Electrical Control of the Spin Relaxation in Quantum Wells

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We have measured the electron spin relaxation time in (111)-oriented GaAs quantum wells (QW) by time-resolved photoluminescence spectroscopy [1]. By embedding the QWs in a PIN or NIP structure we demonstrate the tuning of the conduction band spin splitting and hence the D'Yakonov-Perel spin relaxation time with an external electric field applied along the growth direction [2].

The application of an external electric field of 50 kV/cm yields a two-order of magnitude increase of the spin relaxation time which can reach values larger than 30 ns; this is a consequence of the electric field tuning of the spin-orbit conduction band splitting which can almost vanish when the Rashba term compensates exactly the Dresselhaus one [3].

The measurements under a transverse magnetic field demonstrate that the electron spin relaxation time for the three space directions can be tuned simultaneously with the applied electric field.

The role of the Dresselhaus cubic terms on both the temperature dependence of the effect and the anisotropy of the spin relaxation will be discussed.

The electron spin dynamics in (111) quantum wells will be compared to the well known spin physics for (001) and (110) QWs.

The tuning or suppression of the D'Yakonov-Perel electron spin relaxation demonstrated here for GaAs/AlGaAs quantum wells is also possible in many other III-V and II-VI zinc-blende nanostructures since the principle relies only on symmetry considerations.

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