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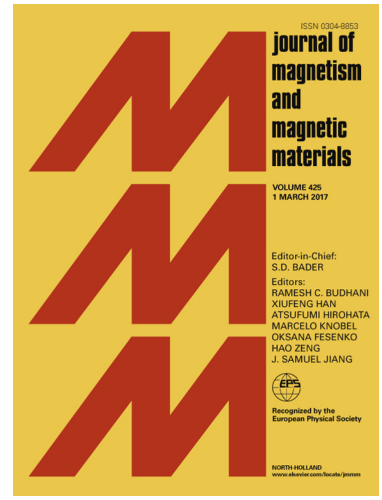

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Spin-Valleytronics of Silicene Based Nanodevices (SBNs)

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The quantum spin and valley characteristics in normal silicene/ ferromagnetic silicene/ normal silicene junction are investigated under the effects of both electric field and the exchange field of the ferromagnetic silicene. The spin resolved conductance and valley resolved conductance are deduced by solving the Dirac equation. Results show resonant oscillations of both spin and valley conductance. These oscillations might be due to confined states of ferromagnetic silicene. The spin and valley polarizations are also computed. Their trends of figures show that they might be tuned and modulated by the electric field and the exchange field of the ferromagnetic silicene. The present investigated silicene nanodevice might be good for spin-valleytronics applications which are needed for quantum information processing and quantum logic circuits.

Keywords: Silicene; Quantum spin; Quantum valley; Exchange field; Spin resolved conductance; Valley resolved conductance; Nanodevice.

1. Introduction

Recently, the spin degrees of freedom of electrons are being taken into consideration in the design of electronic devices, giving rise to the burgeoning field of “spintronics” [1, 2]. It may be anticipated that spintronics will open new perspectives for semiconductor electronic devices [3-9]. Two-dimensional (2D) lattice structures of silicene and graphene are to some extent similar but they have important differences [10, 11]. While both graphene and silicene form hexagonal honeycomb structures, graphene is fully two-dimensional but silicene forms a buckled hexagonal shape [12-24]. In contrast to graphene [10], 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 [25, 26]. The large spin-orbit interaction (SOI) of silicene leads to the strong spin-valley dependence and spin Hall effect [24, 27, 28]. The low-buckled geometry of silicene with strong atomic intrinsic spin-orbit interactions leads to a gap of 1.55 meV between the conduction and valence bands [24]. Also by applying electric