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Ultrasonic Investigations in $MgFe_2O_4$ Nanofluid

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Abstract: ***Study of nanosized ferrites have great application to modern technologies including contrast enhancement of magnetic resonance imaging, high density data storage and magnetic carriers for site-specific drugs delivery. In the present study, magnesium ferrite is synthesized using sol-gel method. We have determined the particle size distribution of the synthesized nanoparticles by ultrasonic spectroscopic method using acoustic particle sizer (APS-100). APS is based on measurement of ultrasonic attenuation depending upon the frequency. Further, temperature dependent ultrasonic velocity in MgO, Fe_2O_3 and $MgFe_2O_4$ nanofluids have been determined using the ultrasonic interferometer.***

Keywords: $MgFe_2O_4$, Sol-Gel process, APS, Ultrasonic velocity.

1. Introduction

Spinel ferrites are very important magnetic materials because of their interesting magnetic properties due to exchange interaction [1-2]. These ferrites demonstrate good chemical and thermal stabilities [3-4]. Ferrites show very good surface reactivity and they have temperature dependent surface morphology. Study of ferrite nanoparticles has great application to modern technologies including contrast enhancement of magnetic resonance imaging, high density data storage and magnetic carriers for site-specific drugs delivery. Magnesium ferrite ($MgFe_2O_4$) is one of the most important ferrites [5-6]. $MgFe_2O_4$ nanoparticles have been synthesized using various methods, such as co-precipitation, reverse micelles, hydrothermal methods, micro-emulsions, laser ablation and aerosol method [5-7].

In the present study, MgO, Fe_2O_3 and $MgFe_2O_4$ nanofluids have been synthesized using sol-gel method. We have determined the particle size distribution of the synthesized nanoparticles by ultrasonic spectroscopic method using acoustic particle sizer (APS-100). APS is based on measurement of ultrasonic attenuation depending upon the frequency. Further, temperature dependent ultrasonic velocity in MgO, Fe_2O_3 and $MgFe_2O_4$ nanofluids have been determined using the ultrasonic interferometer.

2. Experimental Section:

MgO, Fe_2O_3 and $MgFe_2O_4$ nanofluids were synthesized using sol-gel method. The precursors used [Iron (III) Nitrate nonahydrate {$Fe(NO_3).9H_2O$}, Magnesium acetate tetrahydrate $(CH_3COO)_2Mg.4H_2O$, Citric acid monohydrate] in this method were analytical reagent grade. The particle size distributions of these nanofluids have been measured with acoustic particle sizer. It measures attenuation with frequency of sound. Further these data are converted in particle size distribution [8]. Temperature dependent ultrasonic velocities of above mentioned nanofluids have been determined using the well-known ultrasonic interferometer technique at 4 MHz in the temperature range 30 to 80 °C.

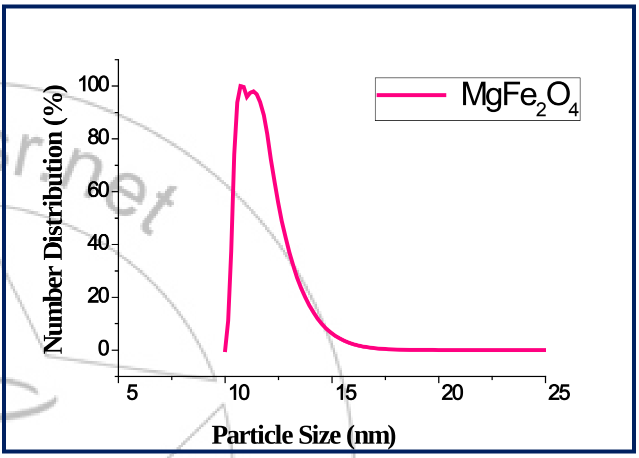

Figure 1: Particle size distribution of $MgFe_2O_4$ nanofluid

3. Results and Discussion

Fig. 1 shows the result of particle size distribution of $MgFe_2O_4$ nanofluid by acoustic particle sizer. From this figure, one can see that $MgFe_2O_4$ nanofluid have particle size in the range of 10 to 15 nm. We have measured ultrasonic velocity in different nanofluids.

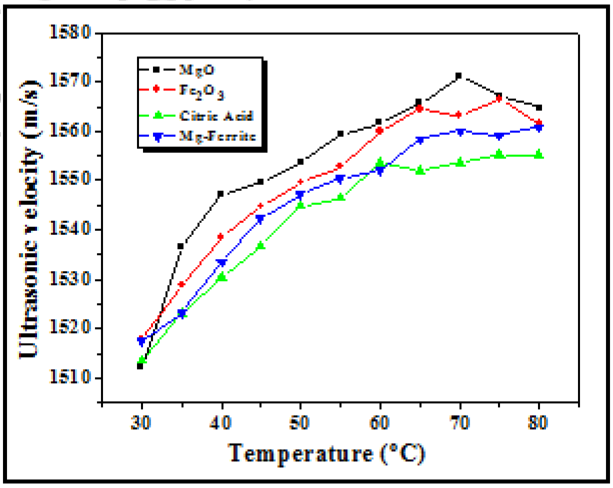

Figure 2: Plot of ultrasonic velocity in different nanofluids as a function of temperature at 4 MHz .

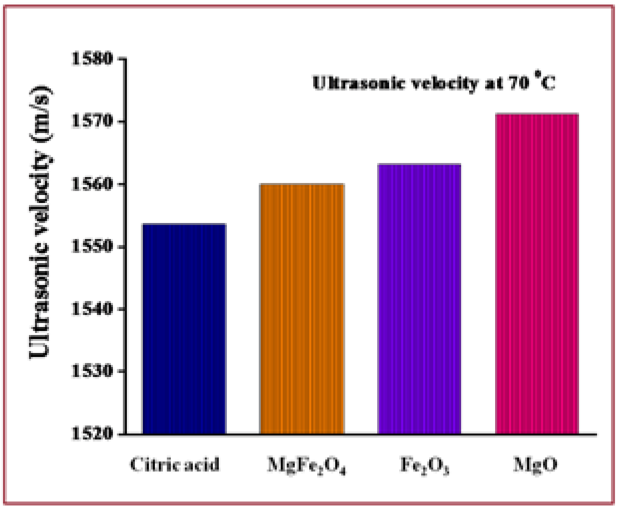

Figure 3: Illustration of ultrasonic velocity at temperature 70°C for different nanofluids at 4 MHz

Results of ultrasonic study are shown in Fig. 2. This figure shows that in case of MgO, velocity increases sharply upto 40 °C, then increases linearly with slow rate upto 70 °C and after that it decreases. Similar behavior is found in case of Fe_2O_3 (in this case velocity increases upto 65 °C) and then shows anomalous nature. In case of $MgFe_2O_4$, velocity increases linearly upto 65 °C and then becomes almost constant. In case of citric acid ultrasonic velocity increases almost linearly upto 60 °C and after that it becomes constant. Ultrasonic velocity in citric acid, $MgFe_2O_4$, Fe_2O_3 and MgO nanofluids at temperature 70 °C and frequency 4 MHz have been found 1553.6, 1560.0, 1563.2 and 1571.2 m/s, respectively, which is shown in Fig 3. From this observation, we can say that MgO is challenging nanofluid among rest.

4. Conclusions

Different nanofluids have been successfully synthesized using sol-gel technique. Particles size distribution of the nanofluid has been determined from APS analysis and temperature dependent ultrasonic velocities in the nanofluids have been studied. Ultrasonic velocity in nanofluids is very significant for non-radiative technique and non destructive structural analysis. The results of the present work may be summarized as follows:

(i) Particles size distribution of $MgFe_2O_4$ nanofluids is in the range 10-15 nm.
(ii) Ultrasonic velocity in nanofluids increases with temperature and for higher temperature it becomes constant.
(iii) Ultrasonic velocity is higher for nanofluid than for pure citric acid and is maximum for MgO nanofluid.

5. Acknowledgement

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