BV-14 Mössbauer studies and magnetic properties of Zn substituted W-type Ba-ferrite.

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INTRODUCTION

Hexagonal Ba-ferrites have a crystalline structure which the called S, R and T blocks. These crystalline structure order determine magnetic, microwave properties and it could be indicated type of M, W, X, Y, Z. [1, 2] Especially, W-type hexaferrites ($BaCo_2Fe_{16}O_{27}$; Co_2W) show outstanding magnetic, microwave absorption characteristics which compared to the other type of hexaferrites. In this study, we studied properties of Zn substituted $BaCo_{2-x}Zn_xFe_{16}O_{27}$ with Mössbauer spectroscopy, XRD (x-ray diffractometer), VSM (vibrating sample magnetometer).

EXPERIMENT PROCEDURES

The Zn substitued Co_2Wsamples were synthesized by solid-state reaction method. Starting materials were Fe_2O_3, $BaCO_3$, ZnO, Co_3O_4. The mixture in distilled water was ball milled for 24h and calcined at 1275 °C for 3h. The calcined powder was ball milled for 12h. The crystal structure were examined by XRD with Cu-$K\alpha$ radiation (λ = 1.5406 Å) and analyzed by Rietveld refinement program. Its magnetic properties were investigated by VSM measurements. The Mössbauer spectra were recorded using spectrometer using a ^{57}Co γ-ray source in a rhodium matrix for a constant acceleration mode.

RESULTS AND DISCUSSION

XRD patterns (Fig. 1) of $BaCo_{2-x}Zn_xFe_{16}O_{27}$ were analyzed by using Rietveld refinement method with Fullprof program. From the refined XRD patterns, the crystal structure of the Co_2W were determined to be hexagonal with space group $P6_3/mmc$ at room temperature. The lattice constants of $BaCo_2Fe_{16}O_{27}$ were a_0 = 5.9055 Å, and c_0 = 32.9365 Å, respectively. Lattice constants a_0 and c_0 decrease with increasing Zn contents. It is obvious that ionic radius of Zn^{2+} = 0.074 nm is smaller than radius of Co^{2+} = 0.082 nm.

To investigate the magnetic properties of $BaCo_{2-x}Zn_xFe_{16}O_{27}$, the M-H hysteresis loops are measured by VSM at room temperature. We obtained the value of magnetization at 20 kOe (M_{20}), coecivity (H_c) for all the synthesized samples. The values of M_{20} = 75.67 emu/g, H_c = 162.08 Oe and M_{20} = 78.48 emu/g, H_c = 64.17 Oe, respectively. As Zn^{2+} substituted for Co^{2+}, the value of M_{20} was increased and the value of H_c was decreased. Increasing the value of M_{20} is due to Zn ion preferred to the tetrahedral site. The temperature dependence of zero-field-cooled (ZFC) and the field-cooled (FC) magnetizations curves are measured under applied field of 100 Oe between 70 and 780 K. We determined Curie temperature (T_c) and T_c decrease with increasing Zn contents.

Co_2W have seven iron ions crystallographic sites of $4f$, $6g_{VI}$, $4f_{VI}$, $4e_{IV}$, $4f_{IV}$, $12k_{VI}$, $2d_V$ and it can be obtained five magnetic site of $4f$, $6g_{VI}$+$4f_{VI}$, $4e_{IV}$+$4f_{IV}$, $12k_{VI}$, $2d_V$.[3] The fitted subspectra of the Mössbauer spectra (fig. 2) were obtained for all samples. With five sextets for Fe sites of Co_2W spectra were least-squares fitted. The values of magnetic hyperfine field were decreased with Zn ions contents increasing. The fitted relative area ratio of Mössbauer spectra reveals that Zn ions affect the area of iron ion, when Zn substituted. With increasing non-magnetic Zn ions contents, the occupation area ratio of down-spin site ($4e_{IV}$+$4f_{IV}$) was decreased. Therefore, it is obvious that the Zn ions preferentially occupy the tetrahedral sublattices, leading to increase in M_{20}.

Reference

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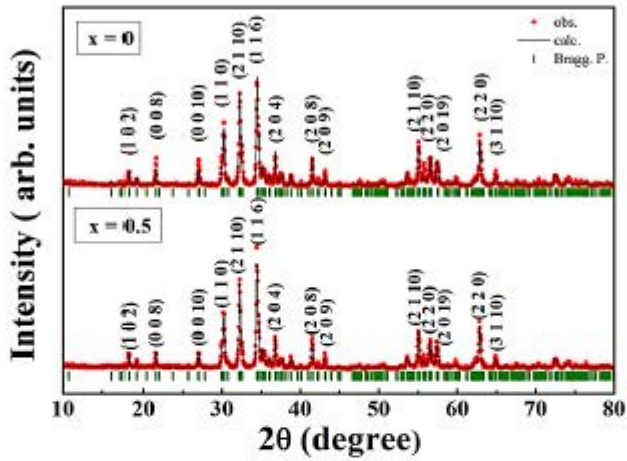

Fig.1 XRD patterns of $BaCo_{2-x}Zn_xFe_{16}O_{27}$ (x = 0, 0.5) at 295 K and refined by using the Rietveld refinement method with Fullprof program.

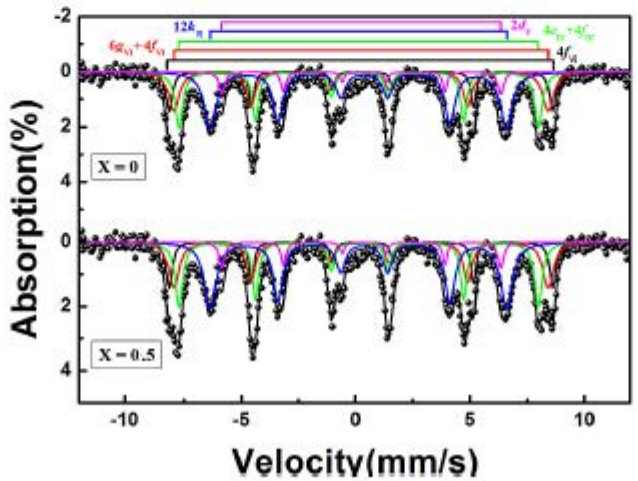

Fig.2 The fitted Mössbauer spectra of $BaCo_{2-x}Zn_xFe_{16}O_{27}$ (x = 0, 0.5) with five sextets($4f$, $6g_{VI}+4f_{VI}$, $4e_{IV}+4f_{IV}$, $12k_{VI}$, $2d_V$) at 295 K.