The Influence Surface Modification of CNT Using Surfactant to Formation of Composite

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Abstract. The nature of pure CNT has a hydrophobic surface and low dispersion stability. To increase CNT dispersibility, it is necessary to modify the CNT. One possible way to modify the electronic and vibronic properties of CNT is charge and functional transfer. Addition of surfactant to CNT is to increase the solubility of CNT in water which produces functional groups from the surface of nanotubes with anionic and cationic groups. The purpose of this study was to study the effect of surfactant addition on CNT treatment on CNT properties. Pure CNT samples that have been added to the surfactant are sonicated for 1 hour then dried. From the results of X-ray Dispersive energy characterization (EDX), there is an increase in the amount of oxygen in the CNT after the addition of surfactant compared to pure CNT. From the results of Fourier Infrared Transformation (FTIR) shows that the process of adding surfactants will produce functional groups on the surface of the CNT. The SEM characterization showed no morphological changes in CNT, this was also stated by the results of X-ray Diffraction (XRD).

1. Introduction

The development of carbon nanotube synthesis (CNT) with extraordinary mechanical and electrical properties offer the possibility of many new applications with a number of CNT-based composite materials [1]. In certain applications, pure CNT must be an effort so that CNT is well dispersed through chemical functionalization [2] and physical interaction [3-5]. In this study, we describe a new approach to CNT modification of cetyltrimethylammonium cationic surfactant bromide (CTAB) and anionic surfactant cocoPAS (coconut-oil based primary alkyl sulfate). Carbon nanotubes are first uniformly dispersed in a surfactant solution and then finally to form a composite.

Since the discovery of Carbon Nanotube (CNT) as nano material, this material continues to grow. CNT is a material that is widely used for research objects in the field of nanotechnology. CNT has a unique structure, superior mechanical and electrical properties. It is the nature of this extraordinary CNT that CNT has great potential in its application in various fields such as energy storage, biomedicine, micro-electronics / semiconductors and other applications. Large surface area and nanosized pore structure are accommodated by carbon so that this material becomes very effective and efficient to use as an adsorbent material.
Pure CNT have a hydrophobic surface and low dispersion stability. To increase dispersibility, it is necessary to modify or treat CNT. Possible way to modify electronic and vibronic properties is with charge and functional transfer. CNT can be modified by adding chemical compounds, such as acid compounds and surfactants. Modification with the addition of surfactants to CNT is to increase the solubility of CNT in water with the functional surface of the nanotube with anionic and cationic groups. The formation of CNT composites with TiO₂ material can be viewed from several approaches, namely through the functional group and electron charge bonds of the material. Functional groups and electron charges can be formed due to treatment. Among these treatments are acid treatment and surfactant. In the treatment of surfactants can prevent the formation of grain during phase transformation and stabilize very small particles so as to facilitate the dispersion process [6].

Adding of surfactant showed many bonding formed by other than covalent bonding. Surfactants act as linking agent of surface adsorption of CNT by interaction of π – π . Surfactants has molecular structure consisted of hydrophilic and hydrophobic group. Hydrophilic group could be dispersed well in the water and organic solute, while hydrophobic group will make bonding with CNT. Zeta Potential charge is influenced by the type of surfactant such as anionic or cationic, anionic charge can cause the potential zeta value to be negatively charged while the cationic surfactant can cause a potential positive zeta value.

2. Methodology
CNT for the research was MWCNT type purchased from Dong Yang (HK) Int’l Group Limited of diameter 10-30 nm, length of 5-15 μm, and purity of 99%, Cetyltrimethylammonium bromide (CTAB), cocoPAS, HNO₃ and distilled water.

1 g of carbon nanotubes (CNT) was added with 0.5 g CTAB surfactant in 100 ml of distilled water. The solution is then sonicated for 1 hour. Then the solution is dried. The same procedure was carried out for the addition of CNT with cocoPAS surfactants.

3. Results and Discussion
The type of carbon nanotube (MWCNT or SWCNT) cannot be known by the results of SEM analysis but with the analysis of the characterization of the TEM. From the characterization of the material obtained from the companies that sell the CNT, namely Dong (HKk) Int’l Group Limited declare that the CNT has the type of MWCNT.

Figure 1 show the results of SEM analysis in the form of morphology of CNT before and after the treatment with cocoPAS and CTAB. Morphology that formed after the treatment is not changes its shape and size of tube. The size of the diameter tube of pure CNT ranged from 48 to 99 nm while the size of the diameter tube CNT that is already modified with surfactants cocoPAS and CTAB is 35 to 82 nm. The size of diameter is not too changed and morphology from SEM analysis showed no significant changes. This is in accordance with previous research stating that the surface of the CNT that yet and after the modification there was no significant difference [7]. It can be concluded that the treatment does not alter the morphological structure and size of the dimensions of the CNT.
Figure 1. SEM image of CNT (a) pure CNT (b) CNT-cocoPAS (c) CNT-CTAB

In Figure 2 below shows the functional group of the CNT that is obtained from the FTIR analysis. Characteristic peaks of the pure CNT and CNT modified with the cocoPAS and CTAB are on the spectrum of $2994\,\text{cm}^{-1}$ indicates the presence of a group of methylene identified as C-H. The peak-to-peak characteristics of the other that is on the spectrum $1522\,\text{cm}^{-1}$ indicates the presence of a bond C=C, on the spectrum of $1225\,\text{cm}^{-1}$ indicating the bonding of C-H [8].

In CNT cocoPAS and CNT CTAB there are different peaks with pure CNT, peaks can be observed around $1110\,\text{cm}^{-1}$ is a C-O functional group that can be present during CNT purification [9]. This C-O functional group is only found in the CNT cocoPAS. This group affects the performance of composites in degrading waste. In pure CNT FT-IR adsorption absorption does not appear so it can be concluded that pure CNT does not contain functional group [8] Functional group is hydrophilic which causes CNT to be easily dispersed in water medium [8].

The XRD patterns of pure CNT and modified CNT is CNT with the addition of surfactant (cocoPAS) and CTAB can be seen from figure 3. Based on the diffraction pattern, the widening peak in figure 3 is an amorphous carbon with a tendency to approach the crystal structure of graphite. Figure 3 shows the XRD patterns of the CNT. The show three mayor peaks $2\theta; 26.0^\circ, 42.9^\circ$ and $53.7^\circ$ corresponding to the graphite planes $(h \, k \, l) = (0 \, 0 \, 2), (1 \, 0 \, 0)$ and $(0 \, 0 \, 4)$, respectively [10].
The reflections obtained indicate the graphene sheet which is a constituent of graphite, while the peak width appears around the angle 2θ; 42.9°, is a reflection of field 100, which indicates the formation of honeycomb from sp² hybridization [11]. The same thing was obtained in pure CNT and CNT added with cocoPAS obtained the same peak with CNT added by CTAB. The peaks in the XRD indicate that the CNT has a good graphite structure. Other peaks that appear are typical peaks of cocoPAS and CTAB [12].

Zeta potential analysis of pure CNT, CNT cocoPAS, CNT CTAB and material that will be composite with TiO₂ of pH can be seen and studied from figure 4. Curve behavior give information about zeta potential which refers to the electrostatic potential of surface ion of colloidal particles. CNT which has been modified with surfactant cocoPAS and CTAB show different curve.

In pure CNT has a low isoelectric point at pH 2. Modification of CNT with the addition of cocoPAS surfactant makes potential zeta value more negative while modification of CNT with CTAB surfactant obtains a positive potential zeta value. Changes of the zeta value of the potential of pure CNT and functional groups on FTIR due to the presence of anionic and cationic loads from surfactants result in a negative and positive CNT charge. Differences of potential zeta values from CNT pure,
CNT cocoPAS and CNT CTAB affect the composite bond with the material to be composite. This is very desirable because for the formation of composites between 1 CNT and composite material (TiO$_2$). Electrostatic interactions between the surface of TiO$_2$ which have a negatively charged zeta positive potential will form a strong composite bond. The greater the electrostatic value, the stronger the composite interaction formed. In this case the CNT modified with the cocoPAS surfactant at pH 3 has the greatest dissociation value thus increasing particle dispersion due to electrostatic forces [13]. Strong composite bonds can support the performance of composites in degrading waste compounds. Electrostatic interactions between the surface of positive TiO$_2$ and negatively charged molecules can help colour absorption [13].

4. Conclusion
We have described a new approach to modification of CNT using surfactant (CTAB dan cocoPAS). Surfactant CTAB dan cocoPAS was applied to overcome the difficulty of CNT dispersing into the matrix of the composite. The characteristics Morphology, FT-IR, Zeta potential, and XRD to show success modification CNT using a surfactant. The surface morphology data suggest that the treatment of cocoPAS and CTAB not effect to structure of CNT. The Characteristics of CNT provide evidence of the potential of these materials for application information of composite.

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