Preparation of Nanofluids from Inorganic Nanostructures Doped PEG: Characteristics and Energy Storage Applications

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Polymeric nanocomposites have drawn a lot of interest when it comes to innovative materials because of their enhanced optical, electrical, and magnetic properties. These materials have a high rising modulus, are flame resistant, and may also halt oxidation and agglomeration. These improvements in properties are related to interactions between nanoparticles and polymers. The addition of nanoparticles to polymers prolongs their life, changes their surface via passivation defect levels, and provides low cost, simple device manufacture, as well as adjustable electrical and optical properties. This study examines the properties and potential uses of nanofluids made from inorganic nanostructures doped with PEG. The results demonstrate that when the concentration of ZrO2/SiC NPs increased to 12wt%, the electrical conductivity of nanofluids increased by roughly 43.6%. Additionally, when the concentration of ZrO2/SiC nanoparticles increases, the melting time reduces. Additionally, when the concentration of ZrO2/SiC NPs increases from 3 weight percent to 12 weight percent within 15 minutes, the growth of melting time reaches 51.2%, and the absorbance increases by approximately 80.3% while transmittance decreases by about 82.5%.

Keywords: nanocomposites; inorganic nanostructures; PEG; energy storage

1. Introduction

The past few years have witnessed a huge increase in interest in nanotechnology since miniaturization and nanomaterials are often predicted to be the key to a sustainable future. In this regard, a significant portion of the scientific community is currently concentrating on a very difficult and pertinent research area, which is the synthesis of novel nanostructured hybrid materials capable of absorbing the photonic energy from sunlight with the intention of converting it into electrical or chemical energy. Whereas, substantial study on the use of solar energy has been sparked by rising worries about energy and environmental issues. Among these, several methods for employing semiconductor photocatalysts to degrade organic dyes and/or produce photocatalytic hydrogen for fuel cells are investigated [1-4]. While electrical features are designed to know conveyance of the fee widespread presence in these compounds, optical qualities are intended to be anti-reflective, getting polarization characters and greater reflection. The dopant addition will customize the polymer matrix-based polymers’ electrical and optical characteristics. Additionally, the outstanding qualities of inorganic compounds, such as thermal resistance, heat strength, and high strength, can be combined with the advantages of polymer fabrics, such as nice moldability, high power, and durability, to create composite materials, which require high strength and chemical resistance. The electrical, magnetic, mechanical, optical, and thermal properties of nanofillers can be enhanced by incorporating organic and inorganic materials into their structures. Nanofillers can be used in a wide range of applications, such as the production of tissue, filters, catalysis, scaffolds, wound dressing, and sensors [5–11].

Phase change materials (PCMs) based on poly(ethylene glycol) 400 g/mol and nano-enhanced by either carbon black (CB), a raw graphite/diamond nano mixture (G/D-r), a purified graphite/diamond nano mixture (G/D-p), or nano-Diamond nano powders with purity grades of 87% or 97% were presented by Cabaleiro et al. (nD87 and nD97, respectively). In order to create PEG/MgCaCO3 as a ss-PCM, MgO-CaCO3 matrices were first constructed and examined by Zahir et al. [13]. PEG-5MgCaCO3 (P-5-MCC), PEG-10MgCaCO3 (P-10-MCC), and PEG-15MgCaCO3 samples were detected in the samples (P-15-MCC). A technique for the manufacture of gelatin-stabilized copper oxide nanoparticles was created by Gvozdenko et al. [14]. The process of synthesis used direct chemical precipitation. For the manufacture of copper oxide, copper sulfate, chloride, and acetate were employed as precursors. As a stabilizer, gelatin was utilized. It was discovered that only when copper acetate was utilized as a precursor would monophase copper oxide II develop. The addition of SiCto polymers has many applications in various approaches like electronics sensors and biomedical [15-21]. This study examines the properties and potential uses of nanofluids made from inorganic nanostructures doped with PEG.

2. Materials and Methods

This study made use of polyethylene glycol (PEG), zirconium oxide nanoparticles (ZrO2 NPs), and silicon carbide nanoparticles as its raw materials (SiC NPs). After dissolving 1 gram of PEG in 50 milliliters of distilled water, we were
able to create the PEG-H2O fluid. The various concentrations of ZrO2/SiC NPs that were used in the fabrication of the nanofluids are 3%, 6%, 9%, and 12%. PEG/ZrO2/SiC-H2O nanofluids had their optical and electrical characteristics investigated as part of this study. The double beam spectrophotometer (Shimadzu, UV-18000A) with a wavelength range of (200-1000) nm is used to analyze the optical characteristics of the PEG/ZrO2/SiC-H2O nanofluids. The technique of assessing the melting features of PEG/ZrO2/SiC-H2O nanofluids during the heating process is included in the thermal energy storage. The PEG/ZrO2/SiC-H2O nanofluids were used as the heat transfer fluid. The temperature of the heat transfer fluid can be varied from 35 degrees Celsius to 100 degrees Celsius using a stirrer, and a digital device was used to measure the temperature of the PEG/ZrO2/SiC-H2O nanofluids while they were being heated.

3. RESULTS AND DISCUSSION

For various concentrations of ZrO2/SiC NPs, the absorbance and transmittance spectra of PEG/ZrO2/SiC-H2O nanofluids are shown in Figs. 1 and 2, respectively. These graphs showed that when ZrO2/SiC NP concentrations climbed from 3 weight percent to 12 weight percent, absorbance increased by around 80.3% and transmittance reduced by about 82.5%. The PEG/ZrO2/SiC-H2O nanofluids exhibit increased UV absorption, making them potential nanofluids for use in a variety of renewable areas, including solar collectors, energy storage, and heating and cooling systems. The absorbance, which alludes to greater nanofluid dispersion, will grow when ZrO2/SiC NP concentration rises [22].

![Figure 1. Absorbance and transmittance spectra of PEG/ZrO2/SiC-H2O nanofluids with photon wavelength for different concentrations of ZrO2/SiC NPs](image1)

![Figure 2. Transmittance spectra of PEG/ZrO2/SiC-H2O nanofluids with photon wavelength for different concentrations of ZrO2/SiC NPs](image2)

The association between the concentrations of ZrO2/SiC NPs and the electrical conductivity of PEG/ZrO2/SiC-H2O nanofluids is shown in Fig. 3. When ZrO2/SiC NP concentrations approach 12 weight percent, the electrical conductivity of nanofluids increases by roughly 43.6%, which is caused by an increase in the number of charge carriers [23]. The melting curves of PEG/ZrO2/SiC-H2O nanofluids are shown in Fig. 4. As the concentration of ZrO2/SiC nanoparticles increases, the melting time reduces. PEG/ZrO2/SiC-H2O nanofluids' reduced melting time for energy storage applications is owing to improved thermal conductivity, which increases heat transfer [24–32]. When the concentration of ZrO2/SiC NPs increases from 3 weight percent to 12 weight percent within 15 minutes, the increment in melting time reaches 51.2%. As a result of this behavior, PEG/ZrO2/SiC-H2O nanofluids may be thought of as a key for heating and cooling systems.

![Figure 3. Variation of electrical conductivity of PEG/ZrO2/SiC-H2O nanofluids and concentrations of ZrO2/SiC NPs](image3)

![Figure 4. Melting curves of PEG/ZrO2/SiC-H2O nanofluids](image4)
4. CONCLUSIONS

Because of its simpler construction process and ability to easily control the properties of polymer electrolytes by altering the blended polymer composition, polymeric blends may have a more beneficial impact. The following list of potential consequences follows:

1. When the concentration of ZrO2/SiC NPs increased to 12 weight percent, the electrical conductivity of nanofluids increased by around 43.6%.
2. As the concentration of ZrO2/SiC nanoparticles increases, the melting time reduces.
3. When the concentration of ZrO2/SiC NPs increases from 3 weight percent to 12 weight percent within 15 minutes, the increment in melting time reaches 51.2%.
4. As the concentration of ZrO2/SiC NPs rose from 3 weight percent to 12 weight percent, the absorbance increased by approximately 80.3% and the transmittance dropped by about 82.5%.
5. The increase in ZrO2/SiC NP concentration will result in a higher absorbance, which indicates improved nanofluid dispersion.

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Полімерні нанокомпозити викликають великий інтерес, коли йдеться про інноваційні матеріали через їхні покращені та забезпечують низьку вартість, росте виготовлення пристроїв, а також регулювані електричні та оптичні властивості. У полімерами. Додавання наночастинок до полімерів підвищує їх життя, змінює їхню поверхню через рівні дефектів пасивації оптичні, електричні та магнітні властивості. Ці матеріали мають високий модуль зростання, вогнестійкі, а також можуть використовуватися для зберігання енергії. Проте варіювання концентрації наночастинок ZrO2/SiC збільшується приблизно на 80,3 %, тоді як пропускна здатність зменшується приблизно на 82,5 %.

Ключові слова: нанокомпозити; неорганічні наноструктури; ПЕГ; зберігання енергії