ENHANCING MAGNETIC MATERIALS AT THE ATOMIC SCALE USING LIGHT ION IRRADIATION

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Materials with perpendicular magnetic anisotropy (PMA) are considered as the most promising candidates for the next generation of ultra-high density Magnetic Random Access Memory (MRAM) devices. One crucial issue for MRAM technologies is to better understand and minimize the role played by structural inhomogeneties that induce a distribution of magnetic properties and stochastic behaviour.

One elegant approach to adress this issue is to use light He ion irradiation that has demonstrated to be extremely efficient in controlling at the atomic scale the magnetic properties of magnetic thin films and multilayers [1-6] since only interatomic displacements are induced with no cascade collisions and surface sputtering. We have investigated the effect of He ion irradiation on the structural and magnetic properties of CoFeB-MgO ultra-thin films with PMA, which are considered as the best materials for MRAM applications. For that, we have developped a very compact He ion irradiation facility that allows us to irradiate thin films at energies 5-30 keV and temperatures up to 500°C. This advanced tool can be easily integrated with an UHV deposition system [7], enabling the in-situ optimization of magnetic layers.

In this poster, we will show three important results that suggest a pathway to optimize MRAM devices using He ion irradiation : (1) crystallization of (Ta or W)- CoFeB-MgO layer can be obtained at much lower temperatures than pure annealling with higher anisotropy value, (2) engineering smoothly interface intermixing by irradiation allows us to increase domain wall velocities in magnetic nanowires and (3) using irradiation through a mask, local modulation of magnetic anisotropy can bring new functionalities for Spin Transfer Torque or Spin Orbit Torque based nanodevices.

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