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Tuning the magnetic properties of functional/magnetic heterostructures across a structural phase transition

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Both in nano-magnetism and in spintronics, tuning the magnetic properties to maximize the working performances for technological implementation is a never-ending quest. In this framework, here we report on our systematic study of heterostructure engineering using Co as well as CoFeB deposited on top of (0001) V_2O_3 thin films, specifically on tailoring their magnetic properties across the oxide structural phase transition [1].

This study presents a combination of both macroscopic and spectroscopic characterizations on Co and CoFeB/V_2O_3 heterostructures grew with *in* and *ex-situ* transfer in-between the growth of the two layers. The x-ray diffraction experiments showed first the relaxation of the crystalline V_2O_3 layers occurring after few nm of growth on c-plane sapphire substrates, allowing thus the structural phase transition, known in its "bulk-like" form [2]. This structural transition, occurring around 160 K, is accompanied by metal-insulator transition that was confirmed by transport measurements as well as x-ray photoemission and absorption measurements at the V $L_{2,3}$ edges. Then we show that the crossing of V_2O_3 structural phase transition induces reproducible and reversible changes to the magnetic properties, as shown in the Figure 1. By tuning both the oxide and magnetic thicknesses, but also the morphology and the surface roughness, we can reach up a 330% coercive field variation between the two V_2O_3 structural phases.

By simply changing the temperature, this systematic study shows that the engineering of V_2O_3 structural transition induces large magnetic property variations to a magnetic thin film, opening wide possibilities in implementing strain-driven control of the magnetic behavior, even better without strict requirements on epitaxial coherence at the interface.

[1] V. Polewczyk *et al.*, Phys. Rev. Mat. **5**, 034413 (2021)
[2] G. Panaccione *et al.*, Phys. Rev. Lett. **97**, 116401 (2006)

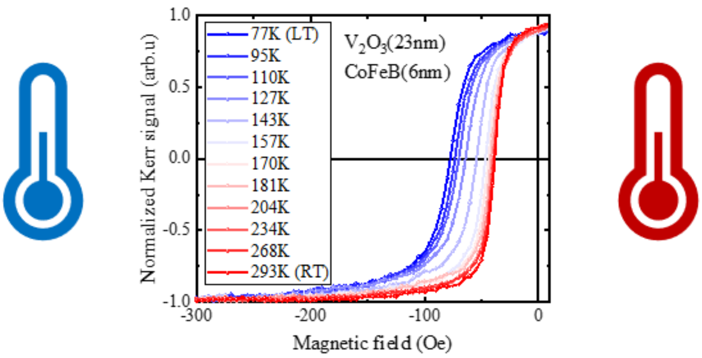

Figure 1 : Half hysteresis loops of a V_2O_3(25nm)/CoFeB(6nm) heterostructure measured along the easy axis of magnetization between 293K (red) and 77K (blue).