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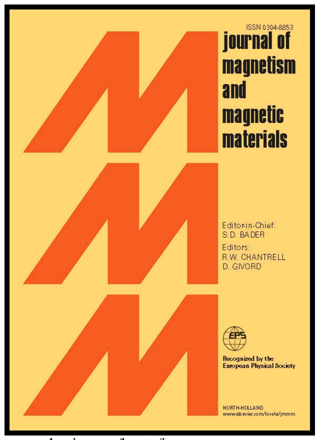

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Fully Valley/spin polarized current and Fano factor through the Graphene/ferromagnetic Silicene /Graphene junction

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Abstract

In this work, we study the transport properties of Dirac fermions through the ferromagnetic silicene which is sandwiched between the Graphene leads (G/FS/G). Spin/valley conductance, spin/valley polarization, and also Fano factor are theoretically calculated using the Landauer-Buttiker formula. We find that the fully valley and spin polarized currents through the G/FS/G junction can be obtained by increasing the electric field strength and the length of ferromagnetic silicene region. Moreover, the valley polarization can be tuned from negative to positive values by changing the electric field. We find that the Fano factor also changes with the spin and valley polarization. Our findings of high controllability of the spin and valley transport in such a G/FS/G junction the potential of this junction for spin-valleytronics applications.

Keywords: A. Graphene, B. Ferromagnetic silicene, C. Landauer-Buttiker formula, D. Fully valley and spin polarized, E. Fano factor.

1. INTRODUCTION

Two-dimensional (2D) lattice structures of silicene and graphene are to some extent similar but they have important differences[1,2]. While both graphene and silicene form hexagonal honeycomb structures, graphene is fully two-dimensional but silicene forms a buckled hexagonal shape[3-12]. In contrast to graphene[1], silicene has a large spin-orbit coupling and due to the low-buckled geometry, its energy gap can be further tuned by an external electric field perpendicular to the silicene sheet[13,14,15]. The large spin-orbit interaction of silicene leads to the strong spin-valley dependence and spin Hall effect[16,17,18]. The low-buckled geometry of silicene with strong atomic intrinsic spin-orbit interactions leads to a gap of 1.55meV between the conduction and valence bands[18,12]. Also by applying electric field, opening the energy gap leads to the topological phase transition in silicene and the conductance can be controlled by the gate voltage[19]. Fully spin and valley polarized current were found to be controllable by electric and exchange field in the ferromagnetic silicene layer[20,21,22]. It is worth mentioning that symmetires in graphene allow two kinds spin orbit interaction: intrinsic effective and extrinsic Rashba like spin-orbit coupling. The former one originates from the carbon inter-atomic coupling which has been estimated to be less than 0.05 meV[23]. The latter one originates from the presence of an electric field perpendicular to a sheet, interaction with a substrate, and curvature of a sheet, which results in spin polarization[24] and spin relaxation[25].