RV01-03

Insights onto the magnetic coupling at hexaferrite-based hard/soft bilayer systems

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Magnets are used in a variety of applications, such as generators, magnetic recording media, components in RF and microwave devices. However, many of these magnets contains rare earths, critical elements whose extraction is environmentally harmful and that present price volatility risks. Their replacement by cheaper and more environmentally friendly materials is therefore sought.

In our case, we have focused on magnetically hard strontium hexaferrite ($SrFe_{12}O_{19}$, SFO) as the base for alternative permanent magnets (Figure 1a). The atomic arrangement of this ferrite results in a high magnetocrystalline anisotropy and a coercive field, however, its magnetization is moderate (1). It is well known that the coupling between a magnetically hard and soft material improved magnetization while avoiding a high cost in coercitivity loss (2). However, results have been disappointing so far as structural and geometrical limitations make it extremely challenging to fabricate. In this work, we aim at further understanding the magnetic coupling at hard-soft interfaces involving ferrites, for which we have deposited soft iron and cobalt metals on top of $SrFe_{12}O_{19}$ thin films with controlled easy-axis of magnetization.

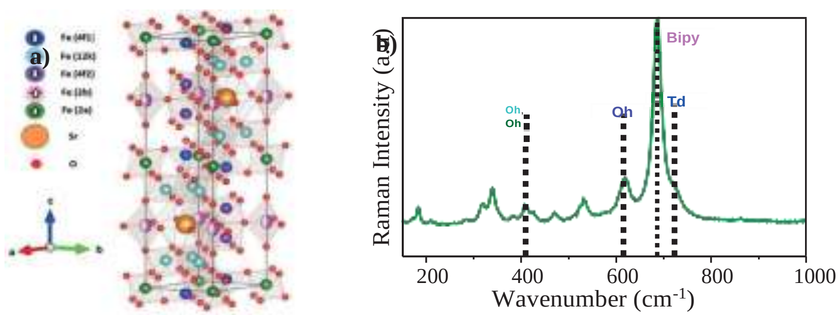

Figure 1 – Crystallographic structure and Raman spectra of $SrFe_{12}O_{19}$

SFO thin films have been obtained by RF magnetron sputtering at 260W followed by a subsequent annealing in air of 850ºC. Their structure and composition was characterized by Raman spectroscopy (Figure 1b), Mössbauer spectroscopy, X-ray photoemission spectroscopy and low-energy electron microscopy (LEEM). We have grown the magnetically soft layer by molecular-beam epitaxy and we have analyzed the resulting bilayer system through photoemission electron microscopy, LEEM and vibrating-sample magnetometry.

References

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