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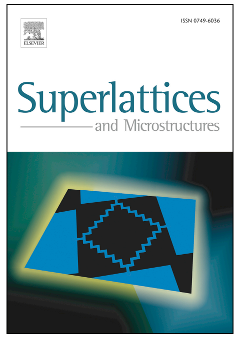

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Guided modes in silicene-based waveguides

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Abstract Silicene is a new Dirac-type electron system similar to graphene. A monolayer silicene sheet forms a quantum well induced by an electrostatic potential, which acts as an electron waveguide. The guided modes in the silicene waveguide have been investigated. Electron waves can propagate in the silicene-based waveguide in the cases of Klein tunneling and classical motion. The behavior of the wave function depends on the spin and valley indices. The amplitude of the electron wave function in the silicene waveguide can be controlled by the external electric field. These phenomena may be helpful for the potential applications of silicene-based electronic devices.

Keywords: silicene, electron waveguide, guided modes, external electric field

1. Introduction

Silicene, a two-dimensional honeycomb sheet [1-3], is formed by a monolayer of silicon atoms. Due to its electronic band structure akin to the graphene [4-6], silicene shares almost every property of graphene [7], including the linear band crossing at the Fermi level. The charge carriers in silicene behave like massless Dirac fermions [8,9] at the Dirac points of the hexagonal Brillouin zone (BZ) [10], with the Fermi velocity of ~10^6 m/s [11]. However, silicene has been theoretically predicted as a buckled honeycomb arrangement of Si atoms [1,10], owing to a large ionic radius of silicon. Compared with graphene, silicene has a large intrinsic spin-orbit coupling (SOC), opening an electrically controlled sublattice-asymmetry gap about 3.9meV between the conduction and valence bands [12,13], which leads to the massive Dirac fermions in silicene [10]. It makes experimentally accessible to quantum spin Hall (QSH)effect