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Effect of oxygen potential on Co solubility limit in La–Co co-substituted magnetoplumbite-type strontium ferrite

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Abstract

La–Co co-substituted magnetoplumbite-type (M-type) strontium ferrite is typically used as a base material for high-performance hard ferrite magnets. Generally, the unquenched orbital moment of Co^{2+}, substituted for Fe^{3+}, is thought to enhance magnetic anisotropy and then coercivity. La^{3+} is substituted for Sr^{2+} to compensate for the charge unbalance associated with Co^{2+} substitution. Even if the synthesis starts with equal amounts of Co and La, the Co contents of the resulting samples are generally lower than the La contents because of the partial reduction of Fe^{3+} to Fe^{2+}. We studied how the oxygen potential suppresses the formation of Fe^{2+} and expands the Co solubility range in this system. Polycrystalline samples, synthesized under oxygen partial pressures of 0.2, 1.0, and 387 atm, were characterized by powder x-ray diffraction, wavelength-dispersive x-ray analysis, and magnetization measurements. We reveal that the application of higher oxygen pressure dramatically expands the Co solubility range, resulting in the enhancement in magnetic anisotropy. We successfully synthesized Sr-free $LaFe_{11}CoO_{19}$ with high magnetic anisotropy using the hot isostatic pressure (HIP) technique.

Keywords: La–Co co-substituted magnetoplumbite-type strontium ferrite, permanent magnet, oxygen pressure magnetic anisotropy, Co solubility limit, hot isostatic pressing

1. Introduction

Magnetoplumbite-type (M-type) strontium ferrite ($SrFe_{12}O_{19}$) with hexagonal symmetry (space group $P6_3/mmc$) is an industrially important hard magnetic material because of its low cost and high chemical stability. In the current

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