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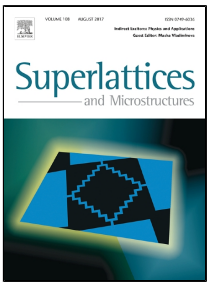

The first excited state energy of strong couple bound polaron in monolayer graphene

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The first excited state energy of strong couple bound polaron in monolayer graphene

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Abstract Properties of strong coupled polaron in monolayer graphene are discussed in the presence of the Coulomb interaction. The linear combination operator method and Lee-Low-Pine unitary transformation method are used to calculate the first exited state energy of the polaron for various values of the electron-phonon coupling. It is shown that the first exited state energy of the system has a linear relationship with the magnetic field strength, the cut-off wave number, the Coulomb bound parameter, the distance between the graphene and the substrate.

Keywords First excited state energy; Monolayer graphene; Substrates; Coulomb bound parameter

PACS numbers: 71.38.-k, 73.21.la, 63.20.kd

1 Introduction

Graphene, a new type of nanoscale material found in recent years, has attracted much attention due to its unique properties, and inspired people's enthusiasm for its research. In recent years, some important physical properties of graphene have been found by the researchers domestic and oversea. Though the people have paid much attention to the physical properties of the graphene, most of theoretical results and experimental results have concerned on electron transport properties on graphene, and the other properties still need to be investigated for graphene material. Especially considering the Coulomb impurity problem of graphene, polaron properties of the graphene is vital for the future of the next generation electronic materials due to its special electronic structure. So far the theoretical studies of the electron-surface phonon interaction (ESPI) in monolayer graphene on polar substrates such as SiO, HfO2, SiC and hexagonal BN has been presented. Thus the eigen energies derived from the tight-binding Hamiltonian in monolayer graphene have been used. The results indicate that the ESPI depends on the polar substrate [1]. Likewise the Rashba spin–orbit coupling (SOC) and electron–phonon interaction (EPI) of the electronic structure in the different width zigzag graphene nanoribbon has been studied by Modarresi et al [2]. The total Hamiltonian of the nanoribbon is written in the tight binding form and the EPI is modeled in the Hubbard term. The effective Hamiltonian of EPI was reached in nanoribbon using a unitary transformation. Similarly, the SOC effects on the electron (hole)-E_{2g} phonon interaction in graphene have been investigated. The SOC effects on electron and hole polaron formation and spin polarizations of charge carriers have been found by Mogulkoc et al. [3]. The field-induced dynamics of the polarons in armchair graphene nanoribbons(GNRs) in the framework of a two-dimensional tight-binding model with lattice relation is theoretically investigated by Jr et al. [4]. Additionally, many theoretical and experimental attempts to the