Coherent X-ray Resonant Magnetic Scattering studies

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Coherent X-ray Resonant Magnetic Scattering (C-XRMS) is a unique tool allowing the investigation of nanoscale structural and magnetic domain topologies in complex materials. While the standard scattering technique gives information about averaged long range order the use of a spatially-filtered coherent X-ray beam implies interference effects between the scattering paths and therefore offers in addition information about specific local disorder, in other terms the specific morphologies[1]. Furthermore the use of resonance effect by tuning the energy of the light to absorption edge of studied element gives a specific sensitivity to magnetic structure in the material[2]. The wavelength of the light, in the soft X-range is perfectly suitable to study structural feature at the nanoscale. The resulting coherent scattering pattern, detected on a bidimensional detector, exhibits speckle feature, which can be defined as a *magnetic speckle pattern* as it gives an indirect image of the specific magnetic topologies and can be used for correlation studies[3].

We present here results obtained on perpendicular exchange bias thin films made by stacking ferromagnetic Co/Pt multilayers with antiferromagnetic IrMn layers[4]. These systems exhibit a perpendicular magnetization arising from the ferromagnet and leading to striped domain structures in the plane of the film. Exchange coupling effects appear at the interface between the ferro and antiferromagnetic layers while cooling the system down, below a blocking temperature. Our C-XRMS studies on these systems in transmission geometry give a unique insight on the influence of the exchange coupling on the behavior of the magnetic domain morphology in the ferromagnet under magnetization process. By acquiring speckle patterns along the hysteresis magnetization loop, and correlating the patterns together, we could evidence that the ferromagnet acquires a strong magnetic domain memory through exchange coupling effects with the antiferromagnetic layer. This phenomenon is interpreted by the formation of a reference magnetic template in the antiferromagnetic underlayer during the cooling process. Most importantly, we have devised a procedure by which this domain memory can be tuned by varying the sample cooling protocol.

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