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The effects of inner radius and width on the energy spectrum and persistent current in zigzag hexagonal graphene quantum rings

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Abstract

In this work, the effects of inner radius and width variation on energy spectrum and persistent current in hexagonal graphene quantum rings with zigzag edges have been studied using the tight-binding model. Our investigation shows that the energy spectra of these rings are grouped into subbands each of which consists of six coupled energy levels separated by energy gaps. The patterns of these subbands and gaps are strongly affected by the inner radius and width. In other words, the width and inner radius of HGRs play a very important role in gap engineering. Narrow HGRs have more regular energy subband patterns and larger gaps, which can be due to the increasing quantum confinement and the edge effects, especially in the corners of the structure. Increasing the inner radius leads to the compression of six coupled energy levels in each subband decreasing the subband gap near the Fermi level. Furthermore, increasing the inner radius or width can have similar effects on the energy spectrum, so the effect of increasing one of them can be neutralized by decreasing the other one. Specially, it is dominant for the energy gap near the Fermi level. Additionally, increasing the inner radius or width leads to increasing the amplitude and oscillations of persistent current versus the magnetic flux. Meanwhile, width variation is more effective than the variation of inner radius on the persistent current.

Keywords: hexagonal graphene quantum ring, tight binding model, persistent current, energy gap

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