Stage N° : 11

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Title

Optimisation of spintorque oscillators

Keywords
Spintronics, magneto-resistive devices, magnetic tunnel junctions, magnetization dynamics

Summary
One of the basic concepts of spintronics is the spin momentum transfer where spin polarized conduction electrons can transfer a magnetic moment to the local magnetization of a thin ferromagnetic film. This magnetic momentum transfer is responsible for the excitation of high frequency (Gigahertz range) magnetization oscillations when a DC current is injected into a magneto-resistive device. SPINTEC studies these effects of spin momentum transfer from a fundamental point of view to better understand the non-linear magnetization dynamics of nansocale devices, but also in context of potential applications for the development of integrated microwave components.
In particular, the effect can be used to generate microwave signals as well as to detect microwave signals. The combination of the two could lead to a novel concept for a wireless communication system..

Details of subject
The non-linear dynamics of a spin transfer torque oscillator and its microwave signal generation have been studied in the past by our group as well as by numerous others. Good results in terms of output power and spectral purity have been obtained for oscillators emitting in the 0.2-1GHz range. Operation at higher frequency ranges (1-10GHz) of interest for applications, still suffers from too high a phase noise, making implementation for instance into a phase locked loop (PLL) difficult. The aim of the present internship project is to explore different magnetic stack configurations (magnetization in-plane and/or out of plane for polarizer and/or free layer), allowing for more stable and robust oscillations. The evaluation of these oscillator devices will be carried out in relation to the optimization of the nanofabrication process that plays a crucial role in defining the device microwave performances. A specific aspect will be the development of a field line that will allow the application of a microwave field to the device in order to either injection lock or modulate the generated microwave signal efficiently. The student will work in close collaboration with other group members responsible for the device nanofabrication. The central aspect of the internship studies will be the high frequency characterization of the different devices that the student will carry out in full autonomy. The result will be a data base that permits selecting the devices and configuration of best performances, in order to test the insertion into a phase locked loop (PLL), which will be tested in collaboration with the University of Dresden.
The student will obtain a sound training in high frequency measurement techniques which include operation of a spectrum analyser, a fast single shot oscilloscope and a signal generator. Besides, the student will be introduced to the concepts of spintronics (spin polarized transport, magnetic tunnel junctions, spin momentum transfer) as well the magnetization dynamics concepts (ferromagnetic resonance, auto-oscillations, non-linear dynamic effects).

Requested skills
The project is well adapted for M1 students, but also for M2 including more advanced studies. Motivated student should have a sound background in solid state physics, nanosciences and magnetism.
Possibility to follow with a PhD Yes/No
No for M1, potentially yes for M2