New Synthetic Route of Single-phase Z-type (Ba$_3$Co$_2$Fe$_{24}$O$_{41}$) Hexaferrite Particles

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Z-type hexaferrite (Ba$_3$Co$_2$Fe$_{24}$O$_{41}$: Co$_2$Z) has recently attracted great attention because of its high ferromagnetic resonance frequency in the range of MHz to 5 GHz [1] and high permeability of about 15 at 1 GHz [2]. Accordingly, microwave devices such as MHz - GHz antenna and MHz inductor based on the Co$_2$Z-type hexaferrite are emerging. There have been several attempts to synthesize the Z-type hexaferrite particles, including coprecipitation and ceramic processes [3-5]. All these processes involve several phase transformations, such as starting materials $\rightarrow$ BaFe$_{12}$O$_{19}$ (M-type hexaferrite) $\rightarrow$ Ba$_2$Co$_2$Fe$_{12}$O$_{22}$ (Y-type hexaferrite) $\rightarrow$ Ba$_3$Co$_2$Fe$_{24}$O$_{41}$ (Z-type hexaferrite), before the starting materials are converted to the Z-type phase. None of these processes is simple and cost effective. Therefore, we have developed a new process, called one-step mixing-firing process. A mixture of M-type (BaFe$_{12}$O$_{19}$) and Y-type (Ba$_2$Co$_2$Fe$_{12}$O$_{22}$) hexaferrite powders was shake-milled, then followed by firing of the milled hexaferrite mixture at 1300 °C in O$_2$ environment. The fired powder was characterized by VSM and X-ray diffractometry for magnetic properties and ceramic phase identification. X-ray peaks shown in Fig. 1 are well indexed to starting M- and Y-type and synthesized Co$_2$Z hexaferrites, and confirm single phase of all hexaferrites. As shown in Fig. 2, the starting M- and Y-type hexaferrites show hard magnetic properties, while the Co$_2$Z powder exhibits soft magnetic properties. The coervicity and saturation magnetization of the Co$_2$Z powder were 19.2 Oe and 48.1 emu/g at 10 kOe, respectively, that is close to theoretical value of 50 emu/g. These results imply that our new process is potentially applicable to synthesis of any other ferrite and also cost effective. We will present phase transformation mechanisms and magnetic properties of sintered Z-type hexaferrite for use in microwave antenna.

REFERENCES