Phase Sensitive Detection of Ferromagnetic Resonance Using XMCD Spectroscopy

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We present the combination of two versatile spectroscopic techniques, time-resolved x-ray magnetic circular dichroism (tr-XMCD) and ferromagnetic resonance (FMR), which produces a new and powerful tool for examining the dynamics of heterogeneous magnetic materials. The combined technique expands the utility of FMR by exploiting the contrast mechanisms of XMCD: element-specificity, sensitivity to oxidation state and site symmetry, and separation of spin and orbital moments. By utilising the high magnetic contrast at transition-metal $L_{2,3}$ edges (as well as rare earth $M_{4,5}$ edges), tr-XMCD+FMR provides excellent resolution of precession orbits, in both precession amplitude and phase. The precession orbit, measured from individual layers in a magnetic trilayer structure, has been resolved down to a cone angle as small as 0.2° , while the phase of the precession oscillation can be determined down to 2° (<5 ps at 2.3 GHz). Moreover, the full XMCD dichroism spectrum can be measured as a function of precession orbit. Finally, we will present recent advances in measuring the precession response of different site symmetries and oxidation states of cations in ferromagnetic oxides, in this instance Mn-ferrites.

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