# Domain-wall contribution to magnetoresistance in ferromagnetic (Ga,Mn)As film

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Electron transport through domain walls (DWs) in ferromagnetic nanowires and constrictions became the subject of great current interest stimulated by possible applications of the magnetoresistance associated with DWs in magnetoelectronic devices. In the present study we fabricated and investigated a simple magnetoresistive microdevice formed by a narrow constriction in the epitaxial film of a ferromagnetic semiconductor (Ga,Mn)As. We performed experiments on 50 nm thick film of $Ga_{0.99}Mn_{0.01}As$ grown by the low-temperature molecular beam epitaxy on semi-insulating GaAs substrate. Magnetic properties of the film were measured with a SQUID magnetometer showing the Curie temperature of 50 K. We fabricated constrictions of submicron width in the film by a method of the electron-beam-lithography patterning and low-energy low-dose oxygen ion implantation. Previously, we have found that such an implantation destroys both the conductivity and ferromagnetism in the film [1].

Individual devices containing the constriction with lithographic width of 400 nm and supplied with two Ohmic contacts were subjected to magnetotransport measurements at temperatures down to 1.5 K and a magnetic field up to 13 T. At the lowest temperatures both the constricted devices and non-constricted reference samples exhibit a large negative magnetoresistance, which can be described by the suppression of weak localization of holes by the external magnetic field. Characteristic features revealed in the magnetoresistance of the constricted devices were abrupt jumps of a *reduced resistance* that appeared when the sweeping magnetic field crossed the regions of the coercive field of the film magnetization. In contrast, the non-constricted reference sample displayed abrupt jumps of *enhanced resistance* at the same values magnetic field. We interpret the both features, the jumps of a reduced resistance in the constricted devices and those of enhanced resistance in the reference sample, whose positions on the magnetic field scale reflect the hysteresis loop of magnetization, as manifestation of DW contribution to the (Ga,Mn)As film resistance. The opposite sign of this contribution revealed in the reference and constricted devices results from different properties of DWs formed in the both structures. Thin DWs formed in the non-constricted (Ga,Mn)As film, through which the charge transport is ballistic, give rise to the *positive* contribution to film resistance. On the other hand, DW in the constricted device tends to localize itself in the constriction extending its width to the constriction size. The diffusive charge transport through such a DW can, according to theory of Tatara and Fukuyama [2], result in the erasing of quantum localization effects, thus giving rise to the *negative* contribution of DW to the resistance in the constricted device.

[1] T. Figielski, T. Wosiński, A. Morawski, O. Pelya, J. Sadowski, A.L. Tóth, and J. Jagielski, phys. stat. sol. (a) **195** (2003) 228.
[2] G. Tatara and H. Fukuyama, Phys. Rev. Lett. **78** (1997) 3773.

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