Supplementary data

Room temperature ferrimagnetic thin films of the magnetoelectric $Ga_{2-x}Fe_xO_3$

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EDX quantification in 200 nm $Ga_{2-x}Fe_xO_3$ thin films

The quantity of matter in a 200 nm thick film of $Ga_{2-x}Fe_xO_3$ is important enough to allow its comfortable characterization by an EDX analysis coupled to a scanning electron microscope.
The analyses were performed at a working distance of 15 mm with a 5 keV beam energy and an accumulation time of 100 s. The obtained spectra (Figure 1) presented well defined peaks for both Fe and Ga and allowed quantification with a rather good precision.

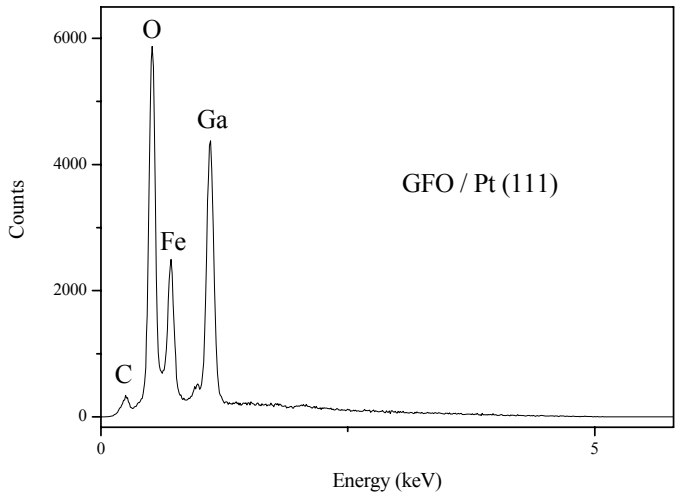

Figure 1 : EDX spectra obtained for 200 nm thick $GaFeO_3$ films (WD 15 mm, Beam energy 5 keV, 100 s accumulation time)

At this low beam energy, the whole EDX signal originates from the $GaFeO_3$ film. No Pt signal, which could originate from the substrate, is observed. This is in total agreement with Monte Carlo simulations, as shown in Figure 2. The backscattered electrons are shown in red and only represent a small fraction of the total electrons entering the matter. The electrons which will get lost in the

matter are indicated in blue. They define the interaction volume, origin of the X-ray emission. This interaction volume occupies the entire thickness of the 200 nm $GaFeO_3$ film, but hardly penetrates the substrate.

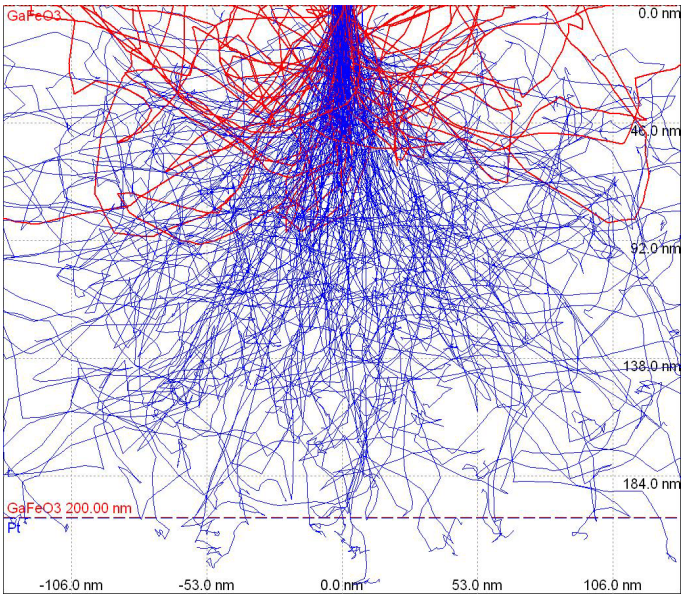

Figure 2 : Monte Carlo simulation of the interaction of an electron beam of 5 keV through a $GaFeO_3$ film deposited on a Pt substrate (red : backscattered electrons, blue : electrons which remain in the bulk)