Quantum Size Effects in Thermoelectric Parameters of Nanostructures Based on Lead Telluride

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In the case when thickness of the film is the same order with the wavelength of the De-Broglie's waves for charge carriers the transverse motion of electrons is quantized. Since the spectra have the partially discrete values, the quantum-size effect appears. Terms of appearance of size quantization are performed for the semiconductor films, as they have the De-Broglie's wavelength for the carriers are on several orders higher than the interatomic distance. One of the effects of size quantization of the energy spectrum in two-dimensional systems is the emergence of oscillations in the dependences of thermoelectric parameters from the thickness of condensate. Due to the ability to regulate this data thermoelectric parameters, these structures are interesting for attract attention for detailed study.

Based on the model of quantum flat rectangular and with infinitely high walls pit, the correspondences were calculated and received value of the Fermi energy and kinetic coefficients (conductivity σ, Seebeck coefficient S and thermoelectric power $S^2\sigma$) for n-PbTe, by the Boltzman kinetic equation.

In the cases with strongly degenerate, degenerate and nondegenerate electronic gas in the films of lead telluride with n-type of conductivity are considered separately.

It is theoretically shown oscillating character of dependences of thermoelectric parameters of nanostructures based on n-PbTe for the degenerate and strongly degenerate electron gas (Fig. 1) and it is shown the monotonous character for the case of a nondegenerate electron gas. The conditions for the implementation of quantum-size effects in thin films are investigated. It is shown that quantum-size can be occurring only when the average electron energy is comparable with the characteristic energy quantization.

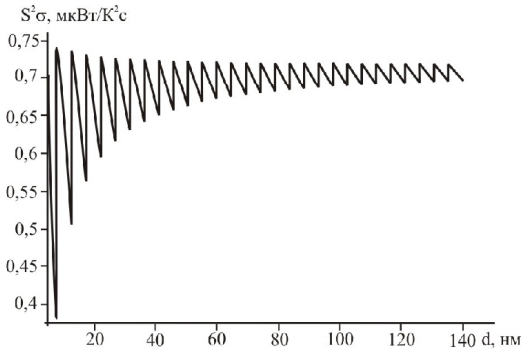

Figure 1. Theoretical dependence of the thermoelectric power $S^2\sigma$ from the thickness d of thin films of n-PbTe at T = 300K

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