Proposition de thèse 2018

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Investigation of charge to spin current conversion with the BiSb topological insulator

***Scientific project* :**

Classical spintronic relies on magnetic materials to produce a spin current from a spin-polarized charge current. It appeared over the last few years that spin-orbit coupling (SOC) provides new directions to generate pure spin currents. The SOC, a relativistic correction to the equations of quantum mechanics, can be significantly strong in materials containing heavy atoms. For instance, it turns out that efficient conversion can be obtained by exploiting the SOC-induced properties of two-dimensional electronic surface states (2DSS) found at some surfaces and interfaces such as so-called Rashba interfaces and the surfaces or interfaces of new materials called three-dimensional topological insulators (TI). During the last decade, TIs have been widely studied for their peculiar properties leading to the discovery of quantum Anomalous Hall effect.

We have recently started MBE growth of BiSb. Despite being the first three-dimensional TI identified by ARPES, BiSb has received little attention due to its very small bulk band gap (<20 meV). However, BiSb could be very attractive as a spin Hall Material thanks to its high carrier mobility (10^4 $cmV^{-1}s^{-1}$) leading to a bulk conductivity as high as 5.10^5 $\Omega^{-1}m^{-1}$. It was recently argued that BiSb could be relevant for MRAM technology thanks to a lower critical current for magnetization reversal. In the framework of our search for an efficient charge to spin current conversion with TI and Rashba materials, we would like to investigate the properties of BiSb taking advantage of the different skills available in the Paris-Saclay University. It will involve growth facilities at C2N which has recently started the study of BiSb MBE growth, the researchers from the CASSIOPEE ARPES beamline at Synchrotron SOLEIL for electronic structure study and the Unité Mixte de Physique CNRS/Thales (UMPhy) specialist of the spintronic properties.

The project will be focus on BiSb material. A critical part will be the growth of a magnetic material on it while preserving the 2DSS. Spacer layer with long spin relaxation time or thin tunneling barrier can be explored. The study of the role of inserted magnetic impurities could also be inquired fabricating hetero-structures involving magnetic topological insulator. Finally, the electronic properties characterized by ARPES will be correlated to the magneto-transport properties and magnetic reversal studies using spin current.

The PhD work will be located on 3 sites (SOLEIL synchrotron, C2N and UMPhy CNRS-Thales) all situated on the "plateau de Saclay" and will require a highly motivated student.

Techniques utilisées : MBE, ARPES (Soleil Synchrotron), Magnetoresistance, MOKE microscopy, Optical lithography
Qualités du candidat requises : Team work - Autonomy – Interest for various experimental technics – condensed matter basic knowledge (M2 level)

Co-Financement : Labex Nanosaclay-Synchrotron SOLEIL