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Influence of pH Adjustment Parameter for Sol–Gel Modification on Structural, Microstructure, and Magnetic Properties of Nanocrystalline Strontium Ferrite

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Abstract

Synthesis of nanocrystalline strontium ferrite ($SrFe_{12}O_{19}$) via sol–gel is sensitive to its modification parameters. Therefore, in this study, an attempt of regulating the pH as a sol–gel modification parameter during preparation of $SrFe_{12}O_{19}$ nanoparticles sintered at a low sintering temperature of 900 °C has been presented. The relationship of varying pH (pH 0 to 8) on structural, microstructures, and magnetic behaviors of $SrFe_{12}O_{19}$ nanoparticles were characterized by X-ray diffraction (XRD), field emission scanning microscope (FESEM), and vibrating sample magnetometer (VSM). Varying the pH of precursor exhibited a strong effect on the sintered density, crystal structure and magnetic properties of the $SrFe_{12}O_{19}$ nanoparticles. As the pH is 0, the $SrFe_{12}O_{19}$ produced relatively largest density, saturation magnetization, M_s, and coercivity, H_c, at a low sintering temperature of 900 °C. The grain size of $SrFe_{12}O_{19}$ is obtained in the range of 73.6 to 133.3 nm. The porosity of the sample affected the density and the magnetic properties of the $SrFe_{12}O_{19}$ ferrite. It is suggested that the low-temperature sintered $SrFe_{12}O_{19}$ at pH 0 displayed M_s of 44.19 emu/g and H_c of 6403.6 Oe, possessing a significant potential for applying in low-temperature co-fired ceramic permanent magnet.

Keywords: Sol–gel, pH, Structural, Microstructure, Magnetic behavior, Strontium hexaferrite ($SrFe_{12}O_{19}$)

Highlight

- Synthesis of strontium ferrite ($SrFe_{12}O_{19}$) nanoparticles using sol–gel auto combustion technique.
- The $SrFe_{12}O_{19}$ nanoferrite phase was obtained at a low sintering temperature, 900 °C.
- Magnetic parameter of saturation magnetization M_s, remnant M_r, and coercivity H_c decrease as pH increases.

Background

Strontium ferrite ($SrFe_{12}O_{19}$) has been extensively studied for their potential applications in microwave devices, high-density magnetic recording, electronic devices, and permanent magnet. Permanent magnet ferrites are widely used in the electrical manufacturing industry due to its several advantages [1] and impressive properties such as high electrical resistivity [2], large hysteresis loss, and high intrinsic coercivity [3]. It is best known as a good heat resistance and corrosion resistance and useful for many applications. Strontium ferrite has attracted more scientific studies in recent years due to its high magnetic anisotropy, which is responsible for the high coercivity of crystalline structure [4, 5] and thus can ensure a high coercivity even when the size of the particles is reduced into nanoscale with single-domain structure. The ferromagnetism exhibited by $SrFe_{12}O_{19}$ is attributed

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