Tailoring and Manipulating Spin Polarization and Optically Pumped NMR in Semiconductor Nanostructures

C. J. Stanton[1]

Department of Physics, University of Florida, Gainesville, Florida, USA

There has been much interest in III-V and II-VI dilute magnetic semiconductors in which incorporation of magnetic impurities, such as manganese, is used to tailor the electronic, magnetic, and magneto-optical properties. Optically-pumped nuclear magnetic resonance (OPNMR) spectroscopy is an emerging technique to probe electronic and nuclear spin properties in bulk and quantum well semiconductors. In OPNMR, one uses optical pumping with circularly polarized light to create spin-polarized electrons in a semiconductor. The electron spin can be transferred to the nuclear spin bath through the Fermi contact hyperfine interaction which can then be detected by conventional NMR. The resulting NMR signal can be enhanced four to five orders of magnitude or more over the thermal equilibrium signal. We report on our OPNMR and magneto-optical studies in semiconductor nanostructures such as *GaAs* and *InMnSb* quantum wells. We focus on the theoretical calculations for the average electron spin polarization at different photon energies for different values of external magnetic field in both unstrained and strained quantum wells. The calculations are based on the 8- band Pidgeon-Brown model generalized to include the effects of the quantum confinement potential as well as pseudomorphic strain at the interfaces. Optical properties are calculated within the golden rule approximation. Detailed comparison to experiment allows one to accurately determine material properties such as valence band spin splitting including the effects of strain and suggest ways of controlling and manipulating both nuclear and electronic spin polarization in materials.

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