# Anisotropic transport of 2D electron gas in heavily modulation-doped GaAs single quantum wells with AlAs/GaAs superlattice barriers

A.K. Bakarov [*], A.V. Goran, A.A. Bykov, D.V.Sheglov, A.I. Toropov

*Institute of Semiconductor Physics, Siberian Division, Russian Academy of Sciences, pr. Akademika LavrentŠeva 13, Novosibirsk, 630090 Russia.*

The interest in fabrication of the modulation-doped semiconductor structures with ultrahigh conductivity is ever increasing, since both aspects of fundamental physical properties and device applications are important. However, the possibility to increase the conductivity by simply increasing the dopant density in conventional GaAs/AlGaAs heterojunctions is limited, because a high dopant density increases the remote impurity scattering. Recently, a new concept for the suppression of scattering from the random potential of a remote doping impurity has been proposed. Within this concept, both a high mobility and a high concentration of a two-dimensional electron gas (2DEG) can be obtained simultaneously. In the proposed modulated semiconductor structure, the 2DEG is located in a GaAs quantum well with AlAs/GaAs superlattice barriers. The X-electrons arising in short-period AlAs/GaAs superlattice barriers smooth out the fluctuation potential of the doping impurity. As a result, the concentration of 2DEG in GaAs quantum well with AlAs/GaAs superlattice barriers can be considerably increased without decreasing the mobility as compared to conventional GaAs/AlGaAs heterojunctions.

The structures under investigation were grown by the molecular beam epitaxy (MBE) on semiinsulating GaAs(100) substrates. The active part of the structures represented a GaAs quantum well with a thickness of 10 nm. The quantum well was restricted on both sides by short-period superlattices composed of alternating AlAs and GaAs layers with a thickness of 1.1 and 2.3 nm, respectively. Two $\delta$ layers of Si with a concentration of $2.5 \times 10^{12}$ cm$^2$ served as the sources of charge carriers. These layers were located in GaAs plates at a distance of 9 and 12.5 nm from the walls of the quantum well. The surface morphology of the prepared structures was studied using atomic force microscopy (AFM). Magnetotransport experiments were carried out at the temperatures $1.6-4.2$K in magnetic fields up to 5 T on L-shaped Hall-effect bridges. It is shown that the longitudinal magnetoresistance of a 2DEG with high mobility and concentration in GaAs quantum wells with AlAs/GaAs superlattice barriers exhibits an anisotropy even when these structures are grown on GaAs(100) substrates. It is found that the reason for the anisotropy of magnetotransport in this case is the spatial modulation of heterointerfaces arising in the process of the self-organisation of growth surfaces.

---

[*] Corresponding author.
*Email address:* `bakarov@thermo.isp.nsc.ru` (A.K. Bakarov).