# Matrix and growth effects in the structure and magnetism of Co nanoparticle ultra thin films

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New systems with tailored magnetic and magneto-optical properties can be designed by adequate synthesis of magnetic nanoparticles embedded in a dielectric or metal matrix [1]. This topic has attracted much interest in the last years due to its possible application in the fabrication of magneto-optical sensors and devices. In this work we present our results on the effect that three different matrices (two insulators such as AlN and MgO and a metal such as Pt) have in the structure and magnetism of Co nanoparticles sputter deposited at different temperatures on $Si_3N_4$ substrates.

Rounded hysteresis loops, with a dispersion in switching fields as a function of the deposition temperature of Co (RT, 400ºC and 700ºC) are indicative of nanoparticle formation as previously observed in similar systems [2], as obtained by *in situ* transverse Kerr loops from as grown ultrathin Co films (8Å thick). While deposition of MgO (100Å) does not modify the hysteresis loop, deposition of either Pt (25Å) or AlN (50Å) layers on top of the Co films has a strong influence in the magnetic properties of the system. The Pt matrix gives rise to a more squared hysteresis loop revealing the magnetic connection between the Co nanoparticles mediated by the polarized Pt. The deposition of an AlN layer on top produces the disappearance of any magneto-optical signal.

These effects are confirmed ex-situ, where higher magnetic fields are available, by polar Kerr loops and spectroscopy. No evidence of perpendicular magnetic anisotropy is found in any case. On the other hand, a reduction of the polar magneto-optical Kerr signal is observed as the Co deposition temperature increases in the case of the Pt

matrix, and a total extinction of the magnetooptical signal is observed in the case of AlN matrix.

These effects are due to the formation of different compounds not ferromagnetic from the Co nanoparticles, for the Pt and AlN cases, as confirmed by TEM experiments. Hexagonal Co nanoparticles are observed in the samples grown at room temperature and covered with Pt. Nevertheless, Co particles grown at higher temperatures present interdiffusion both with Pt matrix and $Si_3N_4$, forming alloys of different compounds, not ferromagnetic in nature. This effect is even stronger in the AlN capped samples, where a strong Co nitridation probably caused by the Nitrogen plasma during the reactive AlN deposition is produced, giving rise to a non ferromagnetic material. The increase in area of the effective surface as growth temperature increases, due to a more 3 dimensional like growth mode, can explain the enhanced interface reactivity of the Co both with Pt and AlN.

**References:**

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