Ferromagnetic resonance detected using soft x-ray absorption, reflection, and diffraction

Oral Presentation
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Synchrotron radiation based techniques provide unique insight into both the element and time resolved magnetization behaviour in magnetic spin systems. X-ray detected ferromagnetic resonance (XFMR) has recently emerged as a powerful synchrotron-radiation-based tool able to study the element-selective magnetization dynamics [1]. Magnetic and chemical contrast in XFMR is obtained by x-ray magnetic circular dichroism (XMCD), while the phase difference between the magnetization precessions is monitored using stroboscopic probing. A unique property of time-resolved XFMR is the visualization of the magnetization precession for each individual layer in a magnetic device. Measurement of the amplitude and phase response of the magnetic layers gives a clear signature of spin-transfer torque (STT) coupling between ferromagnetic layers due to spin pumping.

We highlight the power of two recent developments, utilizing x-ray scattering techniques to reveal the precessional magnetization dynamics of ordered spin structures in the GHz regime, both in diffraction and reflection configurations. Our recently developed diffraction and reflectometry ferromagnetic resonance (DFMR and RFMR) techniques provide novel ways to explore the dynamics of modern magnetic materials, thereby opening up new pathways for the development of spintronic devices [2-5]. We provide an overview of these techniques and discuss the new understanding they provide into the magnetization dynamics in the chiral magnetic structure in Y-type hexaferrite and the depth dependence to the magnetization dynamics in a $[CoFeB/MgO/Ta]_4$ multilayer.

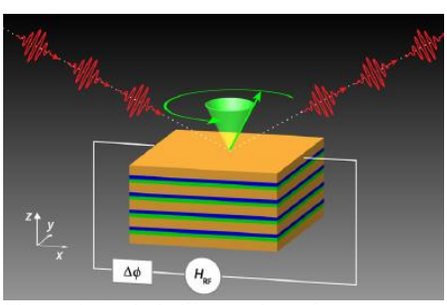

Figure 1: Artistic illustration of x-ray reflectometry ferromagnetic resonance (RFMR). Adapted from Ref. 4.

Our characterization tools for the exploration of the dynamics of chiral and multilayered magnetic materials are significant to the development of high-density and low-energy consumption data processing solutions.

References

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