Abstract No: PO-01

Simple cubic structured ferromagnetic thin films with two spin layers explained by fourth order perturbed Heisenberg Hamiltonian

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Fourth order perturbed Heisenberg Hamiltonian was employed to find the energy of simple cubic ferromagnetic ultra-thin films with two spin layers with all seven magnetic energy parameters. All the magnetic energy parameters such as spin exchange interaction, magnetic dipole interaction, second order and fourth order magnetic anisotropy constants, in plane and out plane applied magnetic fields, demagnetization factor and stress induced anisotropy were included in the fourth order perturbed Heisenberg Hamiltonian. 3D plot of total magnetic energy versus angle and spin exchange interaction were plotted using the different values of fourth order magnetic anisotropy constants. All other magnetic energy parameters were fixed at constant values. All the peaks are closely packed in the graphs plotted using fourth order perturbed Heisenberg Hamiltonian compared to peaks in the graphs plotted using second and third order perturbed Heisenberg Hamiltonian. Several magnetic easy and hard directions were found in all the 3-D plots. The order of magnetic energy was changed when the values of fourth order anisotropy constants of two spin layers are varied. The order of magnetic energy is higher (10^{42}), when the values of fourth order magnetic anisotropy constant in the top spin layer is less than the bottom spin layer. The order of magnetic energy is lower (10^{41}), when the values of fourth order magnetic anisotropy constant in the top spin layer is higher than the bottom spin layer. In addition, the graphs of energy versus angle were plotted to find the magnetic easy and hard directions.

Keywords: Fourth order perturbed Heisenberg Hamiltonian, Magnetic anisotropy constant, Magnetic thin films, Spin, Stress induced anisotropy.