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Effect of sintering temperature on selectivity of zinc ferrite as gas sensors

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ABSTRACT

The effect of variation in sintering temperature (500-900^{o}C/4h) of $ZnFe_2O_4$ synthesized by using co-precipitation method on the gas sensing characters. The spinel structure and the presence of residual phases were checked by XRD analysis. Gas sensing response was evaluated as a function of operating temperature for different test gases/vapours such as ammonia (NH_3), chlorine (Cl_2), LPG, CO_2, hydrogen sulphide (H_2S) and Hydrogen (H_2). Maximum gas response activity was achieved at 300^{0}C concentration for hydrogen sulphide gas.

Keywords: Zinc ferrite; Sintering; Electrical conductivity; Morphology; Gas sensor

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INTRODUCTION

Various oxide as well as dioxides has been well studied as a sensor material to detect most of the reducing gases [1-3]. The gases being explosive, toxic and flammable such as hydrogen sulphide (H_2S) and Hydrogen (H_2) and volatile organic compounds vapour etc. create major problem related to environmental safety and human health. Therefore, prime importance to gas analysis, detection and alarms are of great concern to the industry and the society.

A stream of studies has shown that metal oxide semiconductor (MO) sensors are considered to be effective solutions to detection of harmful gases, owing to their advantages of high sensitivity, fast response and easy integration [4]. Single metal oxides have been widely studied as gas sensing materials. These include zinc oxide (ZnO) [5], tin oxide (SnO_2) [6], tungsten oxide (WO_3) [7,8], titanium oxide (TiO_2) [9,10] and iron oxide (Fe_2O_3).As a typical spinel ferrite, $ZnFe_2O_4$ is a semiconductor with a narrow band gap (~1.9 eV), which possesses various excellent properties. It has attracted much attention in the applications of gas sensors [11,12], catalyst [13], magnetic materials [14] and lithium battery materials [15]. The sensing effect mainly takes place on material surface; the control of particle size will be one of the first requirements for enhancing the sensor's humidity sensitivity. In recent years, the preparation methods of $ZnFe_2O_4$ based gas sensing materials mainly include co-precipitation [16,17], sol-gel [18] and template synthesis method [19], which can prepare $ZnFe_2O_4$ nanomaterials with different morphology, such as nanorods, nanotubes, nano-thin films and core-shell microspheres. $ZnFe_2O_4$ based gas sensing materials mainly include pure $ZnFe_2O_4$ nanomaterials, metal element doping $ZnFe_2O_4$ and oxide - $ZnFe_2O_4$ composite materials, which are mostly used to detect reducing gases. Zinc ferrite based gas sensors in this paper belong to the semiconductor gas sensor family, which shows a response to various reducing gas via converting chemical signals to electrical signals.

In present work we have reported the phase formation, morphology and electrical properties of Zinc ferrite. These allowed us to correlate these results with sensitivity towards different gases/vapours at various conditions.