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Research Paper

THERMAL CONDUCTIVITY AUGMENTATION OF ZnO NANOFLUIDS FOR COOLANT APPLICATIONS

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The Zno Nano particles are Synthesized by using metal organic complex of Zinc using microwave radiation. The nanoparticles are blended with distilled water by sonication and improvement in thermal conductivity is measured for different concentrations of nanoparticles. The improved thermal conductivity will enhance the heat transfer significantly.

Keywords: Nanofluids, Microwave radiation, Thermal conductivity

INTRODUCTION

The heat transfer is everyday phenomenon, which depends on thermal conductivity of the medium through which the flow of heat occurs. The other factors like temperature gradient and area through which heat transfer takes place are fixed and most of the times cannot be modified. Nanofluids are effective and efficient for improving heat flow. The nanofluids are synthesized by either single step are two step. In single step the evaporated metal is made combine with a thin film of base fluid placed on rotating ring. The nanofluids can also be produced by micro reactor in which precursors are made to flow through tubes of very small diameter bore bringing the reactants very close to each other and micro reactor can be placed in hot water bath if heat is needed to bring about the reaction. The two-step method, which is widely used consists of preparation of nanoparticles and later blending them with different base fluids and can be customized to specific applications. Cooling is one of the most important technical challenges facing many diverse industries, including microelectronics, transportation, solid-state lighting, and manufacturing. Technological developments such as microelectronic devices with smaller (sub-100 nm) features and faster (multi-gigahertz) operating speeds, higher-power engines, and brighter optical devices are driving increased thermal loads,

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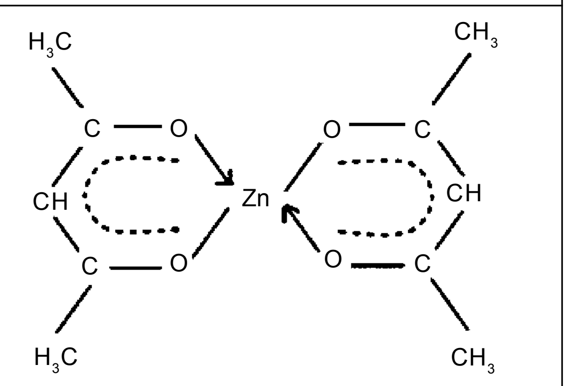
requiring advances in cooling. The conventional method for increasing heat dissipation is to increase the area available for exchanging heat with a heat transfer fluid. However, this approach requires an undesirable increase in the thermal management system's size. There is therefore an urgent need for new and innovative coolants with improved performance. The novel concept of 'nanofluids'—heat transfer fluids containing suspensions of nanoparticles has been proposed as a means of meeting these challenges (Choi, 1995).

Nanofluids are solid-liquid composite materials consisting of solid nanoparticles or nanofibers with sizes typically of 1-100 nm suspended in liquid. Nanofluids have attracted great interest recently because of reports of greatly enhanced thermal properties. For example, a small amount (<1% volume fraction) of Cu nanoparticles or carbon nanotubes dispersed in ethylene glycol or oil is reported to increase the inherently poor thermal conductivity of the liquid by 40% and 150%, respectively (Choi *et al.*, 2001; and Eastman *et al.*, 2001). Conventional Particle-liquid suspensions require high concentrations (>10%) of particles to achieve such enhancement. However, problems of rheology and stability are amplified at high concentrations, precluding the widespread use of conventional slurries as heat transfer fluids. In some cases, the observed enhancement in thermal conductivity of nanofluids is orders of magnitude larger than predicted by well-established theories. Other perplexing results in this rapidly evolving field include a surprisingly strong temperature dependence of the thermal conductivity (Das *et al.*, 2003; and Patel *et al.*, 2003) and a three-fold higher critical heat flux compared with the base fluids (You *et al.*, 2003; and Vassallo *et al.*, 2004). These enhanced thermal properties are not merely of academic interest. If confirmed and found consistent, they would make nanofluids promising for applications in thermal management. Furthermore, suspensions of metal nanoparticles are also being developed for other purposes, such as medical applications including cancer therapy (O'Neal *et al.*, 2004). The interdisciplinary nature of nanofluids research presents a great opportunity for exploration and discovery at the frontiers of nanotechnology (Ajayan *et al.*, 2003). A two-step process works well in some cases, such as nanofluids consisting of oxide nanoparticles dispersed in deionized water (Lee *et al.*, 1999).

MATERIALS AND METHODS

The Zno nanorods are synthesized by using a metal organic complex of zinc (Sanjaya, 2010). The schematic molecular structure of Zn(acac)2 is as shown in Figure 1. The zinc acetylacetonate Zn(acac)2. is mixed with ethanol and stirred by using magnetic stirrer. The surfactant PVP (Poly vinyl pyrrolidone)

Figure 1: The Schematic Molecular Structure of Zn(acac)2



is added to ethanol and metal organic complex mixture. The mixture is subjected to microwave radiation for 1 min and colloidal white nanoparticles are separated by centrifugation. The dried sample is subjected to XRD and Scanning electron microscopy analysis.

The XRD and UV absorption of the sample is as shown in Figures 2 and 3 respectively SEM photographs are shown in Figure 4. All the diffraction peaks could be indexed to ZnO hexagonal structure (JCPDS File No – 05-0664). The thermal conductivity is measured by using KD2 Pro Thermal analyzer

Figure 2: XRD of Sample

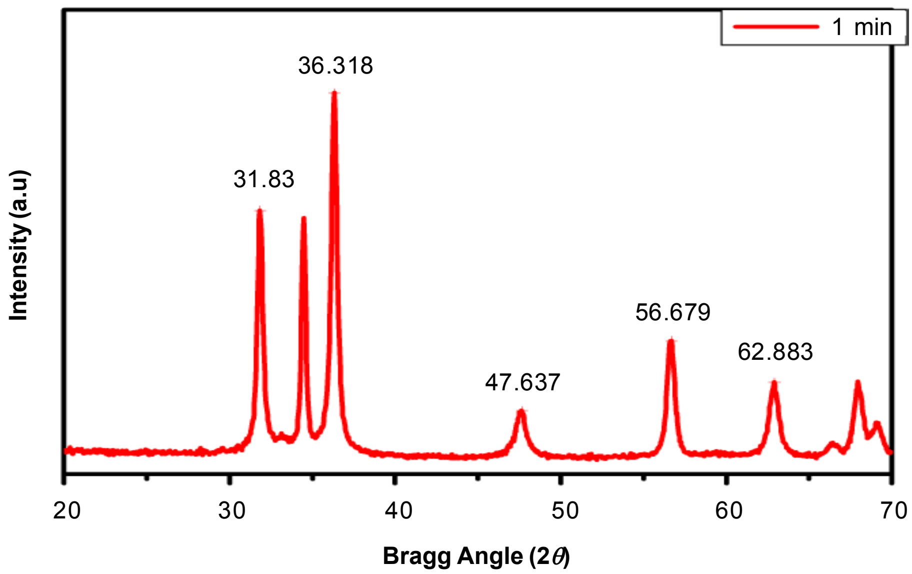


Figure 3: UV Absorption of Sample for 1 min

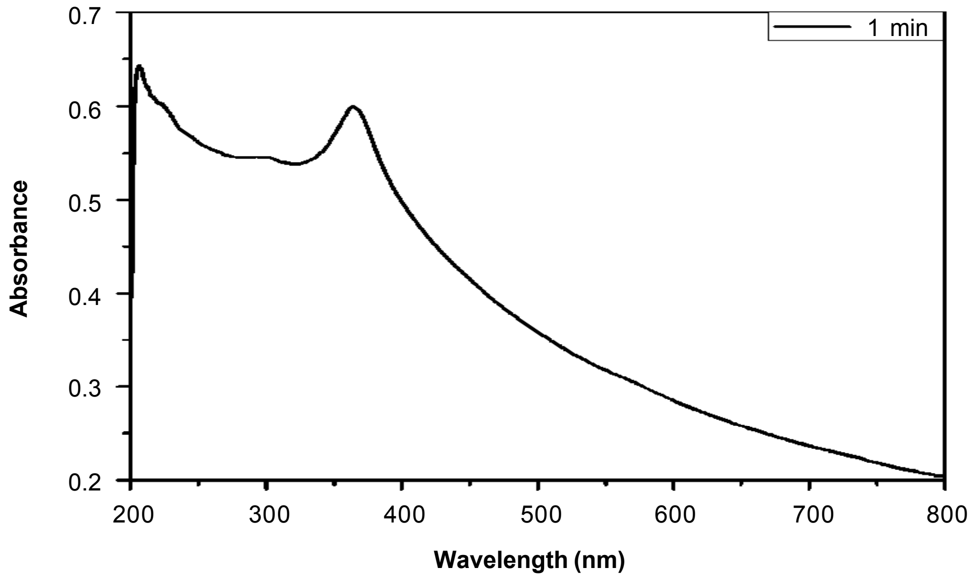
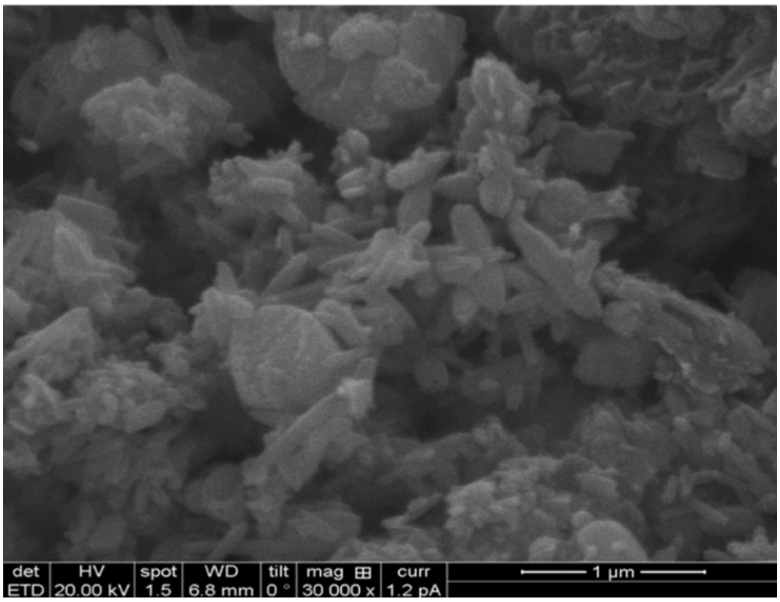


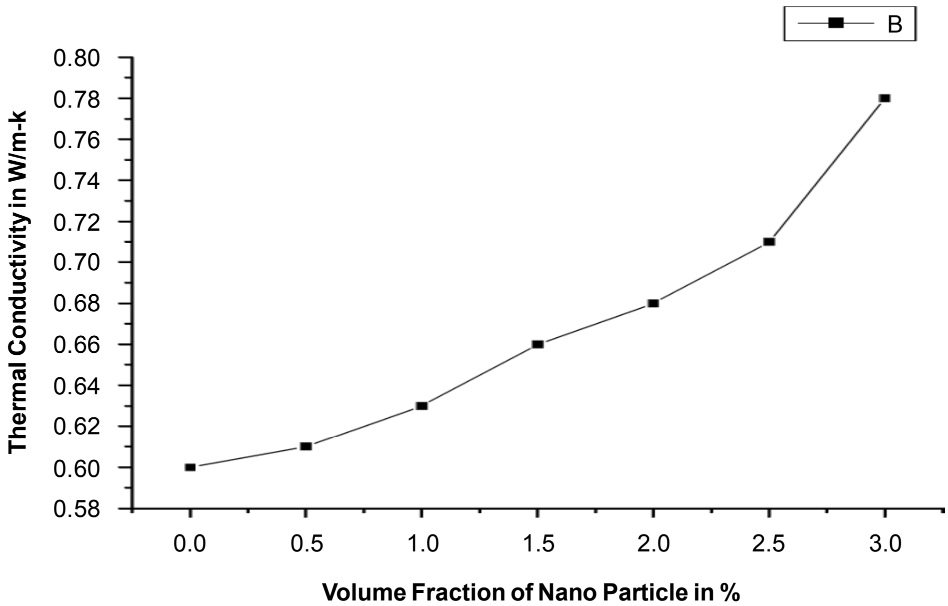
Figure 4: SEM Analysis of ZnO Nanorods



RESULTS AND DISCUSSION

The improvement in Thermal conductivity of water containing nanorods of Zno is evident from experimental results as shown in Figure 5. The improvement in conductivity is attributed to increased surface area of nano particles and Brownian motion of nano particles dispersed in base fluid. The experiments were carried out at room temperature and further rise in conductivity can be expected with rise in

Figure 5: Thermal Conductivity for Different Concentrations of Particle Loading



temperature. The change in viscosity is shown in Figure 6. The EDAX of nanorods is shown in Figure 7 indicating breakup of various elements present in ZnO nanorods .The weight loss by thermo gravimetric analysis of nanorods is as shown in Figure 8.

Figure 6: Viscosity of Nanofluids

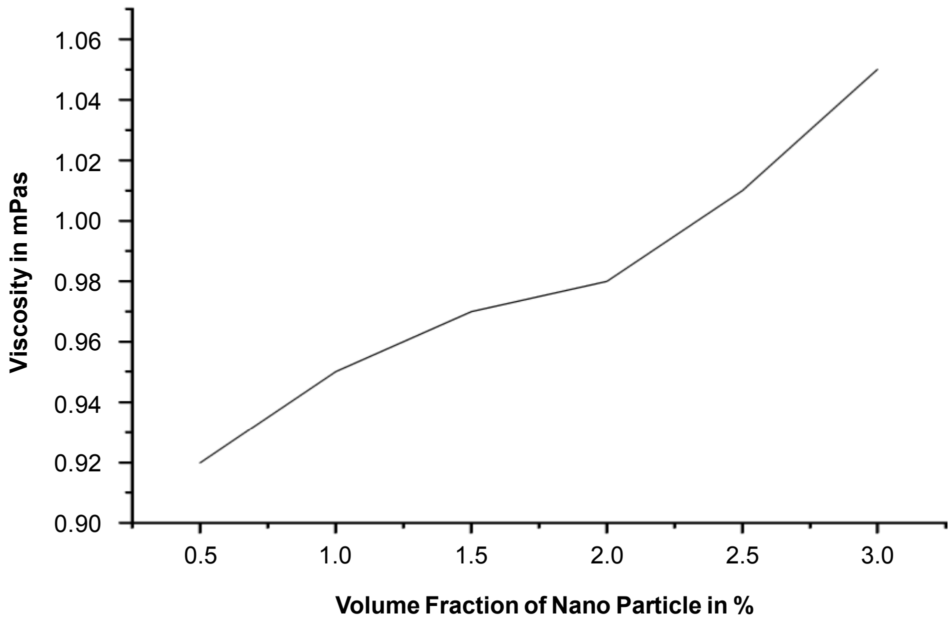
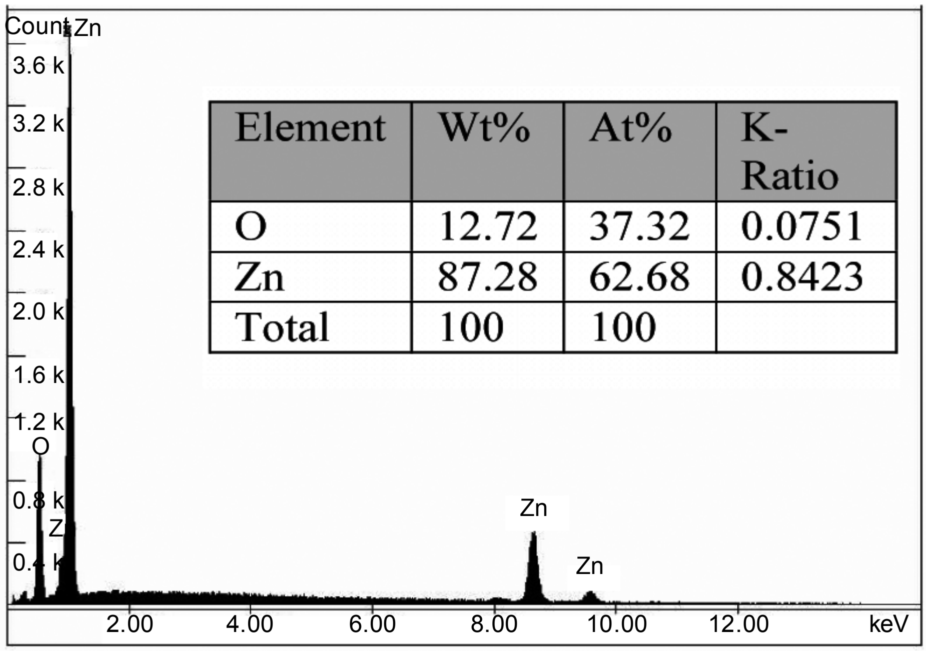
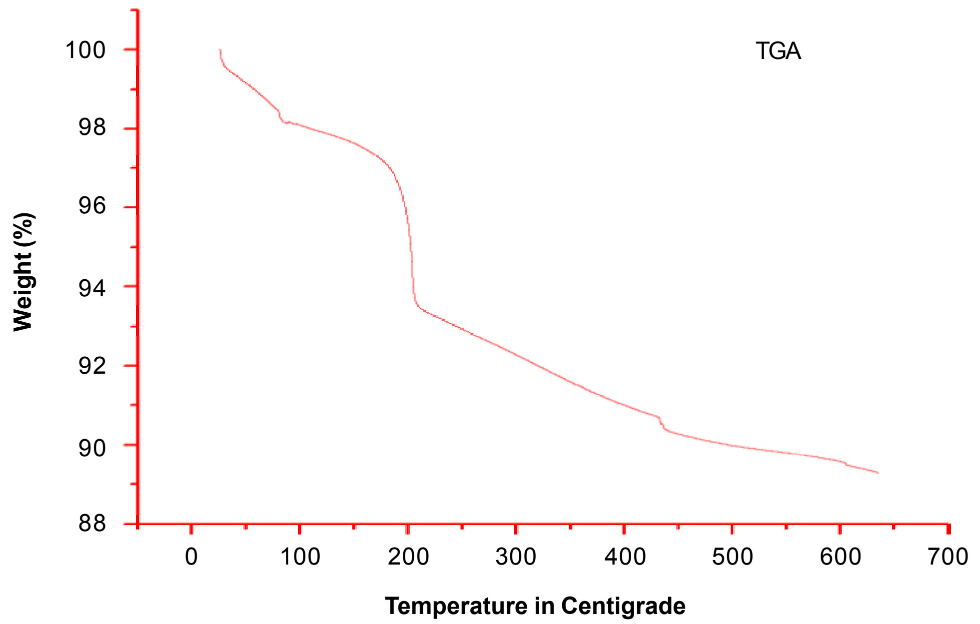


Figure 7: EDAX of ZnO Nanorods



Element	Wt%	At%	K-Ratio
O	12.72	37.32	0.0751
Zn	87.28	62.68	0.8423
Total	100	100	

Figure 8: Thermo Gravimetric Analysis of ZnO Nanorods



CONCLUSION

The nanorods of ZnO are very effective and efficient in improvement of thermal conductivity of base fluid. The increase in viscosity is not high with addition of nano particles to base fluids which is very much desired for coolant applications.

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