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Acoustical Investigations in $NiFe_2O_4$ Nanofluid

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Abstract: ***Synthesis of nanosized ferrite particles has become an important part of modern research. In the present investigation, we have synthesized NiO, Fe_2O_3 and $NiFe_2O_4$ nanofluids using sol-gel method. The particle size distribution of the prepared nanoparticles has been determined using acoustic particle sizer (APS-100). It is based on measurement of ultrasonic attenuation and velocity depending upon the frequency. Ultrasonic velocity measurements in synthesized nanofluids have been made using the ultrasonic interferometer at different thermal conditions.***

Keywords: Nickel ferrite, Sol-Gel synthesis, Acoustic Particle Sizer (APS).

1. Introduction

Synthesis of nanosized ferrite particles is a subject of intensive research and has become an important part of modern research. Magnetic properties of nanosized ferrite particles have attracted considerable attention because of their unique properties [1-3]. In recent years, a number of researchers have prepared nanosized ferrites by emulsion method, co-precipitation method, hydrothermal method, reverse micelle technique, high energy ball milling technique and pulsed wire discharge method [3-6]. Nickel ferrite ($NiFe_2O_4$) is technologically important magnetic material extensively used in high frequency applications such as microwave device due to its high resistivity and sufficiently low losses [7].

Here, in the present investigation, we have synthesized NiO, Fe_2O_3 and $NiFe_2O_4$ nanofluids using sol-gel method. The particle size distribution of the prepared nanofluids has been determined using acoustic particle sizer (APS-100). It is based on measurement of ultrasonic attenuation and velocity depending upon the frequency [8]. Further, ultrasonic velocity measurements in NiO, Fe_2O_3 and $NiFe_2O_4$ nanofluids have been made using the ultrasonic interferometer at different thermal conditions.

2. Experiment Section

Nanofluids of NiO, Fe_2O_3 and $NiFe_2O_4$ have been prepared by using well-known sol-gel method. The precursors [Nickel acetate tetra hydrate $\{(CH_3COO)_2Ni.4H_2O\}$ and Iron (III) nitrate nonahydrate $\{Fe(NO_3).9H_2O\}$] used in the synthesis were AR grade. The particle size distribution measurements have been done by an acoustic particle sizer (model APS-100, Matec Applied Sciences, Massachusetts, USA). Ultrasonic velocity in the nanofluids has been measured with the help of a variable path interferometer technique at 4 MHz in the temperature range 30-80 ºC.

Figure 1: Photograph of Acoustic Particle Sizer (APS-100)

3. Results and Discussion

The photograph of APS-100 used in our study has been shown in Fig. 1. This technique consists of propagating ultrasonic waves of a range of frequencies (1 to 100 MHz) through the system and measuring the attenuation (dB/cm) at each frequency. The attenuation level, as well as, the shape of the acoustic attenuation curve is related to the particle size distribution (PSD). This attenuation spectrum can be converted to a particle size distribution

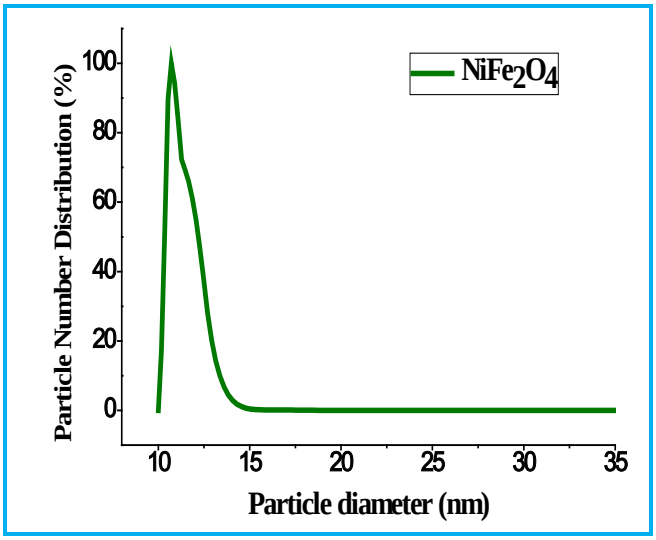

Figure 2: Particle size distribution curves of nanofluids

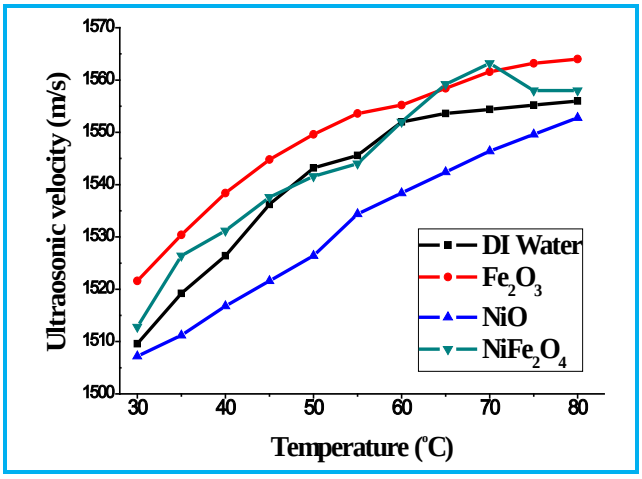

Figure 3: Temperature dependent ultrasonic velocity in nanofluids at 4 MHz.

[8]. The measured particle size distribution in the prepared $NiFe_2O_4$ nanofluid with the help of acoustic particle sizer is shown in Fig. 2, which clearly indicates the size of the $NiFe_2O_4$ nanoparticles found to be in the range 10 – 15 nm, while the maximum number of particles is of size 11 nm.

The ultrasonic velocities measured for pure de-ionized (DI) water solution and the three nanofluids in the temperature range 30-80 ˚C are shown in Fig. 3. The result of ultrasonic velocity shows that the velocity in the nanofluids increases with the temperature and it becomes approximately constant after a certain termperature . Fig. 4 shows the frequency dependent ultrasonic attenuation in $NiFe_2O_4$ nanofluid. It illustrates that as the frequency increases the ultrasonic attenuation of nickel ferrite increases linearly throughout whole range of frequency.

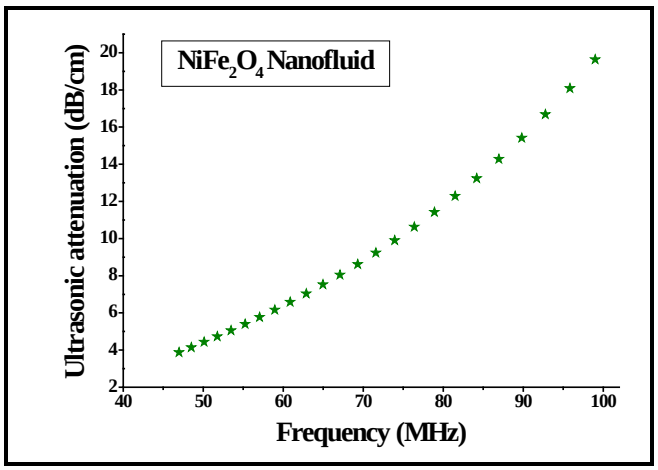

Figure 4: Frequency dependent ultrasonic attenuation in $NiFe_2O_4$ nanofluid

4. Conclusions

Nanofluids of NiO, Fe_2O_3 and $NiFe_2O_4$ have been successfully synthesized using sol-gel method. Particle size distribution of $NiFe_2O_4$ nanofluid determined by APS-100 have been found in the range 10-15 nm. Ultrasonic velocity measurements in the nanofluids have been studied using the ultrasonic interferometer at different thermal conditions.

5. Acknowledgment

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