Using Propagating Spin Wave Spectroscopy to Probe Interfacial Phenomena Modified by an Electric Field

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Electric field-controlled data storage and logic devices promise an energy consumption up to a hundred times less compared to current state-of-the-art [1]. Although the effect of an electric field on the Magnetic Anisotropy (MA) [2] and interfacial Dzyaloshinskii-Moriya (iDMI) [3] has been reported, no measurement technique is available that can untangle the intricate effect of an electric field simultaneously. In this project, we aim to adapt a technique relying on propagating spin wave spectroscopy [4] to probe all these electric field-induced effects of interfacial magnetic properties, self-consistently.

In this presentation, I will present our latest simulations and experimental results aiming at proving the self-consistency, backed up with conventional techniques. We study the influence of the electric field strength as well as the width of the electric gate (E-gate) (see Fig. 1a) on the transmission of the spin waves through the region where the magnetic properties are locally modulated. Here we localized an electric field at the interface between an insulator (MgO) and the spin-wave guiding ferromagnet (Co), which changes the electronic band-structure and hence is expected to give rise to small changes in the interfacial properties e.g. the MA and the iDMI. As can be seen in Fig. 1b, simulations show a change of amplitude of the transmitted forward volume spin wave once it has travelled through a region where the anisotropy (H_{Anis}) is locally modified by an electric field (H_{Efield}).

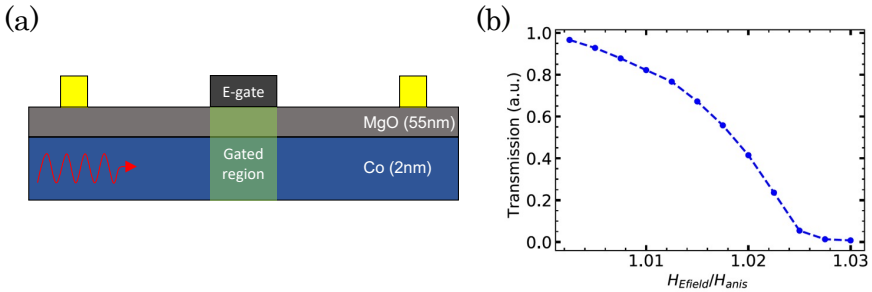

Figure 1: (a) A spin wave (red) is created by the antenna on the left (yellow) and propagates through the gated region (green) before being detected by the antenna on the right. (b) Transmission of a forward volume mode as a function of the relative strength of the anisotropy modified by the electric field in the gated region. Spin wave frequency is 5GHz and Gated region width is 800nm.

Ultimately, as the changes induced by an electric field on MA and iDMI can be small, we hope to provide the scientific community with a technique relying on the propagation of spin waves to probe the smallest change of interfacial magnetic properties, induced by an electric field. Moreover, the wave nature of spin wave and the possibility to control their dispersion relation by locally applying an electric field, could lead to the conception of novel spin-wave based logic devices, contributing to green IT.

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