SEMINAIRE DE LA MATIERE CONDENSEE

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New perpendicular thin films for spintronics & magnetic recording

Mardi 8er mars 2011 à 14h30

Salle de conférence 15 – Bâtiment 563

There is a renewed interest in magnetic materials that exhibit uniaxial, out-of-plane anisotropy due to their high spin injection efficiency and their high thermal stability. The next generation of scalable magnetic memory and logic will integrate such materials as the active elements. Heusler alloys, such as Co_2MnSi, are widely studied due to their nearly half metallic spin polarization, making it possible to reduce the critical current in spin torque switched MRAMs. Tetragonal (τ) Heusler alloys offer the possibility to provide high thermal stability in addition to high spin polarization. τ-Mn_2MnGa (Mn_3Ga) is a tetragonal Heusler alloy with a calculated spin polarization of 88% at the Fermi level. It crystallizes in the $D0_{22}$ structure composed of alternating planes of Mn in X(Y) positions in a bct Ga cage. It is a nearly compensated ferrimagnet with an easy c-axis, and the Curie temperature is higher than 770K, where the material undergoes a first order structural transition to the hexagonal $D0_{19}$ phase.

After an introduction discussing different perpendicular systems, I will present our recent results on smooth, epitaxial, films of stoichiometric τ- Mn_3Ga, with a measured spin polarization of 58% (point contact Andreev reflection). These films exhibit high coercivity (1.8T), low magnetization (110 kA/m) and high anisotropy constant (K_u=0.89 MJ/m^3), which can support thermally stable perpendicular bits down to 10 nm in size. Their low magnetisation allows for easy switching by spin torque while their high coercive field makes them immune to the fields generated by even the strongest permanent magnets. No magnetic shielding is required.

τ-Mn_2Ga films also crystallize in $D0_{22}$ structure with Mn deficiency in the unit cell. This composition has a high magnetization (470kA/m) combined with a high anisotropy constant (K_u=2.35 MJ/m^3); properties potentially useful for high-density magnetic recording with areal densities up to 10 Tb per square inch in bit patterned media. The magnetization and anisotropy in the $D0_{22}$ alloys depend on both the stoichiometry and the site occupancy of Mn atoms. Substitutional doping in the Mn2MnGa structure could allow us to engineer magnetic materials for a specific application. I will also discuss the feasibility of growing epitaxial MTJ and GMR stacks using Mn_3Ga.

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