CONACYT program 2015

PhD project proposal form

Discipline
Engineering Sciences

Doctoral School
422 - Sciences and Technologies for Information, Telecommunications and Systems

Thesis subject title
Development of micro-electro-mechanical devices based on functional oxides for energy and biomedical applications

- **Laboratory name** Institut d'Electronique Fondamentale
- **Laboratory web site** http://www.ief.u-psud.fr/

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- **Thesis proposal**

Intensive research is currently focused on the miniaturization process of electronic devices in order to decrease power consumption and create novel functionalities. In this context, the development of hybrid materials based on oxide thin films combining several physical properties (such as piezoelectricity and ferromagnetism) is a clear scientific and technological challenge. The integration of complex functional oxides in epitaxial thin films in heterostructures on silicon requires controlling involved physical mechanisms, such as magneto-electric coupling and polarization screening. The **development of all-oxide electronic micro-devices** is thus based on the optimization of materials and their interfaces. One of the research activities in our lab is centered on the design of oxide heterostructures based on $Pb(Zr,Ti)O_3$ (PZT), a piezoelectric and ferroelectric material, and on $La_{2/3}Sr_{1/3}MnO_3$ (LSMO), a ferromagnetic material, in order to **design multiphysic sensors and micro-electro-mechanical systems (MEMS)**.

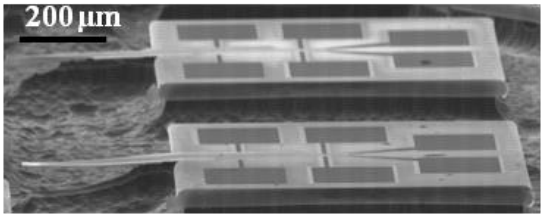

Figure: Scanning electron microscopy picture of micro-devices based on functional oxide thin films

The aim of the present project is to study the ferroelectric and transport properties of several heterostructures based on $Pb(Zr,Ti)O_3$, by addressing particularly the effect of doping and magneto-electric coupling with LSMO. Interface engineering will be a major tool to tune the physical properties of the Electrode / PZT / LSMO / Electrode / Substrate multilayers. The experimental part

will include the growth of oxide layers by pulsed laser deposition, their micro-structuration in clean room, their charaterization by X ray diffraction, Atomic Force Microscopy, electrical measurements in a cryostat. According to the candidate motivation and interests, the project could also include experiments using synchrotron radiation and move towards different types of applications (electronic, photovoltaic or biomedical) through established collaborations.

Techniques: strong experience on epitaxial growth of thin films, design of micro-devices using clean room processes, and several characterization techniques (X ray diffraction, AFM microscopy, electrical measurements).

- **Publications of the laboratory in the field**

1. Patent FR14 55623: "capteur très faible consommation pour mesures de température et de pression", Ph. Lecoeur, G. Agnus *et al*.

2. Temperature dependence of the conduction mechanisms through a Pb(Zr, Ti)O_3 thin film. C. Jegou, Ph. Lecoeur, et al., Thin Solid Films 116, 204102 (2014).

3. Strain-controlled magnetic domain wall propagation in hybrid piezoelectric/ferromagnetic structures. N. Lei, Ph. Lecoeur, et al., Nature Comm. 4, 1378 (2013).

4. Pulsed laser deposition of epitaxial ferroelectric Pb(Zr,Ti)O_3 films on silicon substrates. A. Borowiak, Ph. Lecoeur, et al., Thin Solid Films 520, 4604 (2012).

- **Specific requirements to apply, if any**

The candidate should have a solid formation in solid state physics or chemistry. He/She is expected to be interested by experimental sciences and very motivated by the research in material sciences.