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Order parameter and spin moment of Fe_3Pt studied by white X-ray magnetic diffraction

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1 Introduction

An alloy of Fe_3Pt belongs to Cu_3Au group which shows order-disorder structural transformation. At finite temperatures the structure is in the intermediate phase between the order and disorder phases, and a degree of order is represented by an order parameter α: α=0, 1 for the disorder and order phases, respectively.

The Fe_3Pt alloy is ferromagnetic at room temperature, and the magnetic properties such as spin moments of atoms are dependent on α because nearest neighbor circumstance of each atom changes according to α. Therefore it is important to know the order parameter α for investigating the magnetic properties.

Values of α are usually measured by diffraction experiments using monochromatic X-rays. Once we tried preliminarily to estimate the α of this alloy by a white X-ray diffraction experiment [1]. Here we show an improved analysis to obtain the α. This measurement is made as a part of X-ray magnetic diffraction (XMD) experiments, and the obtained α value will be applied to evaluate the spin moments of Fe and Pt in this alloy.

2 Experiment

The XMD experiment using elliptically-polarized white X-rays has been performed on PF-BL-3C where the XMD system is equipped as shown in Fig. 1. Diffracted X-ray intensities, I_+ and I_-, for the magnetization directions + and − are measured. The sum intensity $I_+ + I_-$ and the flipping ratio $(I_+ - I_-)/(I_+ + I_-)$ are used to analyze the order parameter and spin moments, respectively.

3 Results and Discussion

The observed diffraction intensities are compared with the calculated intensities for the ordered phase of Fe_3Pt (α=1). In this calculation we take into account (1) the structure factor where temperature factors and anomalous dispersion terms are included, (2) synchrotron radiation flux at the sample, and (3) absorption of X-rays by the He gas and air in the X-ray paths and by the sample itself.

The observed and calculated diffraction intensities of 400, 500 and 600 reciprocal lattice points are shown in Fig. 2. The indices 400 and 600 are fundamental reflections which should be independent of α. The index 500 is superlattice reflection which is dependent on α. In Fig. 2 the observed and calculated intensities were normalized to 400 reflection intensities, and the temperature factors were adjusted so as that the calculated 600 intensity was equal to the observed one. Then the order parameter α was obtained from the ratio of the observed intensity of super lattice 500 reflection to the calculated one, which was 0.88. The same analysis was applied to *hh*0 (*h*=3-6) and 2*h h* 0 (*h*=2-4) series, and we have obtained α=0.82±0.03 as an average.

Then this value has been applied for the XMD data analysis to estimate the spin moments of Fe and Pt. In the previous report the order phase (α=1) was assumed, and the spin moment of Fe and Pt at each site were estimated [2]. In this study we have to take into account inter-diffused Fe and Pt into Pt and Fe site, respectively. The obtained spin moments of Fe are $1.9\mu_B$ and $2.8\mu_B$ at Fe and Pt site, respectively, and that of Pt is $0.5\mu_B$. Details will be presented elsewhere.

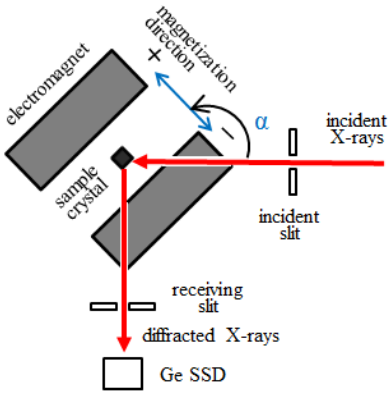

Fig. 1: Experimental configuration.

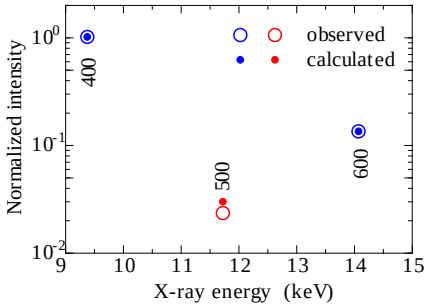

Fig. 2: Normalized intensities for fundamental (400, 600) and superlattice (500) reflections

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References

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