FTIR analysis of prepared nanoparticles: Strontium hex ferrite nanoparticles

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Abstract

In this study, M-type strontium hexaferrite nanoparticles were successfully synthesized by the sol-gel method and characterized by fourier transform infrared spectroscopy (FTIR) to investigate the lattice vibration in characteristic bands. The absorption characteristic near the frequency range confirms the stretching vibration of metal oxygen bond.

Keywords: Stronitum hexaferrite, sol-gel method, FTIR

1. Introduction

Prominence of any material is depends on properties of material such as its magnetic as well as physical and chemical property. After discovery of hexaferrite in 1950 by diligence of Philips [1], hexaferrite material becomes centre of attraction for all researchers over the world due to their high performance -to-cost ratio [2]. Properties of material made it reasonable in wide variety of applications in industrial and technical world such as used in magneto optical device, permanent magnet, high frequency devices, components in microwave, recording media and telecommunication [3]. Previous researches are witness of dependency of material properties on method of preparation and doping. Along with intrinsic magnetic property, particle size, cation configuration, shape depends on synthesis condition in strontium hexaferrite ($SrFe_{12}O_{19}$). Similarly many chemical route of synthesis such as; sol-gel auto combustion, chemical co-precipitation, sol-gel, hydrothermal used to get ultrafine homogenous particle [4,5]. In this manuscript, sol-gel technique has been used for the preparation of hexaferrite nanoparticles due to simple preparations and cost effectiveness route helpful to achieve homogenous ultrafine particles powder.

2. Experimental

2.1 Chemicals

 I. Strontium nitrate $Sr(NO_3)_2$, and ferric nitrate nonahydrate $Fe(NO_3)_3.9H_2O$.

 II. Citric acid monohydrate $C_6H_8O_7.H_2O$.

 III. Aqueous ammonia (25%) AR-grade was taken as pH controller.

2.2 Preparation of strontium hexaferrite nanoparticles

Firstly, the salts are dissolved in distilled water in a stoichiometric proportion in a separate container for the preparation of aqueous solution of the metal nitrates. Then an aqueous solution is mixed with the salt solution of the metal ions. Adjust the pH level of 6-7 in matrix solution by adding aqueous ammonia drop wise to the solution, Fig.1. Then solution heat treated at 70-80°C with constant stirring for a few hours with the help of a magnetic stirrer. The solution is transferred and heated on a hot plate for higher heat treatment at 150-250°C to obtain a dried precursor powder. In order to get ultrafine nanoparticles the precursor powder is calcined in a muffle furnace at a temperature of 950°C and then it is subjected to characterization process.
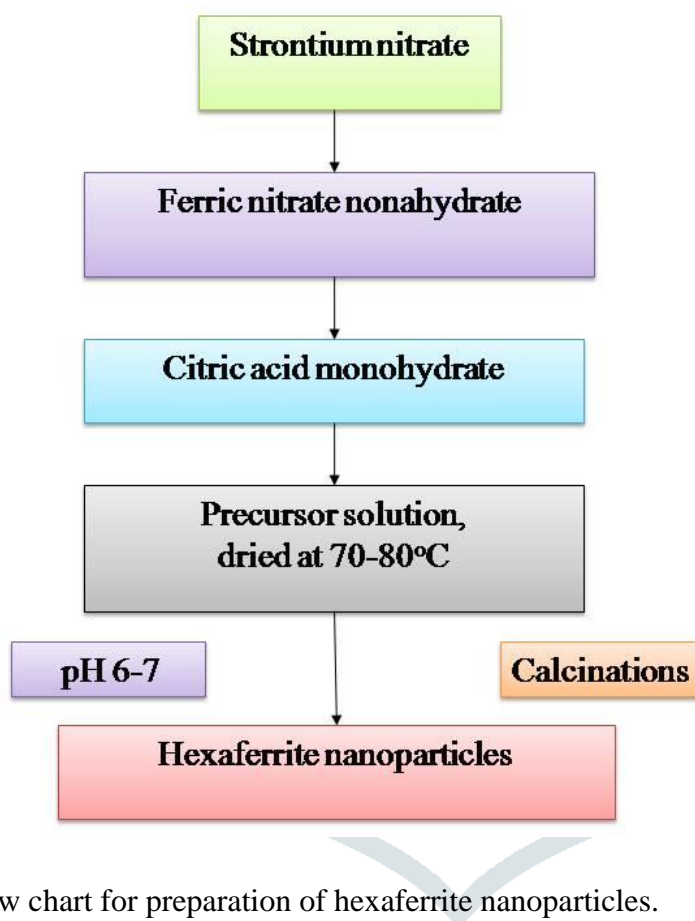

Fig.1: Systematic flow chart for preparation of hexaferrite nanoparticles.

3. Results and discussion

Infrared spectroscopy is used for observing structural and chemical properties and to identify the nature of chemical bonding. Fig.2 shows the FTIR spectra of precursor and calcinated hexaferrite nanoparticles [6]. The absorption peak position in frequency range 3000-3400 cm^{-1} and 1300-1650 cm^{-1} are corresponding to vibration of OH group and nitrate group which was found to be decreased with the increase in calcinations. The calcinations process amends the undesired absorption peaks into lattice vibration of oxygen atom and metal ions [7]. It is observed that bands in the range 430-590 cm^{-1} are due to the stretching vibration of oxygen atom and metal ions in this case it Fe-O which confirms the formation of hexaferrite [8,9]. The visible difference in the

position of bonds is due to the change in bond length between Fe^{3+}- O^{2-} ions for tetrahedral and octahedral complexes [10].
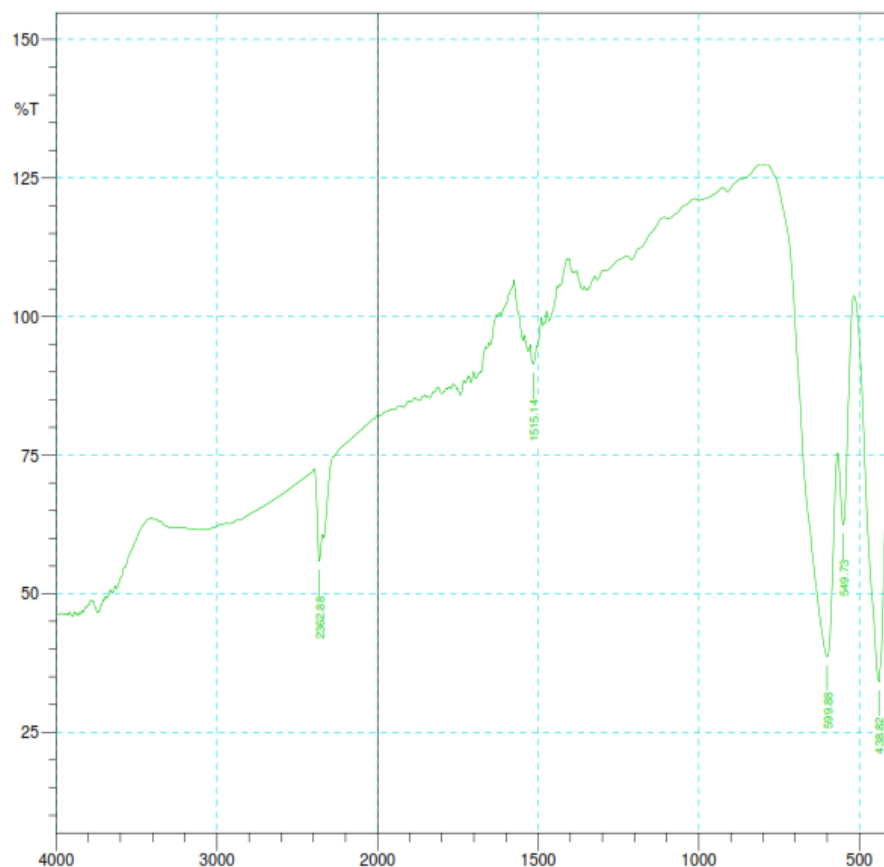

Fig. 2: FTIR spectrum of prepared ferrite nanoparticles.

4. Conclusion

The sol-gel method is used for the synthesis of the strontium hexaferrite sample. The sample synthesized by this process is cost-efficient, convenient and versatile for mass production of homogenous materials with controlled grain size and enhanced reaction activity. FTIR confirmed that the observed band in the range 430-590 cm^{-1} is because of stretching of the oxygen atom and metal ion which hence confirms the formation of hexaferrite.

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