

Novel phase plate strategy for X-ray magnetic dichroism

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Abstract

We report on a new strategy to use a X-ray 1/4 wave plate to convert linearly polarized X-rays into circularly polarized for efficient X-ray magnetic circular dichroism (XMCD) experiments. This instrumentation, unique in the world, combines the use of dispersive optics present at DXAS beamline of the LNLS and a phase plate with synchronous acquisition mode using a method know as Turbo-XAS. Using this setup, we have successfully generated 98% rate of circularly polarized X-rays with a diamond plate with the possibility to switch the helicity in up to 100 Hz synchronized by a lock-in acquisition. To characterize this state-of-art instrumentation we measured XMCD spectra of the ferromagnetic GdCo2 compound at Gd L3-edge and Co K-edge. Our results demonstrated an unprecedented improvement on the quality of the data provided by this new instrumentation when compared with the conventional scheme in the X-ray dispersive optics (polarization provided by the out-of-orbit dipole radiation).

Key words: Scientific instrumentation, magnetism, X-ray spectroscopy.

Introduction

The main goal of this project is to use an X-ray 1/4 wave plate^{1,2,3} to convert linearly polarized X-rays into circularly polarized for efficient X-ray magnetic circular dichroism experiments. This plate is a made of birefringent material, single crystalline diamond in this case, so its refraction index depends on the incidence angle and generates a phase retardation of 90° between the horizontal and vertical components of the electrical field. This instrumentation is motivated by the need to have the total control of the polarization and a fast helicity switching, besides the improvement of the polarization rate and beam intensity, today limited to 70% circularly polarized and ~1/3 of the initial intensity.

Results and Discussion

We have designed a complete experimental set-up (Figure 1) to use the 1/4 wave plate at two beamlines of LNLS, and one beamline of the future synchrotron Sirius.

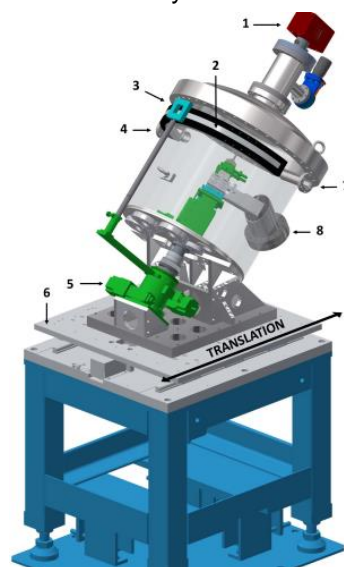


Image 1. Schematics of the quarter wave plate support, with the vacuum chamber outside. The incidence angle of the X-ray beam on the phase retarder is controlled by the

θ motor and the diffracted X-ray angle is 2θ , where the photodiode is localized. 1) Ion pump; 2) Be window for the diffracted beam measurement; 3) Photodiode; 4) Be window (beam out); 5) θ - 2θ motors; 6) Motorized translation table; 7) Be window (beam in); 8) Viewport.

Our results show, for two different methods, that measures with the same time of acquisition have lower noise when using synchronous mode. It shows an improvement on the quality of the data when compared with the conventional scheme.

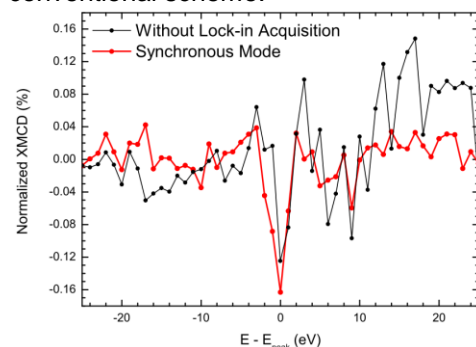


Image 2. Results obtained when compared measurements performed with (red line) and without (in black) synchronous mode. Each signal was obtained after ten minutes of acquisition.

Conclusions

Our results demonstrated an improvement on the quality of the data provided by this new instrumentation when compared with the conventional scheme in the X-ray dispersive optics (polarization provided by the out-of-orbit dipole radiation).

Acknowledgement

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