MASTER DE PHYSIQUE ET APPLICATIONS - 2ème année
Spécialité Sciences des Matériaux et Nano-objets
International Nanomat Master Program

Internship proposal 2010-2011

Laboratory : Laboratoire de Photonique et Nanostructures – CNRS

Address : Route de Nozay, 91460 Etampes

Laboratory director : Jean-Yves Marzin

Internship supervisor : Aristide Lemaître

Phone : 01 69 63 60 72

e-mail: aristide.lemaitre@lpn.cnrs.fr

Magnetization manipulation by electric fields in GaMnAs

Scientific project :

The (Ga,Mn)As compound exhibits a rather singular ferromagnetic phase: it is induced by the coupling between the Mn magnetic moments and the spins of the carriers from the valence band, the holes. A very interesting property of this alloy is the reduced carrier density needed to achieve the ferromagnetic ordering, around 10^{20} holes.cm^{-3}. Therefore carriers can be easily depleted or accumulated in the magnetic layer by a reasonable electric field. Consequently a small voltage (a few volts) applied across a dielectric gate can control the Curie temperature or even the magnetic anisotropy. Controlling the magnetic anisotropy is a first step toward the fabrication of magnetic memories. Using an electric field instead of a current would considerably reduce the memory power dissipation during operation. This concept is emerging, and is becoming a very active subject of research in magnetic systems.

At LPN, we have developed recently a new alloy containing a small fraction of phosphorous ions. By tuning the phosphorous amount, the strength and the direction of the uniaxial magnetic anisotropy can be controlled at will. This uniaxial anisotropy is dominant in GaMnAs.

We propose to study the electric field control of the magnetization in (Ga,Mn)(As,P). In this layer, the uniaxial anisotropy should be weak enough to be able to observe a magnetization switching between in plane and out-of-plane directions with a moderate gate voltage. Our first results indicate that such a control is possible. The magnetization orientation and the anisotropy constants will be measured as a function of the electric field by magneto-transport experiments.

Techniques in use :
Magneto-transport experiments at low temperature, clean-room processing, molecular beam epitaxy

Applicant skills :
A strong knowledge in material sciences, in particular magnetism and semiconductors
Good abilities for experimental work

Granted internship : yes (417.09 €/month + 50 % of the travel expenses)
C'nano IdF laboratory (France only) : yes
Possibility for a thesis : yes (type of grant : allocation from research ministry)