Magnetic Properties of $\text{SrO} \cdot n\text{Fe}_2\text{O}_3$ Powder Synthesized by Self-Combustion Process

E. Otsuki, H. Matsuzawa

► To cite this version:

E. Otsuki, H. Matsuzawa. Magnetic Properties of $\text{SrO} \cdot n\text{Fe}_2\text{O}_3$ Powder Synthesized by Self-Combustion Process. Journal de Physique IV Proceedings, 1997, 07 (C1), pp.C1-323-C1-324. 10.1051/jp4:19971128 . jpa-00254770

HAL Id: jpa-00254770

<https://hal.science/jpa-00254770>

Submitted on 1 Jan 1997

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Magnetic Properties of $\text{SrO} \cdot n\text{Fe}_2\text{O}_3$ Powder Synthesized by Self-Combustion Process

E. Otsuki and H. Matsuzawa

Materials Development Laboratory, Tokin Corp., 6-7-1 Koriyama, Taihaku-ku, Sendai 982, Japan

Abstract. $\text{SrO} \cdot n\text{Fe}_2\text{O}_3$ ($n=1 \sim 6$) powders were attempted to be synthesized by glycine nitrate process, and their crystal structure and magnetic properties were investigated. The powders prepared in a beaker were mixtures of α - Fe_2O_3 and $\text{Sr}(\text{NO}_3)_2$, which could be transformed to M-phase with the coercivity of 7kOe by heat-treatment. Spray roasting process can afford to produce M-phase directly, which shows $\sigma(18)=56\text{emu/g}$, $H_c=5.3\text{kOe}$. The difference of coercivity by the preparation procedures can be attributed to grain size.

1. INTRODUCTION

Since practically attainable coercivity for ferrites is relatively small in comparison with anisotropy field, many attempts have been done to enhance the coercivity by chemical and powder metallurgical methods.

We attempted to prepare the $\text{SrO} \cdot n\text{Fe}_2\text{O}_3$ ($n=1 \sim 6$) powders with glycine nitrate process(1), that is, a self-combustion of metal-nitrate/glycine complex aqueous solution.

2. EXPERIMENTAL

<Synthesizing in a beaker> Iron nitrate enneahydrate, strontium nitrate and glycine were weighed into prescribed compositions and dissolved in distilled water. The molar ratio of glycine to the total content of metal nitrates was 0.8.

The aqueous solution turned into red-brown gel as water vaporized almost completely, and then caught fire to become a solid foam.

<Spray roasting> Similar aqueous solution, of which the molar ratio of glycine to total content of nitrates was 1, was sprayed into furnace heated at 850-1150°C. Foam powders were obtained from the bottom of the furnace.

3. RESULTS AND DISCUSSION

<Synthesizing in a beaker> Figure 1 shows the XRD patterns from the powders fired and heat-treated powders at 1200°C in the air. The phases comprising the powders were identified as follows;

(as fired) (heat-treated at 1200°C)

$n=6$ $\alpha\text{-Fe}_2\text{O}_3, \text{Sr}(\text{NO}_3)_2 \rightarrow \text{SrO} \cdot 6\text{Fe}_2\text{O}_3(\text{M})$

$n=3$ $\alpha\text{-Fe}_2\text{O}_3, \text{Sr}(\text{NO}_3)_2 \rightarrow \text{SrO} \cdot 6\text{Fe}_2\text{O}_3, 7\text{SrO} \cdot 5\text{Fe}_2\text{O}_3$

$n=1$ $\alpha\text{-Fe}_2\text{O}_3, \text{Sr}(\text{NO}_3)_2 \rightarrow \text{SrO} \cdot 6\text{Fe}_2\text{O}_3, 7\text{SrO} \cdot 5\text{Fe}_2\text{O}_3$

Fig.1 X-ray diffraction patterns of $\text{SrO} \cdot n\text{Fe}_2\text{O}_3$ synthesized in a beaker and heat treated at 1200°C for 1 hour

High temperature heat-treatment up to 1200°C was necessary for the completion of reaction to ferrite.

Figure 2(a) and (b) show the magnetic properties of as fired and heat-treated powders. Saturation magnetization $\sigma(18)$ increases with an increase in n-value for the high temperature heat-treated samples. Coercivity H_{cJ} increases gradually as n-value increases and $H_{cJ}=7\text{kOe}$ was obtained with 800°C heat-treated sample. However H_{cJ} decreases as heat-treatment temperature rises further.

The inability of M-phase synthesis in a beaker may be attributed to (1) too low temperature, (2) too short reaction time, (3) deficient in oxygen. Since M-phase can be obtained by heat-treatment of the fired powders, the direct synthesis of M-phase may be possible at high temperature reaction. Thus the spray roasting method was applied.

<spray roasting> Figure 3 shows the XRD patterns from the powders spray roasted at 1000°C. The sample with n=6 consists of almost single phase of M, and samples with n=1,3 contain 7SrO·5Fe₂O₃ as well.

Figure 4(a) and (b) show the magnetic properties of spray roasted powders. The dependence of $\sigma(18)$ on n-value is similar to beaker synthesized samples, however the effect of reaction temperature is not so much. In the case of H_{cJ} , its dependence on n-value differs each other for roasting temperature. Anyhow our experiment shows gradual change of H_{cJ} with n-value for both preparation ways, and the sharp drop of H_{cJ} at n=3-4 as reported by Kagotani(2) was not obtained.

Figure 5 shows the electron diffraction patterns for beaker-synthesized powders followed heat-treatment at 800°C and 1200°C. Reduction of H_{cJ} by high temperature heat-treatment can be attributed to the grain growth.

4. CONCLUSIONS

The synthesis of Sr-ferrite was attempted by self-combustion of nitrate complex solution and the results are as follows:

- (1) By beaker synthesis and heat-treatment, Sr-ferrite powders with $H_{cJ}=7\text{kOe}$ and $\sigma(18)=17\text{emu/g}$ (n=6) were obtained.
- (2) By spray roasting, Sr-ferrite powders with $H_{cJ}=5.2\text{kOe}$ and $\sigma(18)=56\text{emu/g}$ (n=6) were obtained.
- (3) Spray roasting can afford to produce the Sr-ferrite powders with higher magnetic properties by optimizing process conditions.

5. ACKNOWLEDGMENTS

The authors are grateful to Mr. T. Sato for TEM analysis.

6. REFERENCES

- (1) L.A. Click et al.; Material Letters, vol.10,(1990),6.
- (2) T. Kagotani et al.; IEEE Trans. on Magn., vol.31, No.6, (1995), 3674.

Fig.2 Magnetic properties of SrO·nFe₂O₃ synthesized in a beaker, before and after heat treatment.

Fig.3 X-ray diffraction patterns of SrO·nFe₂O₃ spray roasted at 1000°C

Fig.4 Magnetic properties of SrO·nFe₂O₃ spray roasted.

Fig.5 TEM of SrO·6Fe₂O₃ synthesized in a beaker
(a) heat treated at 800°C for 1 hour
(b) heat treated at 1200°C for 1 hour