Theoretical studies of spin-orbit phenomena at interfaces comprising magnetic and nonmagnetic materials in a view of memory devices

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Stage pouvant se poursuivre en thèse : Oui

Résumé :

This internship project is on theoretical investigations of microscopic mechanisms of spin-orbit phenomena including perpendicular magnetic anisotropy in order to help optimizing spin-based memory applications and provide scientific underpinnings of next generation energy efficient, ultrafast and ultrasmall spintronic devices.

Sujet détaillé :

Spin electronics, or spintronics, is a rapidly expanding field of high interest for both scientists and engineers since its breakthrough research discoveries give rise to novel development of industrial applications in the fields of magnetic recording, sensors and solid-state storage class magnetic memory devices known as magnetic random access memories (MRAM). Among the latter, spin-transfer-torque MRAM (STT-MRAM) based on out-of-plane magnetized magnetic tunnel junctions (pMTJ) has become in recent years a subject of tremendous interest due to a number of advantages which could allow addressing, for instance, embedded FLASH and static random access memory-type of applications. However, there are fundamental problems to be addressed arising from two main critical requirements for these devices in which information is encoded in the form of magnetization orientation.

? First, in order to ensure good memory retention, magnetic layers used in pMTJs must preserve magnetic orientation against thermal fluctuations (thermal stability).

? Second, free layer's magnetization has to be manipulated efficiently, i.e. with lowest energy consumption.

The purpose of this Master internship is to address fundamental phenomena and properties, which will help ensuring aforementioned requirements, with focus on perpendicular magnetic anisotropy (PMA) mechanisms including its temperature dependence and possibility of electric field control (VCMA). The calculations will be performed on Spintec computer cluster nodes using first-principles packages based on density functional theory (DFT) combined with other simulation techniques. Results obtained will be analysed with possibility of publication in international scientific journals. Strong collaboration with labs in France and abroad is previewed.

Compétences requises :

Good background in quantum mechanics, solid state physics and condensed matter theory