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Non-destructive characterization of $CaFe_2O_4$-ethylene glycol based nanofluids

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In the present work, $CaFe_2O_4$ nanoparticles have been synthesized using sol-gel method. The prepared nanoparticles have been characterized using X-Ray diffraction (XRD) and transmission electron microscopy (TEM). $CaFe_2O_4$ nanoparticles have been dispersed in the ethylene glycol using high power ultrasonicator to prepare $CaFe_2O_4$-ethylene glycol based nanofluids of different volume fraction (*viz*. 0.1 vol%, 0.2 vol%, 0.5 vol%, and 1.0 vol%). Particle size distribution of synthesized nanofluids has been investigated by acoustical particle sizer (APS-100). Frequency and concentration dependent ultrasonic attenuations in the nanofluids have been measured by APS-100. A comparative study of the results, obtained by XRD, TEM and APS, has been done. Various factors responsible for ultrasonic attenuation and their correlation have been made to understand the inter-particle and intra-particle interactions.

Keywords: Nanofluids, ultrasonic attenuation, acoustical particle sizer, particle size distribution.

Introduction

Nanoparticles have attracted research community's attention extensively because of their superior physiochemical properties, compared to their bulk part, which depend on their size, shape, and morphology[1]. Nanofluids are suspension of nano-sized particles in conventional fluids such as water, ethylene glycol, glycerol and engine oil. Acoustical and thermal properties of base fluids got enhanced after nanoparticle loading in base fluids. Due to exceptional properties, nanofluids have potential applications in the field of automotive, heat transfer management, electronic cooling, and biotechnology[2].

Spinel-type ferrites provide better thermal and chemical stability under ambient operating condition[3]. In recent times, ferrites materials of different shape and size have been studied because of their possible applications in magnetic behaviour, data storage system, gas sensor, and photocatalysis[3-4]. Orthorhombic nanostructured $CaFe_2O_4$ nanoparticles are of great importance because the constituting metal ions at tetrahedral and octahedral site, *viz.* Ca^{2+} (d^0), Fe^{3+} (d^5) respectively, exhibit zero crystal field stabilization energy[4]. In the present work, we have synthesized $CaFe_2O_4$ nanoparticles-ethylene glycol nanofluids of different volume fraction and their ultrasonic investigations have been performed.

Acoustics have opennew possibilities for non-destructive testing (NDT) of highly sophisticated industrial as well as biomedical materials[5]. Reliability and consistency of the materials can be gauged not only after production but also throughout the processing of the material by means of ultrasonic NDT[6]. For this drive, high frequency sound wave is extensively applied not only in industrial sector but also in medical sectors[7]. Ultrasonic attenuation of the wave in the medium provides an understanding of other physical properties of materials such as elastic constants, thermal conductivity, structural inhomogeneity, and dislocation that can predictthe potential usage of the materials for suitable applications[8]. Further, frequency dependent ultrasonic absorption may be utilized for detection of microstructure, grain size and extensional rheology of the materials[9]. In the present work acoustical spectroscopic technique has been applied to determine particle size distribution of nanoparticles in $CaFe_2O_4$ nanofluids. Frequency and concentration dependent