Synthesis and magnetic properties of Co doped rare-earth sputtered films

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As the speed of today magnetic devices increase evermore, the need of an understanding of the ultrafast dynamic properties of magnetic materials becomes a key subject. To tune the ultrafast magnetic response, one possible strategy is to take a material approach, through a choice of a designed material composition in order to tailor such dynamic properties as the ultrafast demagnetization time and/or the damping of the magnetization precession [1]-[2]. It has been already sugested, that the alloys of rare-earths and 3d elements may be well suited materials to reach this purpose [3]. Here we describe the synthesis and static magnetic properties of Co doped rare-earth films that were produced with the goal of studying their ultrafast dynamical properties by time-resolved magneto-optical Kerr experiments. The films were prepared by magnetron sputtering. Co-rare earth alloys were formed by co-sputtering a Co target with an elemental rare earth target (Sm, Gd, Ho, Tb and Dy). We have also prepared Co samples doped with Y which is non-magnetic but chemically similar to the rare-earth elements. The films were sputtered at an Ar pressure of 5 mTorr at room temperature over substrates of glass and silicium. The evaporation rate of each element was calibrated using Rutherford Backscattering Spectroscopy (RBS) and these concentrations were checked using RBS and the thickness and composition of each sample were determined fitting the experimental RBS spectra with the Rump software. Magnetic static characterization of the samples was done at 300 K with a Vibrating Sample Magnetometer (VSM) and with a Superconducting Quantum Interference Device (SQUID) magnetometer (Quantum DesignTM 7T-SQUID). Increasing the doping concentration, we observe a clear decrease of Ms for Tb doped samples. This behaviour can be understood if we consider that the coupling between Co and Tb is anti-ferromagnetic. A more slight decrease in Ms with increasing doping concentration is also observed for doping with Gd, Ho and Dy which have also an anti-ferromagnetic coupling with Co. Opposing behavior is observed when doping Co with Sm, what we interpret as being related to the ferromagnetic coupling between Sm and Co atoms. For nonmagnetic Y we observe a decrease of Ms with doping concentration as expected. [1] M. Vomir et. al., Phys. Rev. Lett. 94, 237601, (2005). [2] L. H. F. Andrade et al, Phys. Rev. Lett. 97, 127401 (2006) [3] S. G. Reidy et. al, Appl. Phys. Lett. 82, 1254, (2003).