Nonlinear Resonant Tunneling as mechanism for Cold Electron Filtration in Nanodevices

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The thermal distribution of charge carries is the essential limitation for the use of nanoelectronic devices. In such systems with a small number of charge carries (low current) subjected to scattering, the information component may be lost. In Ref. [1] it was reported about the energy-filtered cold electron transport at room temperature in the tunneling device where a nanoparticle embedded in a dielectric matrix served as a quantum dot (QD). The cold electron transport was detected from extremely narrow differential conductance peaks with the width at half maximum of 15 mV at room temperature.

We proposed the explanation of the effect of suppressing the temperature distribution of the current carriers in such a system. Due to spatial confinement, the quantization of energy takes place in the QD. Each level is four-fold degenerated. The important feature of this approach is the breaking of degenerate states as a result of an interaction of electrons with low energy phonons in the QD. The splitting energy levels can have lower energies than the Fermi energy of the source electrode. The tunneling current through these levels will not be affected by the temperature. The analogous mechanism of nonlinearity with the strong electron-phonon interaction has been considered in Ref. [2] and was developed in Ref. [3].

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