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One-dimensional miniband transport in doped GaAs/AlAs superlattices

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Evidence of the crucial role of random fluctuations of the well size in vertical transport in doped GaAs/AlAs superlattices with broad minibands has been obtained by both Fourier-transform reflection spectroscopy and C–V measurements. The samples with different density of free electrons and, as a consequence, with different filling of the miniband were examined.

It turned out that even monolayer fluctuations of the periodicity, or random fluctuations of the impurity potentials, which are unavoidable, can cause a partial localization of electrons providing one-dimensional conducting channels where the periodicity is conserved, and through which the electron transport across the superlattice would occur.

This was found to be the reason why, instead of the constant vertical conductivity (independent of the electron density) predicted by the theory to occur when the Fermi energy exceeds the miniband width, a drop of the conductivity giving a metal-to-dielectric phase transition was observed.

The percentage of the electron states localized in the lowest miniband was determined in the superlattices with different electron concentrations and with different miniband widths. This showed the increase of a number of the localized states with increase of the electron concentration and with decrease of the miniband width.