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Synthesis, Characterization and Thermal Behavior Studies of Nanoparticles Cobalt (II) Chloride

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ABSTRACT

Synthesis, characterization, and thermal behavior of nanoparticles Cobalt(II) chloride has been investigated in this work. Cobalt (II) chloride was synthesized by using of mill device. The general formula of this compound is MCl_2 (M = Co). The synthesized nanoparticles were characterized by Fourier transform infrared spectroscopy (FT-IR) and the size and structure of synthesized nanoparticles has been analyzed by x-ray diffraction (XRD). Morphology of surface and structure of synthesized nanoparticles has been done by scanning electron microscopy (SEM). This compound has many applications in mineral synthesis as a catalyst. The nano particles of $CoCl_2$ with approximate size of 41 nm synthesized and we can see them with porous and spongy morphology in SEM pictures. Thermal behavior of this nanoparticles considered by using of DTA /TGA thermal analysis device.

KEYWORDS: Synthesis, characterization**,** Cobalt(II) chloride*;* mill device, X-ray diffraction, scanning electron microscopy , thermal behavior

1. INTRODUCTION

Cobalt (II) chloride is an inorganic compound of cobalt and chlorine, with the formula $CoCl_2$. It is usually supplied as the hexahydrate CoCl2·6H2O, which is one of the most commonly used cobalt compounds in the laboratory. Niche uses include its role in organic synthesis and electroplating objects with cobalt metal. Cobalt (II) chloride gives a blue-green color in a flame. Nano cobalt (II) chloride may be prepared through many processes but in this work top to down approach has been used. Nanocrystalline metallic compounds are said to have enhanced ductility and yield strength compared to conventional grain-sized materials [1].

The type of mill employed in the mechanical milling process accounts for different milling mechanisms, that is, the way in which the available energy is transferred from the milling media to the material.

Developed by Benjamin, mechanical alloying (MA) is an alternative technique for the fabrication of powder particles [2]. MA is a solid state powder process in which the powder mixture is mechanically ball milled using a high-energy ball mill. Different alloys, ceramics, composites and amorphous materials [3-7] can be synthesized by this process.

In this work, nanoparticles of $CoCl_2$ compound were synthesized in planetary high-energy ball mill and it's characterize and thermal behavior were studied.

2. EXPERIMENTAL

2.1. Materials and Instruments

Starting materials were obtained from Merck (Berlin, Germany) and were used without further purification. Fourier transform infrared (FT-IR) spectra were recorded on a Bruker spectrophotometer in KBr pellets. Surface morphology of product was characterized by using a LEO-1430.VP scanning electronic microscopy (SEM) with an accelerating voltage of 15 kV. X-ray powder diffraction (XRD) measurements were performed using a Philips diffractometer manufactured by X'pert with monochromatized Cu Ka radiation. Sizes of selected samples were estimated using the Scherer method. For identification a scanning electron microscope samples were gold coated.

2.2. Synthesis of nanoparticles Cobalt(II) chloride

First, 5 grams of Cobalt(II) chloride ($CoCl_2$.6H2O) for 30 minutes was placed in the oven at a temperature 50 °C was completely wiped out and humidity combine was dried. Then Cobalt (II) chloride without of water was transported to a lacuna the mill and the was milled in a planetary high-energy ball mill operated at 250 rpm for 10h . Twenty zirconium balls of 10 mm diameter are being used in all milling processes.

3. Characterization of nanoparticles

X-ray diffraction (XRD) technique was used to determine the ingredients of the sample. The morphology of nanoparticles was observed using a scanning electronic microscopy (SEM). The obtained samples were

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characterized and compared via FT-IR analysis with bulk (non-nano) forms. FT-IR spectrometer at room temperature was in the range from 400 to 4000cm^{-1}.

4. RESULTS AND DISCUSSION

In this paper, we report the synthesis of nanoparticles Cobalt (II) chloride. After preparing nanoparticles, it was characterized by IR.(Figure 1)

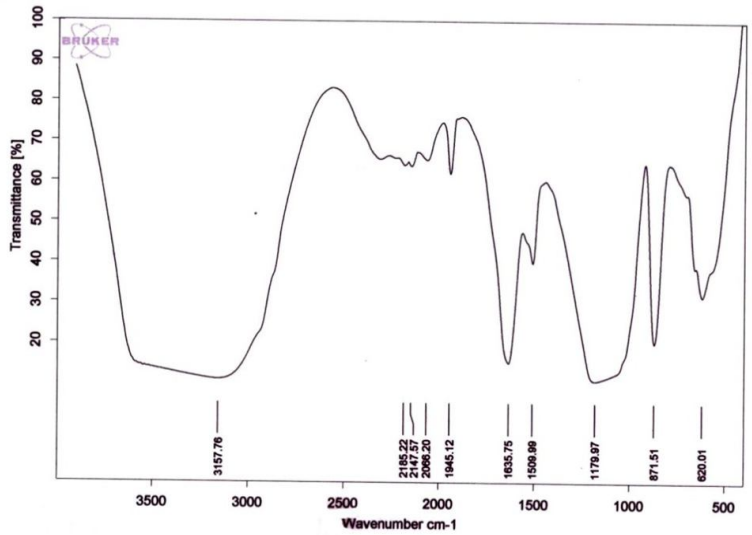

Fig. 1. FT-IR spectra of $CoCl_2$ nanoparticles.

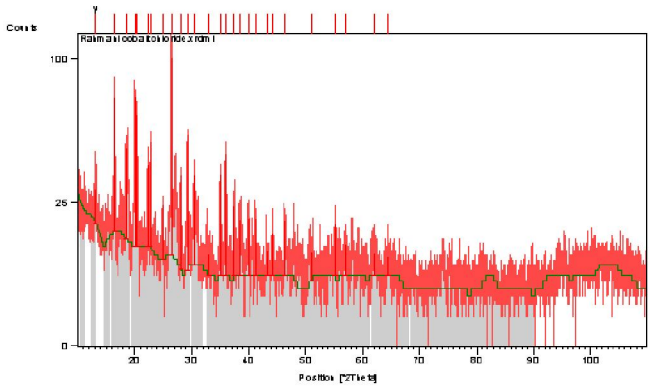

Fig. 2. The XRD pattern of $CoCl_2$ nanoparticles.

Figure 2 shows the XRD pattern of nanoparticles prepared by the planetary high-energy ball mill process. Estimated from the Sherrer formula for the calculation of particle sizes from the broadening of the XRD peaks ($D= 0.9\lambda/\beta\cos\theta$, where D is the average grain size, λ is the X-ray wavelength (0.154 nm), and θ and β are the diffraction angleand full width at half maximum of an observed peak, respectively). The nano particles of $CoCl_2$ with approximate size of 41 nm synthesized and we can see them with porous and spongy morphology in SEM pictures. (Figure 3, 4).

Fig. 3. SEM photograph of the sample $CoCl_2$ nanoparticles

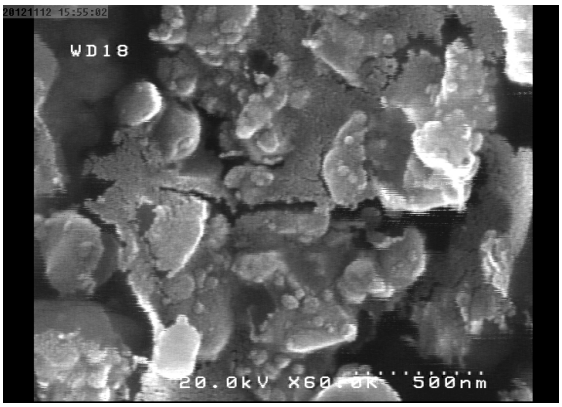

Fig. 4. SEM photograph of the sample $CoCl_2$ nanoparticles

4.1. Study the thermal behavior

To study the thermal stability combined weight Cobalt(II) chloride calorimetry methods (TG) and differential thermal analysis (DTA) of the temperature range of zero to 900° C under nitrogen inert gas was used. Figure (5) shows the combination of thermal analysis chart.

The TG composition diagram above, there are two stages of weight loss's. First weight loss is due out in the temperature range 90-110° C (%8) of the initial mass (19 gr) are combined. The second weight loss in the temperature range 590- 810° C can be seen that the removal %90 of 214.128 gr is the mass of cobalt chloride.

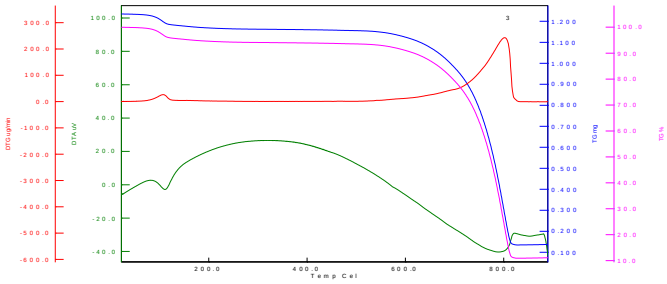

Fig. 5. thermal behavior of the sample $CoCl_2$ nanoparticles

Most weight loss occurs in the second stage and the remaining mass is 23.8 gr. The DTA curve combination, the combination of analysis zero to 900° C at the temperature range from two, with two exothermic processes, respectively, in the temperature range 0-110° C and 800-110° C is associated.

5. CONCLUSION

In this study synthesis, characterization**,** and thermal behavior of nano particles Cobalt (II) chloride. In summary, the molecular structure of nano particles is confirmed by the presence of functional groups in FTIR spectra. Also theoretical data show good agreement with the experimental result. In addition, the values of crystallite size in nano scale are demonstrated by X-ray diffraction method for nano Cobalt (II) chloride powders.

6. ACKNOWLEDGEMENTS

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