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Structure and Magnetic Properties of Low-Temperature Synthesized M-W Hexaferrite Composites

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Abstract : M-type Sr-hexaferrites (SrFe12O19) is one of the most utilized materials in permanent magnets due to their low price, outstanding chemical stability, and appropriate hard magnetic properties. For a M-type Sr-hexaferrite with a saturation magnetization (MS) of ~74.0 emu/g the practical limits of remanent flux density (Br) and maximum energy product (BH) max are ~4.6 kG and ~5.3 MGOe. Meanwhile, W-type hexaferrite (SrFe18O27) with higher MS ~81emu/g can be a good candidate for the development of enhanced ferrite magnet. However the W-type hexaferrite is stable at the temperature over 1350 ºC in air, and thus it is hard to control grain size and the coercivity. We report here high-MS M-W composite hexaferrites synthesized at 1250 ºC in air by doping Ca, Co, Mn, and Zn into the hexaferrite structures. The hexaferrites samples of stoichiometric SrFe12O19 (SrM) and Ca-Co-Mn-Zn doped hexaferrite (Sr0.7Ca0.3Fen-0.6Co0.2Mn0.2Zn0.2Oa) were prepared by conventional solid state reaction process with varying Fe content ($10 \leq n \leq 17$). Analysis by x-ray diffraction (XRD) and field emission scanning electron microscopy (FE-SEM) were performed for phase identification and microstructural observation respectively. Magnetic hysteresis curves were measured using vibrating sample magnetometer (VSM) at room temperature (300 K). Single M-type phase could be obtained in the non-doped SrM sample after calcinations at the range of 1200 ºC ~ 1300 ºC, showing MS in the range of 72 ~ 72.6 emu/g. The Ca-Co-Mn-Zn doped SrM with Fe content, $10 \leq n \leq 13$, showed both M and W-phases peaks in the XRD after respective calcinations at 1250 ºC. The sample with n=13 showed the MS of 70.7, 75.3, 78.0 emu/g, respectively, after calcination at 1200, 1250, 1300 ºC. The high MS over that of non-doped SrM (~72 emu/g) is attributed to the volume portion of W-phase. It is also revealed that the high MS W-phase could not formed if only one of the Ca, Co, Zn is missed in the substitution. These elements are critical to form the W-phase at the calcinations temperature of 1250 ºC, which is 100 ºC lower than the calcinations temperature for non-doped Sr-hexaferrites.

Keywords : M-type hexaferrite, W-type hexaferrite, saturation magnetization, low-temperature synthesis
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