Tunneling spectra of the gapped-gapless graphene-based Thue-Morse superlattice.

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Abstract

The gapped graphene superlattice (SL) constructed of two elements a and b in accordance with the Thue-Morse rule (see e.g. [1]) is considered. The SL consists of the rectangular potential barriers along the 0x axis. We suggest to create the quasi-periodic modulation due to the difference in the values of the energy gap Δ in different SL elements . The transfer matrix method is used for evaluations of energy spectra in a continuum model (see e.g. [2]). It is proved that the splitting of the allowed bands is effective and the series of gaps is formed under the normal incidence of electrons on the SL and in the case of the oblique incidence of the quasi-particles on the SL (e.g. Fig. 1). Energy spectra reveal periodical character on the whole energy scale. Spectra also change periodically as potential barriers height increases. As in the case of periodical SL ([2]) the gap associated with the new Dirac point is formed in every Thue-Morse generation (gap D in Fig.1). The location of this gap is robust against the change in the SL period but at the same time it is sensitive to the ratio of barrier and well widths. Both the width of the SL Dirac gap and its location is weakly dependent on values of the mass term in the Hamiltonian. Also we analyze some differences between the cases of the graphene-based SL and the SL based on the conventional semiconductors (with the parabolic dispersion law, see e.g. [3,4]). The results obtained allow for controlling the energy spectra of the graphene-based superlattices and may be useful for operating the nanoelectronic devices.

References

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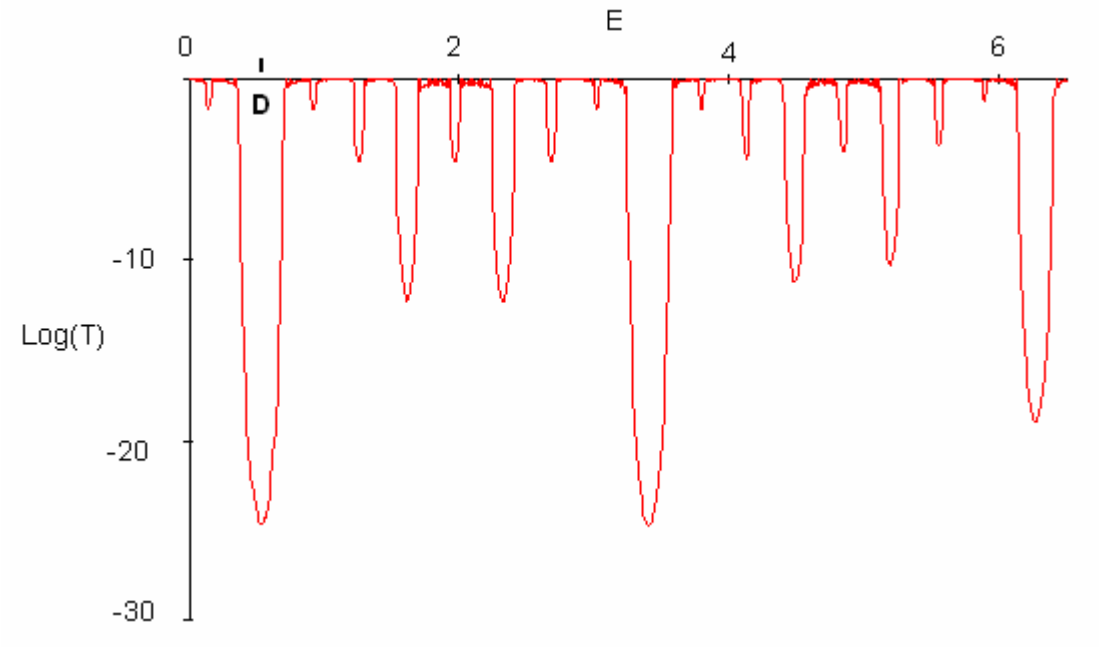

Figure.1: Dependence of the common logarithm of the transmission coefficient T on electrons energy E for the 5-th Thue-Morse generation; values of the parameters: k_y =0, d=0.4,w=0.7, V_a=V_b =2, Δ_b=0, Δ_a=1. k_y is the y–component of the wave number, d and w are the widths of the potential barrier and the quantum well respectively; units c=ħ=e=v_f=1 are adopted, v_f is the Fermi velocity.