Soutenance de thèse

Lundi 14 septembre 2020

14h00
Centre de Nanosciences et de Nanotechnologies
10 boulevard Thomas Gobert
91120 Palaiseau
Amphithéâtre

Lien public : https://eu.bbcollab.com/guest/0d47aaac2abb4cfb9120e3f2500006fd

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Paul BOUQUIN

"The switching paths of spin transfer torque magnetic random access memories"

Jury members :

André THIAVILLE, Professeur, Université Paris-Saclay (LPS), Examinateur
Catherine GOURDON, Directrice de recherche CNRS, Institut des Nanosciences de Paris, Rapporteur
Ricardo SOUSA, Chercheur (HDR), SPINTEC CEA Grenoble, Rapporteur
Yves HENRY, Chargé de recherche CNRS, IPCMS, Examinateur
Siddharth RAO, Chercheur, Institut de microélectronique et composant (IMEC), Examinateur
Thibaut DEVOLDER, Directeur de recherche CNRS, Université Paris-Saclay (C2N), Directeur de thèse
Sébastien COUET, Chercheur, Institut de microélectronique et composant (IMEC), Invité
Claude CHAPPERT, Directeur de recherche CNRS, Université Paris-Saclay (C2N), Invité

Abstract :

In spin transfer torque random access memories (STTMRAM), the magnetization of a thin ferromagnetic layer is reversed under the action of a polarized spin current. Along this manuscript we study the switching path that the STTMRAM undergo.
First I present the basic theoretical concepts necessary for our forthcoming calculations. Then comes a state of the art of the switching path. The first results I present are micromagnetic simulations of the switching. We study the impact of the diameter of the device on the switching path. From these numerical calculations we predict for devices between 20 and 100 nm at room temperature a switching path composed of a coherent phased followed by a domain wall nucleation and motion. It is the switching path expected in our forthcoming measurements.
The domain wall dynamics observed in the micromagnetic simulations present complex Walker oscillations that are not understood from the domain wall models of the state of the art. Therefore, I present a more complete model for the domain wall dynamics within a STTMRAM which takes into account the exact geometry of the system. In this geometry the elasticity terms act as a new effective field called the stretch field. The stretch field plays a key role in the wall dynamics and explains the complex Walker oscillations. The conditions under which these effects can be measured are also predicted by our new model.
Our measurements are performed on state-of-the-art STTMRAM based on perpendicular magnetic tunnel junction. The diameter of the devices varies between 26 and 200 nm. We characterize our devices by magnetometry, ferromagnetic resonance and electrical time-resolved measurements of the switching path.
The switching path in our time-resolved measurements presents the signatures of an initial coherent phase and of a domain wall motion. This is in agreement with the simulated switching path. The complex Walker oscillations predicted by our models are measured in specific devices with an ultrasoft free layer, but not in our most standard stack. This highlight the interest of our analytical models for understanding the behavior of application-oriented devices.

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