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

Internship proposal 2009-2010

Laboratory : Institut des Nanosciences de Paris

Address : 140, rue de Lourmel

Laboratory director : Bernard Perrin

Internship supervisors : Max Marangolo and Jean-Yves Duquesne

Phone : 01 44 27 52 37

e-mail: marangolo@insp.jussieu.fr

Materials for magnetism without applying magnetic field

Scientific project : The traditional way to rotate the magnetization vector is by means of an external magnetic field; however, it is very difficult to handle fields at the submicron scale: surrounding regions can be disturbed by the stray field of the inductive device. Recently new means have been developed in order to drive the magnetization down to the nanoscale. In this framework, we can mention spin torque effect, light induced switching, ferroelectric materials. Here we propose to adopt magnetoelastic coupling to replace external fields to control magnetization. Indeed, magnetoelastic coupling arises from the spin-orbit interaction. It is responsible, for example, of the magnetic anisotropy changes due to the structural relaxation at surface or at interface. One of the magnetoelastic related phenomena is magnetostriction, which takes into account the change of the lattice parameters when the magnetization direction is altered. Also, vice versa, this property allows us to control the magnetization direction by inducing changes in the lattice parameters.
This projext concerns epitaxial MnAs layers deposited on GaAs(001) that will be prepared at the Institut des NanoSciences de Paris by Molecular Beal Epitaxy. MnAs/GaAs(001) thin films present an interesting self-organized pattern of submicron-wide and very long stripes, alternating the ferromagnetic hexagonal α–MnAs phase (ridges) with the non-ferromagnetic orthorhombic β–MnAs phase (grooves). In the past we have demonstrated that the α→β phase transition can be controlled by the sample temperature.
The aim of this project is double. We want (i) to drive the MnAs phase transition by magnetoelastic means. The substrate will be bonded to a piezoelectric actuator in order to induce the α→β transition. (ii) To induce a dynamical magnetization switching by using a transducer grown directly on the MnAs surface.

Techniques in use : Kerr effect (INSP), MBE growth, elaboration of surface transducers.

Applicant skills :

Granted internship : yes (around 350€/month)
C'nano IdF laboratory (France only) : yes
Possibility for a thesis : yes (type of grant : Ministry of research grant**)**