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Synthesis of $Ni_{0.5}Zn_{0.5}Fe_2O_4$ by Chemical Precipitation Method at Different pH Value

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ABSTRACT
$Ni_{0.5}Zn_{0.5}Fe_2O_4$ nanocomposites have been prepared by a simple chemical co-precipitation method. The prepared samples were characterized by Powder X-ray Diffraction (XRD) and Scanning Electron Microscopy (SEM). The shape of X-ray diffraction (XRD) pattern spectrum shows the appearance of the spin phase of zinc and an increase in the intensity of the peaks with increasing pH. While the magnetic nanomaterials showed a spherical-like agglomeration with random and slightly unclear precipitation. After analysis it found that with increasing the PH value for the nickel –zinc ferrite the grain size decrease with increase the concertation of zinc content also it found the morphology of the simple also effected by adding different concentration for pH.
Keywords: nonmagnetic material, chemical co-precipitation, XRD, SEM.

1. Introduction
Nowadays, spinel type magnetic metal oxide nanoparticles (NPs) have attracted significant attention in many areas such as ceramics, semiconductors, sensors and catalytic materials, due to their unique dielectric, magnetic, and optical properties, Nano-crystalline ferrites are materials of great interest from both a scientific and technological standpoint [1-2]. Due to the interaction of quantum, finite-size, surface, and interfacial effects, these magnetic materials serve as the foundation for a very active area of research. New phenomena are occurring at the nanoscale, and these phenomena are the result of this interaction. Spinel ferrite nanoparticles have numerous technical applications in a variety of fields, including hyperthermia, magnetic separation, magnetic resonance imaging, high-density information storage, Ferro fluids, catalysts, drug targeting, and magnetic separation [3]. The critical inquiries in these frameworks are the manner by which these Nano-structures adjust their attractive and electronic properties and how one can exploit those new properties to work on the applications. Subsequently, understanding and controlling the impacts of the nanostructures on the properties of the particles have become progressively significant issues for innovative applications [4]. In the present work, synthesis of $ZnFe_2O_4$ nanoparticles was carried out by chemical co-precipitation method. Synthesized NiZn-ferrite nanoparticles were characterized by standard characterization techniques to study the structural and morphology of surface.

2. Experimental work
To prepare the compounds used in work by chemical precipitation method, iron nitrate, zinc nitrate and nickel nitrate were dissolved in (100ml) of distilled water using a magnetic stirrer (Stirrer magnetic) at a temperature of (60 ˚C) and for half an hour in order for the substance to be completely and homogeneously dissolved in distilled water, then all the solutions are mixed in a glass flask at a temperature of (60 ˚C) for half an hour with continuous stirring by means of the magnetic mixer. As for the second stage, (40g) of sodium hydroxide (NaOH) was dissolved in (200 ml) of distilled water in a glass flask with continuous stirring using a magnetic mixer at a temperature of (60˚C) for 15 min. Sodium hydroxide solution is used as a precipitating agent and to determine the pH value. As for the third stage, it included mixing all the solutions in a glass flask at a temperature of (60˚C) for half an hour with continuous stirring by means of the magnetic mixer. Then the sodium hydroxide solution mixture was distilled by a burette slowly over the solution of the mixture of solutions while continuing the mixing process at a temperature (60˚C) until the sodium hydroxide solution is distilled to determine the pH value. After completing the distillation process, the solution will be clear with a pH that it is determined. This solution is filtered with filter paper and then washed several times with distilled water to get rid of insoluble nitrates. Then the resulting substance is taken and dried in a drying oven at a temperature (100 ˚C) to obtain a dry moisture-free compound. Then the obtained powder is calcined at a temperature of (700 ˚C) for 2 hours.

3. Results and discussion

3.1. X-ray Diffraction (XRD):

The ferrite samples were prepared based on the molar concentration and molecular weights by comparing the X-ray diffraction patterns of ferrite after sintering at a temperature of 700°C and in comparison with the standard labels it was found that they are identical to the standard label number (JCPDS 8-324). And as shown in Figure (1) X-ray diffraction spectrum of $Ni_{0.5}Zn_{0.5}Fe_2O_4$ with a pH number (pH=1.8,7,10) and the appearance of peaks(220), (311), (222), (400), (422), (333), (440), (533) within the angular range (20°-80°) for all the compounds prepared by chemical precipitation method, where the peaks are considered dominant, which refers to the geometric crystal structure of ferrite powder and from observing the shape of the diffraction spectrum, the appearance of the spin phase of zinc [5-6]. No impurities were found for any other material, which proves that the material has a very high purity.

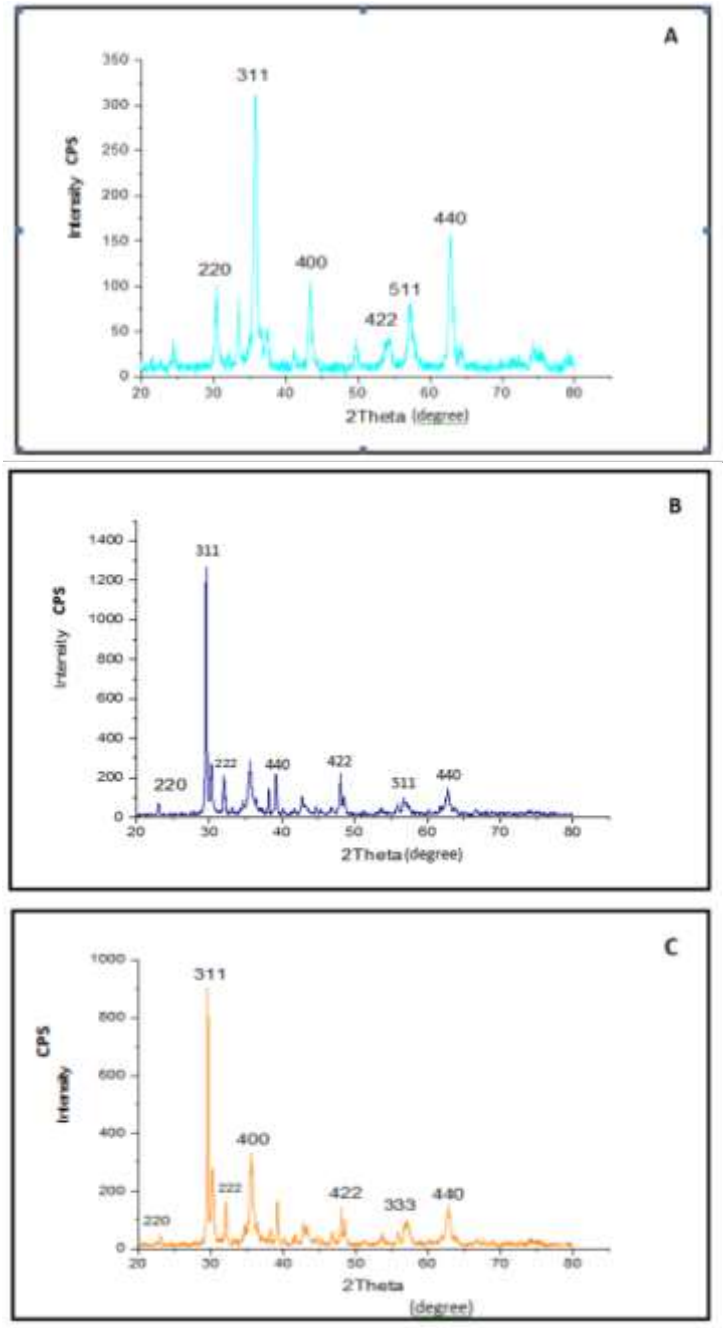

Fig. 1: (a-c): X-ray diffraction spectrum of $Ni_{0.5}Zn_{0.5}Fe_2O_4$ at pH = 1.8,7,10

3.2. SEM analysis:

The morphology and the size distribution of the $Ni_{0.5}Zn_{0.5}Fe_2O_4$ nanoparticles were determined using SEM. Typical SEM images of $NiFe_2O_4$ synthesized as for the sample with the structural formula Figure (2) shows the $Ni_{0.5}Zn_{0.5}Fe_2O_4$ prepared by the method prepared at different pH values, as the results showed that the grain size changes (32-55 nm) and is

relatively regular, and this is consistent with the results of X-ray diffraction, as the results showed that the particles of the sample $Ni_{0.5}Zn_{0.5}Fe_2O_4$ consist of nanoparticles. The presence of small particles and the presence of these assemblies is evidence of the presence of crystals free of pores on the resulting surface and also found that they have a strong tendency to stick together and form clumps, due to magnetic interactions between particles of ferrite materials during the preparation process and this is consistent with what the researcher said [6-8]. It was also noted that the nanoparticles are in larger sizes the higher the pH of the solution there are also some voids in the prepared sample and this may be due to the interaction between magnetic nanoparticles and thus these particles grow to some extent to form larger particles at a high pH of the solution. (1.8 to 10). The reason for the increase in the granular size of ferrite materials is due to the fact that magnetic materials tend to agglomerate, which leads to the gathering of particles with each other, which leads to an increase in the surface area of the material Thus, the granule size increases. This increase can be justified due to the recrystallization that reduced the amplitude of the lattice constant [9-10].

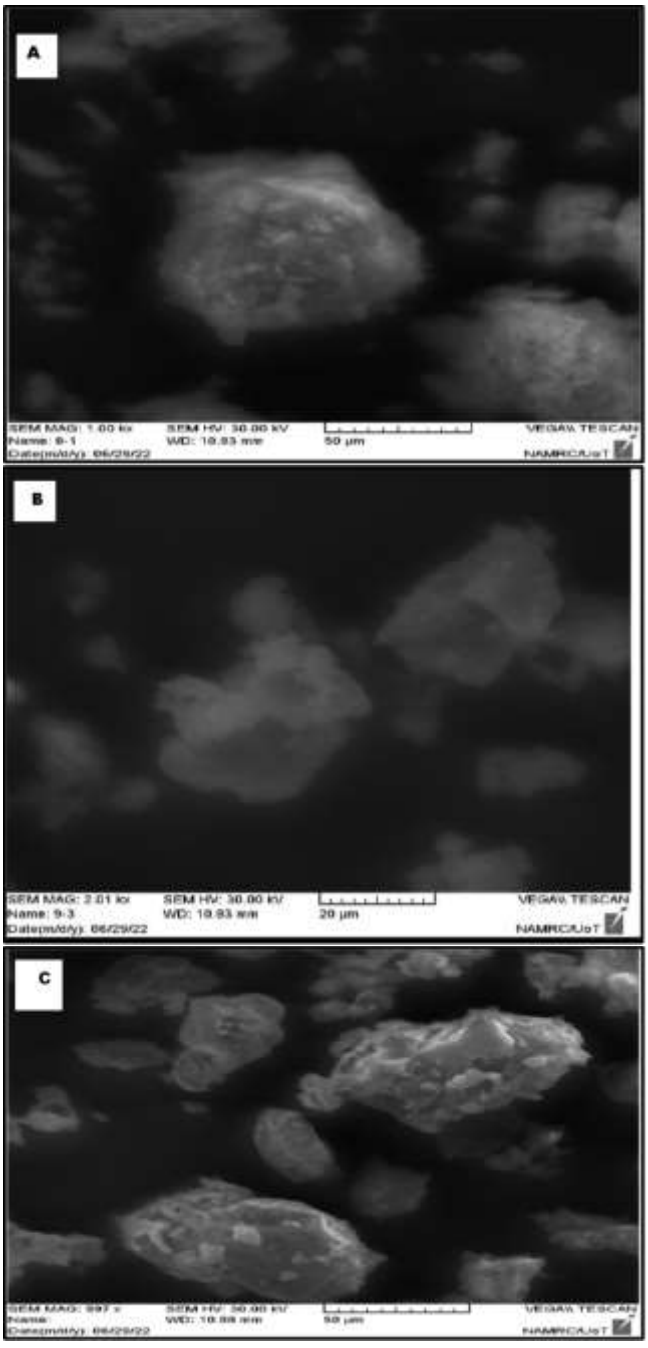

Fig. 2: (a-c): SEM for $Ni_{0.5}Zn_{0.5}Fe_2O_4$ at pH=1.8,7,10

4. Conclusion

$Ni_{0.5}Zn_{0.5}Fe_2O_4$ nanoparticles using Co-precipitation chemical routes were successfully synthesized with an ideal structure. XRD pattern showed the cubic spinel structure of space group. Further, observed that the particle size of sample prepared by the co-precipitation method is very small. Thus, it is concluded that the co-precipitation is a better route for the synthesis of fine Zinc ferrite nanoparticles.

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