Spin injection in semiconductor nanostructures

Alexey Toropov *

Ioffe Physico-Technical Institute, 26 Polytekhnicheskaya, St.Petersburg 194021, Russia.

In the last decade there has been a rapidly growing interest in the concept of spin electronics (*spintronics*), which aims to add spin-dependent functionality to the existing principles of operation. A prerequisite for successful implementation of the concept is the ability to create a desired spin orientation of carriers and to transport them to an active region of a device with minimum loss of spin polarization. Different approaches have been pursued to achieve spin polarization in semiconductor-based spintronic devices, including injection of spin-polarized carriers from a ferromagnetic metal or from a diluted magnetic semiconductor (DMS) that is either ferromagnetic (III-V compounds) or paramagnetic (II-VI compounds). Another prospective idea is to utilize spin-dependent transport characteristics of magnetic resonant tunneling diodes for both spin injection and spin switching. In this paper the underlying physical principles and possible implementations of such devices will be discussed. Experimental spectroscopic data will be presented on spin functionality in II-VI heterostructures with DMS quantum wells and superlattices. Furthermore, we will report on the realization of a novel combined III-V/II-VI heterostructure, where electron spin polarization is achieved in a nonmagnetic III-V quantum well (GaAs/AlGaAs) due to the resonant electronic coupling with an adjacent II-VI DMS quantum well (ZnCdMnSe/ZnSe). The potential advantages of such structures are the combination of high solubility of magnetic ions in II-VI compounds and long electron spin relaxation times in III-V compounds, as well as possible tuning of the electron spin polarization by application of an external bias.

* Corresponding author. Tel. +7 812 2479124. FAX +7 812 2471017.
Email address: `toropov@beam.ioffe.ru` (Alexey Toropov).