Q-16

Hematite의 입자크기 효과에 따른 자기적 성질

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THE MAGNETIC PROPERTIES FOR PARTICLE SIZE EFFECT OF HEMATITE

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1. Introduction

The preparation and properties of some material like iron oxide have attracted person's attention because of their importance in magnetic material technology[1]. Materials present different electrical, magnetic, electro-optical, and chemical properties when reduced to sizes in the nanometer range. This is due to the so-call "size effect", i.e. the change in physical properties when the size becomes comparable with some characteristic microscopic physical length, giving rise to quantum phenomena for very small dimensions[2,3]. In this work, the samples were prepared by a chemical method to obtain nanocrystalline $\alpha-Fe_2O_3$ powders. The crystallographic and magnetic properties have been studied by X-ray diffraction, Mössbauer spectroscopy ,and Vibrating Sample Magnetometer(VSM). Mössbauer spectra were obtained within the temperature range from 85K to 650K for the sample heated at 100℃. The Debye Model and spin wave theory were applied to some Mössbauer parameters. The macroscopic magnetic properties are investigated by using VSM.

2. Experimental Procedure

The hematite($\alpha-Fe_2O_3$) was prepared by the following method. Iron powder of $0.01\,mol$ was dissolved in nitric acid solution of $0.24\,mmol$ about 2hours. The contents were heated and completely evaporated at about 100℃ in air. And then the xerogel was homogeneously ground and calcined at different temperatures(140℃, 180℃, 220℃,350℃) for 4hours.

3. Results and Discussion

Fig. 1 shows the X-ray diffraction pattern for the samples at room temperature. The average grain size of the different $\alpha-Fe_2O_3$ were calculated by using the Scherrer equation for diffracted [104]line[4]. The crystal structure of the samples are rhombohedral. Fig. 2 shows the Mössbauer spectra of samples at room temperature. The sample heated at 100℃ gives a spectrum consisting of Zeeman splitted 6-line and doublet. The average particle size is small enough so that the behavior is superparamagnetic[5]. The magnetic hyperfine interaction becomes preponderant over the electric quadrupole interaction with increasing heat treatment temperature of the sample. The Debye temperature of the sample heated at 100℃ was obtained by using expression for recoil-free fraction. The spin wave theory has been applied to the temperature dependence of magnetic hyperfine field $H(T)$. We have obtained the correcting arising from interactions between spin waves in the temperature range of 85K～300K. The sample heated at 350℃ gives clear evidence of Morin transition from a pure antiferromagnetic to weak ferromagnetic occurring near to 230K. On the other hand, it shows in Fig.3 that the coercivity of the sample heat treated at 350℃ is larger than that of the samples heat treated at difference temperature.

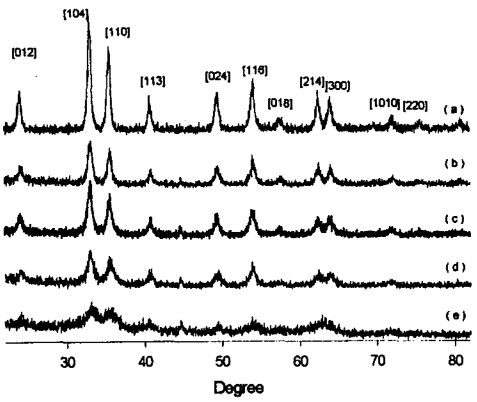

Fig. 1. X-ray diffraction pattern for the heat treated samples at (a)350℃, (b)220℃, (c)180℃, (d)140℃, and (e)100℃.

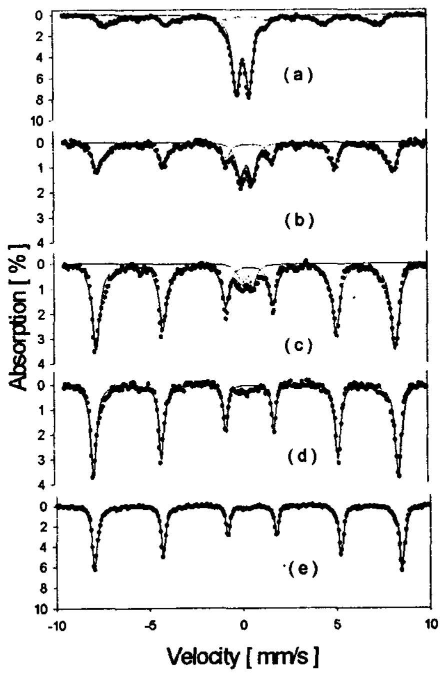

Fig. 2. Mössbauer spectra for the heat treated samples of (a)100℃,(b)140℃,(c)180℃,(d)220℃ and (e)350℃ at room temperature.

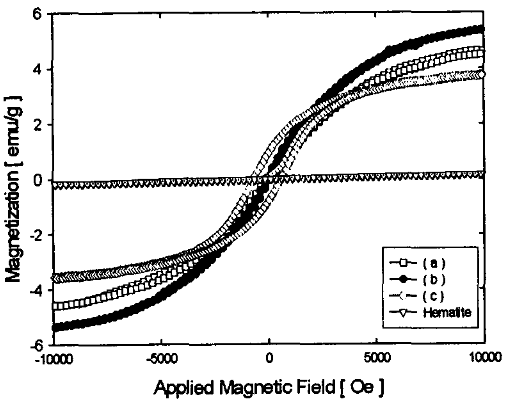

Fig. 3. Hysteresis loops for the heat treated samples of (a)100℃, (b)140℃, and (c)350℃ at room temperature..

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