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Sol–gel auto combustion synthesis of $BaFe_{18}O_{27}$ nanostructures for adsorptive desulfurization of liquid fuels

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ABSTRACT

In this work, for the first time, W-type barium ferrite nanostructures ($BaFe_{18}O_{27}$) were synthesized by sol–gel auto combustion method. The role of the calcination temperature and the type of sugar were investigated on the basis of their morphology and the size of the particles. The obtained products were characterized by Electron microscopy (EM), X-ray powder diffraction (XRD), Fourier transform infrared spectroscopy (FT-IR) and energy dispersive spectrometry (EDS) and vibrating sample magnetometer (VSM). Adsorptive desulfurization (ADS) is one of the most promising complementary and alternative methods. To evaluate the ADS reactivity over the W-ferrite, a series of ADS experiments with a model gasoline feedstock were performed using a fixed-bed reactor. The results of catalytic tests reveals that $BaFe_{18}O_{27}$ nanoparticles have the potential to be used as a new absorptive for desulfurization of liquid fuels. 0.5 g $BaFe_{18}O_{27}$ exhibited the highest ADS properties. This ferrite was successfully regenerated after calcining at 500 °C in air.

Introduction

Among magnetic materials, ferrite ceramics are currently the focus of considerable interest over these years because of their properties such as relatively strong anisotropy and moderated, corrosion resistant and have wide potential application as electromagnetic wave absorption materials, magnetic materials and in perpendicular magnetic recording [1,2]. $BaFe_{18}O_{27}$ ceramic is categorized in hard ceramics category because it has unique properties such as high chemical stability, large saturation magnetization, high coercivity, large uniaxial magnetic anisotropy in a longitudinal direction (*c*-axis) and high Curie temperature. When particle size of ceramics are large, demagnetization occur due to numerous magnetic domain structures [3]. Several techniques including coprecipitation and glass crystallization have been developed to synthesize $BaFe_{18}O_{27}$ ceramic [4,5]. It is good to know that properties of powder depend on their particle size and morphology. Herein, we develop the sol–gel auto combustion route to prepare $BaFe_{18}O_{27}$. This is a novel way with a unique combination of the chemical sol gel process and the combustion process. In comparison to

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Table 1 – Preparation conditions for samples 1–6.

Sample no.	Fe^{+3}/Ba^{+2}	Kinds of sugar	Calcinations temperature (°C)	Morphology and particle size
1	16	–	1000	Particles; 100 nm
2	16	Glucose	1000	Interlaced rods; ~70 nm (diameter)
3	16	Fructose	1000	Particles; 150 nm
4	16	Maltose	1000	Particles; ~100 nm organized ultra fine particles; ~15 nm
5	16	Maltose	1100	Interlaced rods; ~50 nm and particles; ~100 nm
6	16	Maltose	1200	Uniform particles; ~100 nm

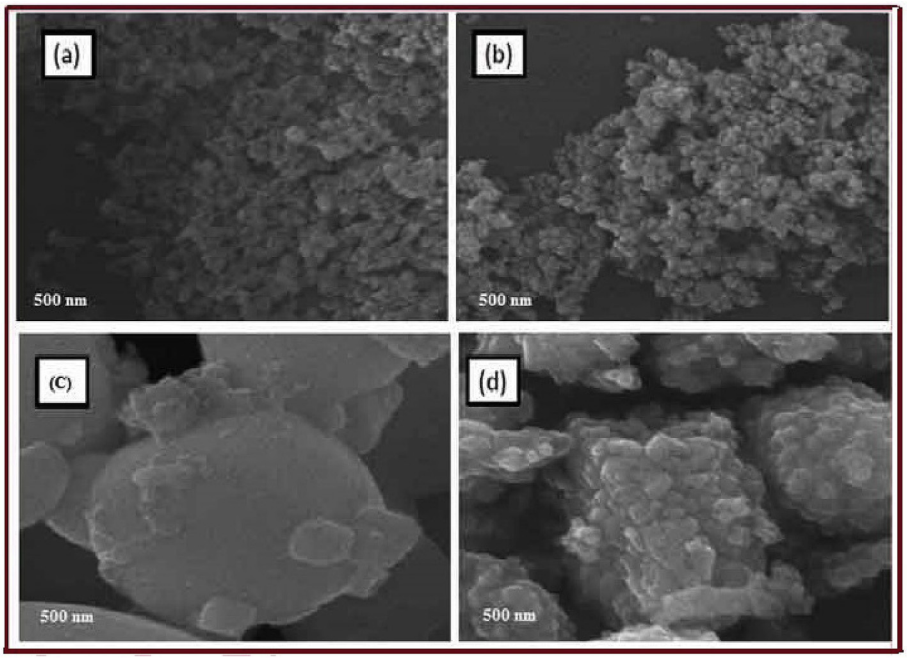

Fig. 1 – SEM images of $BaFe_{18}O_{27}$ from sample (a) 2, (b) 4, (c) 3, (d) 1.

other works, our method is simple, convenient and low cost approach [6]. Due to the environmental worries, the use of natural resources instead of chemical compounds has experienced considerable development in the past decades [7]. For these reasons, alternate desulfurization processes are absolutely necessary for producing clean fuels. Possible strategies to realize ultra-deep desulfurization currently include adsorption [8–10], extraction [11], oxidation [12,13] and bioprocesses [14,15]. Adsorptive desulfurization (ADS) is one of the most promising complementary and alternative desulfurization techniques. Reactive adsorption refers to processes using metal-based adsorbents to capture sulfur to form metal sulfides in the presence of hydrogen [16]. The sulfur atom is retained on the adsorbent, while the hydrocarbon portion of the fuel molecule is released back into the process stream. This process can achieve deep desulfurization with low octane number loss. During the past decade, several reports have been published on fuel

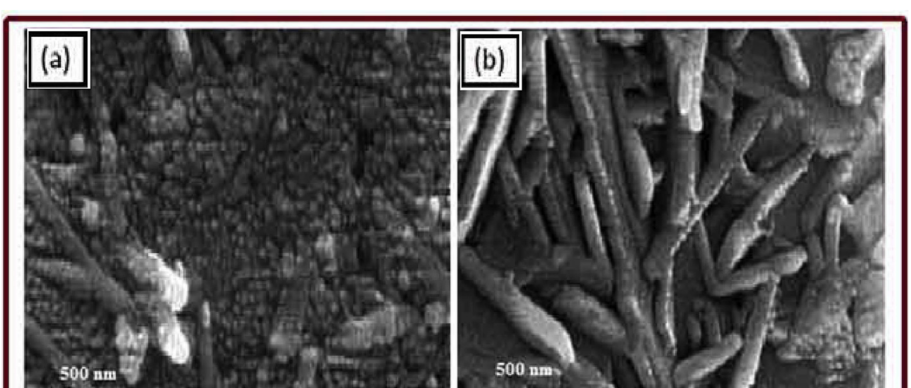

Fig. 2 – SEM images of $BaFe_{18}O_{27}$ from sample (a) 5 and (b) 6.

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