spin-dependent electronic conductance of a lengthy ladder-like magnetic nanoribbon. A part of this nanoribbon which is located in the middle is presumed to be different from other ideal parts. We utilize a unitary transformation to separate conductance modes in the ideal parts in order to insert them effectively by fully analytical self-energies in the middle part of Green's function. Finally, the model is examined to perform numerical calculation for some proposed configurations. The model can aid our understanding and design of the spin-filtering electronic narrow nanoribbons.

Keywords: spintronics, nanoribbon, Green's function, tight-binding

1. Introduction

Spintronics, a novel branch of nanotechnology, plays a basic role in generation of spin-based electronic devices such as magnetic memories and sensors [1–3]. Such devices could be used with less energy and are faster than usual charge-carrying based ones. They could have effective application and potential in read head, radio frequency component and magnetic random access memory [4]. Nowadays, thanks to modern technology and laboratory techniques, it is possible to preserve the spin orientation of the electrons along the nanoscale devices [5]. Therefore, it can be said that the main challenge in the spintronics is to achieve injection and accumulation as well as detect electron spin in the nanoscale structures [6, 7]. In the molecules of organic materials and polymers, because of the weak spin-orbit and hyperfine interactions, spins can remember their orientation over unusually long times [8]. This point predicts that the organic molecules are important in development of spintronics. In recent years, graphene nanoribbon has been found to be one of the materials that have wide application in generation of the spintronic devices due to its fascinating physical and transport properties [9–11]. The researchers show that one can control the electronic and band structure of graphene nanoribbons by defects and magnetic impurities created by chemical or physical doping [12–15]. For example, Ti-adsorbed graphene is a favorable 2D-material in spintronics [16]. Nowadays, it is possible to produce graphene nanoribbons with width below 10 nanometers experimentally [17] . Also, it can be fabricate the magnetic honeycomb nanoscale network [18] and artificial patterns [19] . Theoretically, the spin-dependent transport properties of the ladder-like graphene nanoribbon in finite size (which are called n-acene polymers) are investigated by means of DFT and ab-initio approaches [20].

In this paper, following our work on magnetic conductance of nanostructures [21–23], we study theoretically the spin-dependent electronic transport of a lengthy ladder-like magnetic nanoribbon with a different part at its center. We construct our model in the linear response regime by using Green's function technique and the tight-binding approach. First, we find a unitary transformation to separate the conductance modes of the ideal parts of the nanoribbon. Then, we calculate the self-energies of these modes in completely analytic forms and insert them in the inverse of the transformed Green's function of the center part. The most outstanding feature of our preferred method is that in

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