Stage N° : 2

Anglais

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Title

Development of optically switchable storage layer materials to be integrated in magnetic tunnel junctions

Keywords
Spin-electronics; Magnetic memory ; MRAM ; STT-MRAM ; magnetic tunnel junctions, all optical magnetic switching, photonics

Summary
Magnetic storage has been used from the very beginning of the computer era and has shown an astounding development in area density and speed, with a 50-million fold increase over the past 50 years. However, the current hard disk storage is a mature technology that is only producing incremental changes, while the demand for storage grows by 40% per year. A radically new technology will be required to keep up with the demand. Spintronic or spin-based memory (STT-RAM), will revolutionize memory technology, as it has the potential to combine the low cost of DRAM, the speed of SRAM, the non-volatility of flash, and has almost no static energy consumption, like hard disks. In practice though, write power and write speed are still too high, compared to the state-of-the-art memory technologies. An interesting trend that improves the write speed and power of such spintronic memory is the discovery, of magnetization reversal by femtosecond laser pulses in thin ferromagnetic Gd/Fe/Co films. It is a conceptually new way to control the magnetic state of a medium, at the highest efficiency and shortest possible time-scale. Recent results show that a wide class of magnetic materials can be switched in this way, including rare-earth free transition metal multilayers and Co/Ir heterostructures. All-optical magnetic switching can be done in the femtosecond regime, promising terabit-per-second magnetic recording, at femtojoule per bit switch energies.

Full description of the subject

The purpose of this internship will be to develop optically switchable storage layer materials that can be integrated in traditional tunnel junction pillar stacks to be used as MRAM cells.
Development of rare earth/ferromagnetic multilayers of Pt/Co or Tb/Co are the starting points to bring magneto-optic interaction to the field of spintronics. MTJ fabrication will explore various scenarios of photonics-assisted switching, where the optical pulses are used for heating up the MTJ, while simultaneously sending an electrical 'write' current through the MTJ. The developed materials are to be optimized and integrated as an optically-switched layerstack. The aim is to realize an optically switchable magnetization layer in an MTJ stack, having a switching fluence comparable with state of the art for single layers. Taking advantage of the expertise of the laboratory in this field, we propose to participate in the growth of materials by sputtering, to characterize their magnetic and electrical properties. The magnetic stacks will then be nanostructured in our clean room in the form of electrically contacted nanometer pillars. The optical characterization of the MTJ stack will be done in collaboration with Radboud University using top-side illumination, using lensed fibers or high numerical aperture microscope objectives and/or SNOM. This gives the required parameters for integration with and illumination from the photonic layer. This work is part of a 4 year EU FET-open project "SPICE" funded in the framework of Future and Emerging Technologies (FET) program.

Requested skills
Basics in Magnetism

Possibility to follow with a PhD Yes

Figure