Magnetic Bragg polarimeter

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The first explicit mention of the application of the magnetic x-ray scattering to polarimetry dates back to the early 1950s in the context of the nuclear physics. Since then, the intensity variation of an order of 1% of the Compton scattering from the Fe metal upon the magnetization reversal has been utilized as the only practical mechanism for sensing the circular polarization of x rays [1]. Though the magnetic x-ray scattering is also sensitive to the linear polarization, some simpler methods are known and ordinarily adopted as the linear polarimeter.

One of the difficulties in applying the magnetic x-ray scattering to polarimetry originates from the weakness of the interaction in question between x rays and a target material. Nowadays, thanks to the advent of the intense polarization-tunable synchrotron radiation light sources, the experiment making use of this weak interaction is adequately performable and routinely done at many synchrotron radiation facilities as a unique and powerful tool to study magnetic materials from a microscopic point of view. But, concerning its application to polarimetry, this weakness is certainly a disadvantage.

Recently, in the course of the data analysis of the magnetic x-ray diffraction experiment on the ferromagnetic intermetallic compound of $GdAl_2$, we have theoretically found that the dependence of the x-ray scattering on the target magnetization can be dramatically magnified [2] and have successfully observed as predicted the giant intensity modulation of a diffracted beam concomitant with a change of the target magnetization [3].

In the present study, taking into account the primary mechanism of the observed magnetization dependence, we have derived the formulae for the fractional change in scattering intensity upon the magnetization reversal for three particular cases of the magnetization direction. With illustrating the numerical results, the prospects for the application to polarimetry will be discussed.

References

[1] See, for example, H. Kawata, H. Adachi, and I. Matsumoto, *AIP Conf. Proc.* **705**, 549 (2004).

[2] H. Adachi, H. Kawata and M. Ito, *J. Appl. Cryst.* **48**, 1114 (2015).

[3] H. Adachi, E. Arakawa, and K. Mori, *in preparation*.