Spin manipulation in III-V/II-VI heterovalent structures

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The development of novel multifunctional spintronic devices implies employment of magnetic semiconductor components because, in contrast to ferromagnetic metals, several important properties, such as carrier type (n or p), carrier density, and carrier spin polarization can be readily controlled in semiconductor materials. Recently, significant efforts have been made in developing ferromagnetic III-V-based semiconductors, such as GaMnAs [1], InMnAs [2], or InMnSb [3], which have already opened a number of fundamental issues in magnetism and magnetotransport. However, the common problem of these materials is that the temperature of a III-V:Mn layer cannot be raised above ~300º C without creating metallic inclusions and, hence, the overgrowth of perfect nonmagnetic III-V compounds is impossible. This circumstance sets severe constraints on the design of the magnetic heterostructures based on III-V semiconductors alone. The promising materials to be combined with the magnetic III-V compounds are II-VI compounds (ZnSe for GaMnAs, CdSe or ZnTe for InMnAs, and CdTe for InMnSb), whose optimal growth temperature is below 300º C and lattice constant is very close to that of the respective III-V material. Therefore, the understanding of the details of III-V/II-VI heterovalent interfaces and their functionality in spintronic devices acquires special importance. In this context, a critical issue is understanding of the transmission of spin information through the heterovalent junction separating chemically different materials.

In this lecture I'll review previous and very recent results on electronic and spin-dependent properties of III-V/II-VI heterovalent structures. The following phenomena, approaches, and structures will be considered.

- Engineering of electronic band offsets at heterovalent interfaces.
- Diffusive and coherent transfer of spin through a heterovalent interface between bulk materials [4,5].
- Spin-dependent tunneling in electronically coupled heterovalent quantum wells (QWs) [6-8].
- Proximity effects emerging e.g. when a III-V ferromagnetic layer is interfaced with an antiferromagnetic II-VI layer [9].
- Exchange interaction of carriers confined in nonmagnetic III-V QWs with Mn ions in II-VI magnetic barriers [10].

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