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Influence of Precursors Molar Ratio and Basic Agent on Processing of Nickel-Zinc Ferrite Nanopowders by a Sol-Gel Auto-Combustion Method

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Nickel-zinc ferrites are technologically important materials in the group of soft magnetic ferrites, which are suitable for high-frequency applications with low magnetic coercivity and low eddy current loss. These materials are extensively used as high frequency coils and transformer cores. To produce ferrite nanopowders, some techniques such as chemical co-precipitation, hydrothermal and sol-gel have been developed [1, 2].

In the present investigation nickel-zinc ferrite nano crystalline powder have been prepared directly after a sol-gel auto-combustion process using a gel including citric acid as a reductant and nitrates as oxidants. The results showed that the nitrate citrate gels exhibit a self- propagating behavior after ignition in air. For the first time, the effects of Fe/(Ni, Zn) molar ratio and the kind of the basic agent on the thermal decomposition of gels and the phase constitution, crystallite size and morphology of resultant nickel-zinc ferrite powders, were investigated by DTA/TGA, FTIR, XRD, SEM and TEM techniques. The results revealed that in the presence of ammonia as pH adjusting agent and Fe/(Ni, Zn) molar ratio of 2, the smallest crystallite size of single phase nickel-zinc ferrite at about 27 nm could be obtained directly after auto combustion without any need to a post calcination process.

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Fabrication and Magnetic Properties of Electrospun Zinc Ferrite ($ZnFe_2O_4$) Nanofibers

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This paper describes the fabrication of zinc ferrite ($ZnFe_2O_4$) nanofibers by electrospinning method using a solution that contained poly(vinyl pyrrolidone) (PVP) and Zn and Fe nitrates as alternative metal sources. The as-spun and calcined $ZnFe_2O_4$/PVP composite samples were characterized by TG-DTA, X-ray diffraction, FT-IR, and SEM, respectively. After calcination of the as-spun $ZnFe_2O_4$/PVP composite nanofibers (fiber size of 344 ± 76 nm in diameter) at 500, 600, and 700 ^oC in air for 2 h, the nature of nanofibers was changed due to the reorganization of the $ZnFe_2O_4$ structure at high temperature, and $ZnFe_2O_4$ nanofibers of 58~75 nm in diameter having well-developed spinel structure were successfully obtained. The crystal structure and morphology of the nanofibers were influenced by the calcination (Fig. 1). The calcined $ZnFe_2O_4$ samples have a structure of packed particles or crystallites with crystallite sizes of 19, 20, and 26 nm for the samples calcined at 500, 600, and 700 ^oC, respectively. Room temperature magnetization results (Fig. 2) showed a superparamagnetic behavior of the $ZnFe_2O_4$ samples calcined at 500, and 600 ^oC, and paramagnetic behavior of the $ZnFe_2O_4$ samples calcined at 700 ^oC. The specific magnetization (M_s) values at 10 kOe are 2.34, 2.55, and 1.53 emu/g for the samples of $ZnFe_2O_4$/PVP composite nanofibers calcined at 500, 600, and 700 ^oC, respectively.

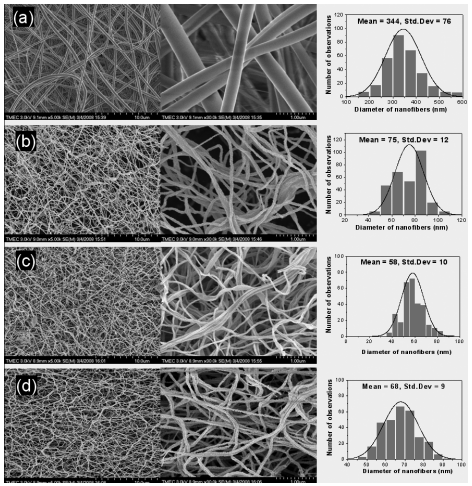

Fig. 1. SEM micrographs with fiber size distributions of the as-spun $ZnFe_2O_4$/PVP composite sample and $ZnFe_2O_4$/PVP composite samples calcined in air at different temperatures for 2 h. (a) as-spun, (b) 500 ^oC, (c) 600 ^oC, and (d) 700 ^oC.

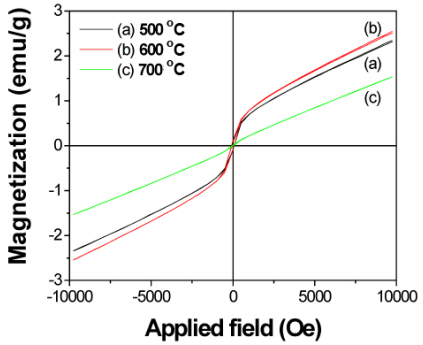

Fig. 2. The specific magnetization of the $ZnFe_2O_4$/PVP composite samples calcined in air for 2 h at different temperatures, as a function of field, measured at 20 ^oC. (a) 500 ^oC, (b) 600 ^oC, and (c) 700 ^oC.