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Synthesis and characterization of pure and Zn doped lead hydroxide nano structure through chemical root method

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ABSTRACT

In this research our aim was to obtain pure and Zn doped lead hydroxide nanostructure by chemical root method. For making reaction solution we used 0.04 M aqueous solution of lead nitrate and zinc chloride was mixed with 0.08 M aqueous solution of sodium hydroxide 0.001 M aqueous solution of TEA (Tri Ethanol Amine) was also added to reaction solution. Powder was annealed at 190 °C. The prepared pure and Zn doped lead oxide nanostructure was characterized, X-ray diffraction (XRD), scanning electron microscopy (SEM) and high resolution-transmission electron microscopy (TEM) and photo luminescence of the sample. The prepared pure and doped lead hydroxide consists of the average crystallites about 20 and 12 nm and band gap obtained 4.93 and 5.25 eV respectively. The pure lead oxide phosphor material shows a broad peak at 501 nm (near to Green region) and Zn doped lead oxide show the peak at lower wavelength side 402 nm (blue region).

1. Introduction

In recent years, one-dimensional (1-D) nanostructures [1,2] such as nano wires [3–5], nano rods [6,7], nano tubes [8–10] and two dimensional (2-D) nano plates/nano sheets [11] have attracted much attention. Their potential applications [12–14] and remarkable properties [15,16] resulted in research upsurge of nano science and nanotechnology. Synthesis of 1-D and 2-D nanostructures is vital area of research [17,15,16]. Therefore, developing new and simple methods to synthesize nanostructures is an attractive topic.

Different methods have been used for synthesis of Nano structures like sol gel, combustion method, chemical bath deposition method, oxide-assisted growth and solution–liquid growth in organic solvent [17–20]. In this paper, we have reported plate like morphology of lead hydroxide nano powder prepared by chemical root method by using complexing agent (TEA), because of its simplicity, convenience and low cost.

Lead hydroxide also has wide application such as staining [22,23] and absorbent [24]. It is also used in making porous glass; electrical-insulating paper; electrolytes in sealed nickel–cadmium batteries; recovery of uranium from sea water and as a catalyst for oxidation of cyclododecanol [25]. However, it is doubtful if the simple Lead hydroxide $Pb(OH)_2$ is stable in solid state so the morphology of lead hydroxide powders has rarely been reported. Some researchers have studied the crystal structure of lead hydroxide. Previous studies have shown that the $Pb(OH)_2$ powder can be formed in solution at low sodium hydroxide concentration [26,27]. Sole and Yoff observed plate like morphology of lead hydroxide crystal [28] whereas Cheng et al. observed the rod/plate like morphology [29]. In our previous results, the particle size varies from micro to nano meter (nm) range with decreasing concentration of TEA, when samples are annealed at 80 °C; plate like morphology was also observed. This was rarely observed ever before [21,22].

In this paper we report structural and optical properties of pure and doped sample annealed at 190 °C. To our knowledge there is no literature available on the optical effects of doping Zn into the lead hydroxide host material.

2. Experimental procedure

2.1. Powder preparation

For making reaction solution 0.04 M aqueous solution of lead nitrate is mixed with 0.08 M aqueous solution of sodium hydroxide (all AR grade 99.9% pure) and other reaction solution 0.04 M aqueous solution of both lead nitrate and Zinc chloride (both in same quantity, 50–50%) is mixed with 0.08 M aqueous solution of sodium hydroxide. After, we have added 8 ml of 0.001 M aqueous solution of TEA in both solutions [20,21]. The reaction solution is allowed to stand for 20–24 h. The powder is thoroughly washed out

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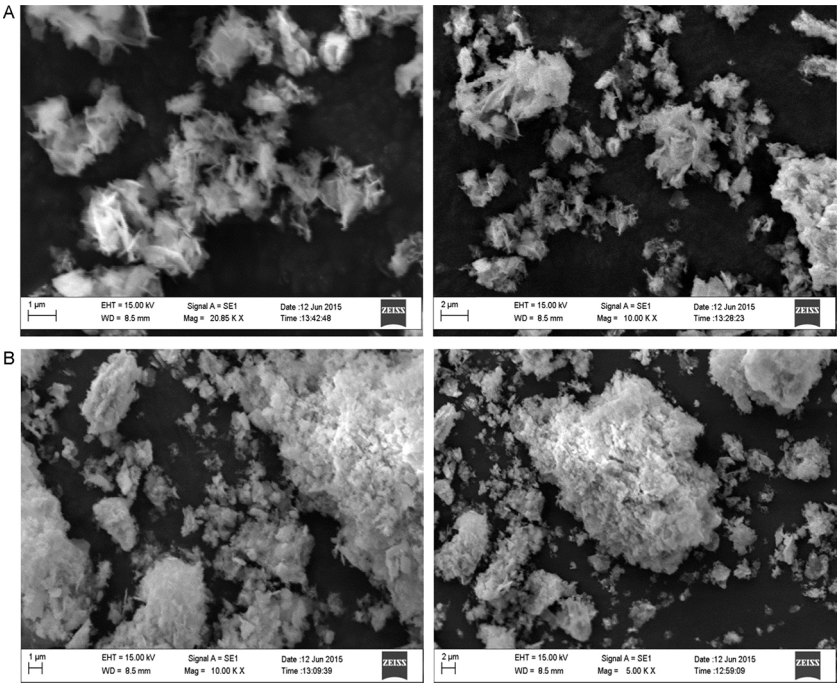

Fig. 1. (A) SEM images of pure lead hydroxide at different magnification. (B) SEM images of Zn doped lead hydroxide at different magnification.

(more than 8 times) with distilled water. It is filtered and dried in sunlight. It is then annealed in hot air oven at 190 °C. The resultant effect of the powder is appeared in the color white [30–32].

2.2. Measuring instruments

XRD and Transmission Electron Microscopy (TEM) were employed to characterize the sample. The surface morphology of the white precipitate was determined by Field Emission Scanning Electron Microscope (FESEM) JSM-7600F. The structural parameters of the powder were determined using X-ray Diffraction technique. The XRD patterns were recorded with Bruker D8 Advanced X-Ray Diffractometer using a Cu Ka radiation source ($\lambda \pm 1.54056$ Å). The X-rays were detected using a fast counting detector based on silicon strip technology (Bruker Lynx Eye detector). Particle diameter and surface morphology of white powder were determined by transmission electron microscope using Philips CM-200. Absorption spectrum was measured by UV

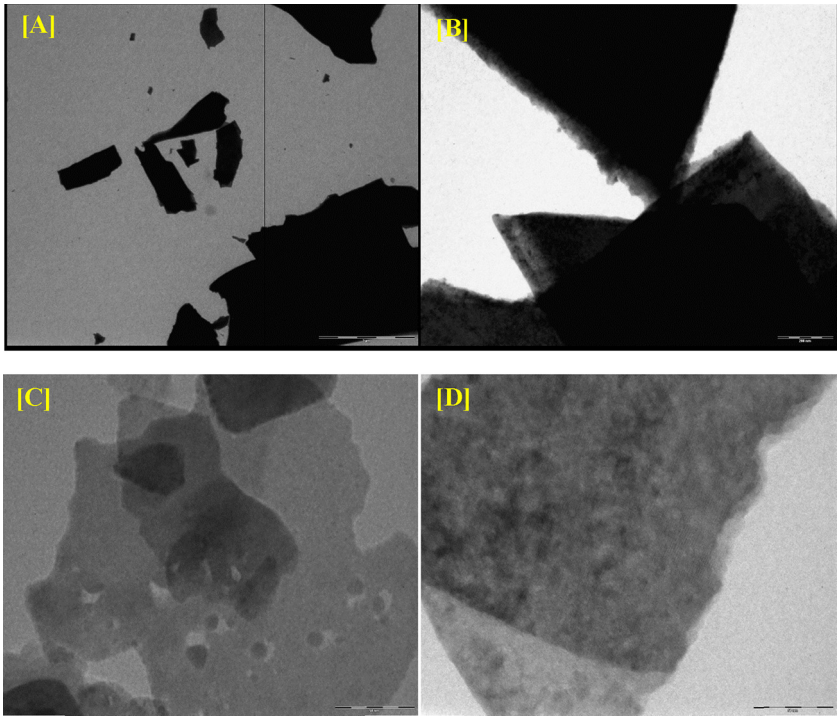

Fig. 2. (A–D) TEM images of pure lead hydroxide.