Abstract for an Invited Paper
for the MAR09 Meeting of
The American Physical Society

Electrically Injected Spin Polarized Lasers[1]

PALLAB BHATTACHARYA, Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor, MI 48109-2122, USA

The ability to electrically modulate orthogonal polarization states in spin-polarized lasers opens up avenues for a wide range of applications such as photochemical spectroscopy, optical switches, and communications with enhanced security [1]. This has motivated us to investigate the properties of quantum well (QW) [2] and quantum dot (QD) [3] spin-polarized vertical cavity surface emitting lasers (spin-VCSELs). The laser heterostructures are grown by molecular beam epitaxy (MBE). The active region consists of In0.2Ga0.8As/GaAs QWs [2] or InAs QDs [3]. VCSELs are fabricated using standard micro-fabrication techniques. The FM Schottky tunnel contact is realized with Fe or MnAs re-grown by MBE. The QW spin-VCSELs exhibit a maximum threshold current reduction of 11 % and output degree of circular polarization of 23 % at 50 K. The corresponding values observed in QD spin VCSELs at 200 K are 8 % and 14 %, respectively. Inhibition of the D'yakonov-Perel spin scattering process results in higher operating temperatures for spin-lasers with QD active region. In addition, we have demonstrated electrical modulation of the output polarization with a peak modulation index of 0.6. The spin polarization of carriers in the active region of a spin laser gives rise to large gain anisotropy at biases near threshold. As a result, the output polarization can be much larger than the spin polarization of the injected carriers. This is contrary to the linear relation between carrier spin orientations in the active region and the polarization of photons emitted upon their radiative recombination in spin light emitting diodes. The exact magnitude of the output polarization in spin lasers and the parameters upon which it depends have been analytically determined and are in excellent agreement with those obtained from measurements. These results will be described and discussed.

References:

[1] M. Holub et al., J. Phys. D. 40, R179 (2007).
[2] M. Holub et al., Phys. Rev. Lett. 98, 146603 (2007).
[3] D. Basu et al., Appl. Phys. Lett. 92, 091119 (2008).
[4] M. I. D'yakonov et al., Sov. Phys Solid State. 13, 3023 (1971)

[1]Work supported by the Office of Naval Research.