Morphological Characteristics of PANI/GNPs-DBSA Conductive Composite by Oxidative Polymerization of Aniline

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ABSTRACT – This article report will study the new conductive composite as an advanced material in hi-tech novel electronics. Polyaniline/Graphenenanoplatelets-Dedocylbenzene sulfonic acid (PANI/GNPs-DBSA) was synthesized by oxidation polymerization of aniline with APS as oxidant. An optimization utilization of GNPs as nanofiller and DBSA acid as a dopant for an electro-conductive potential application. Independent tests were carried out on the characterization of morphological properties. SEM results show that the particle agglomeration of PANI/GNPs was higher compared to pure PANI. TEM investigation has found that pani diameter becomes 25.82, 36.76 and 42.43 nm after adding 1 wt% of GNPs loading. FESEM analysis with EDX also found that the presence of carbon(c), nitrogen (N), and oxygen(O) with atomic 74.36, 7.48 and 14.74% respectively. This study makes a major contribution to the field of military, medical electronic, mobile devices, smart textile and wireless communication.

1. INTRODUCTION

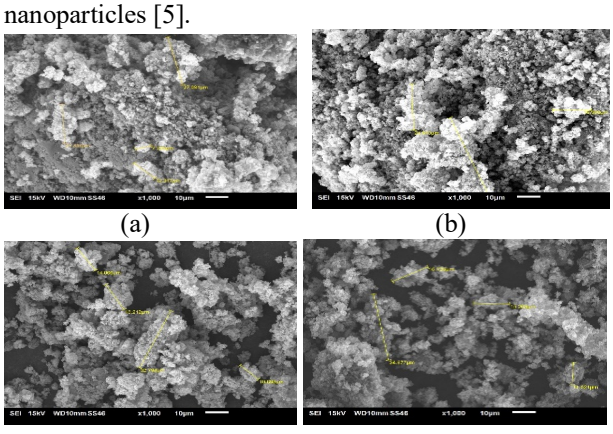
In recent years, there has been increasing interest in polyaniline as a conducting agent due to the ability to transfer electron combined with their rich chemistry, low cost, renewable and easy synthesis as a previous study suggests [1-2]. Much research has consistently shown that GNPs nanofiller has incorporated with this advanced material matrix to exploit the performance [3-4]. Electrical conductivity enhances with the increasing amount of GNPs loading [5]. Other researchers are also having a serious effect on DBSA acid as a dopant in enhancing electro-conductivity [6-7]. The primary purpose of this study is to comprehend the relationship between morphological characteristics against electrical conductivity by modifying the PANI structure.

2. METHODOLOGY

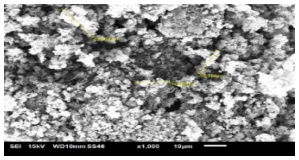
Aniline chloride(AN), and Ammonium persulphate (APS) were cooled before adding 2.0 mmol of DBSA acid and GNPs using a magnetic stirrer at room temperature. The GNPs loading was used is 0.25wt%, 0.5wt%, 0.75wt% and 1.0wt% with the weight of 0.12, 0.24, 0.37 and 0.5g respectively. The solution was then washed consecutively with 300ml of 0.2MHCl and 300ml acetone to an extent where dark green solid material would be obtain. Lastly, the solid particles were dry in a vacuum oven and ground to get fine powders. The morphology characteristics were determined by Scanning Electron Microscopy(SEM), Transmission Electron Microscopy(TEM) and Field Emission Scanning Electron Microscopy(FESEM) with EDX. The SEM was measured at 15 kV using a ZEISS machine. The TEM was recorded by Talos L 120 from Thermofisher. The FESEM test with EDX was carried out by JSM-7600F from JEOL.

3. RESULT AND DISCUSSION

The SEM images(Fig. 1) represented the layered staking of PANI and PANI/GNPs under 1000x magnification. Aniline monomer would be absorbed on the surface of PANI as the polymerization reaction process occurs [8]. The particle size of PANI/GNPs-DBSA(Fig. 1b-1e) was larger compare to pure PANI(Fig. 1a). The matrix structure presence of GNPs acting as binders in the nanocomposites as a previous study[9]. The electrical conductive path is formed through the connection of network structure in nanoparticles [5].



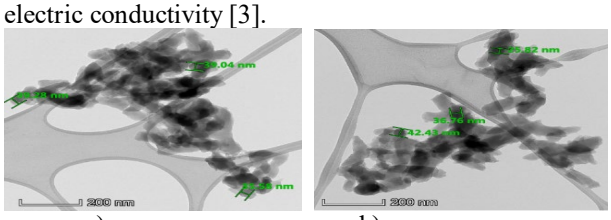
(a) (b)



(e)

Figure 1 SEM image of (a) PANI-DBSA, (b) PANI/GNPs-DBSA 0.25wt%, (c) PANI/GNPs-DBSA 0.50wt%, (d) PANI/GNPs-DBSA 0.75wt% and (d)PANI/GNPs-DBSA 1wt% of GNPs loading

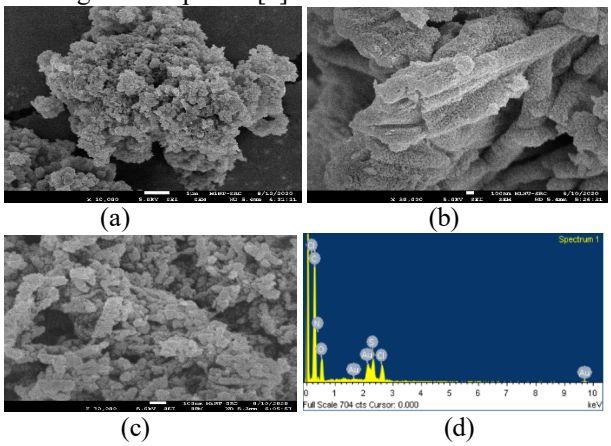
TEM testing has been used to see nanocomposite structure between PANI/GNPs-DBSA. Fibrillar structure morphologies had fascinating looks due to the length-diameter ratio(Fig. 2a). The size of the nanofiber depends on its bond, whereby the average diameter of PANI-DBSA is 39.04, 39.28 and 35.58nm. After adding 1wt% of GNPs loading, morphological structure change with the average diameter of PANI/GNPs-DBSA 25.82, 36.76 and 42.43nm. This result demonstrates higher crystallinity PANI/GNPs than pure PANI due to van de waals interaction forming a matrix structure[10]. Fig. 2(b) shows GNPs well dispersed in the PANI matrix due to absorption on the surface [11]. This extended chain length aids in carrying charge and produce better electric conductivity [3].



a) b)

Figure 2 TEM image of (a) PANI-DBSA without GNPs as nanofiller, (b) PANI/GNPs-DBSA with 1wt% GNPs loading

In order to provide appropriate an appropriate interpretation of morphological structure, a FESEM test with EDX was conducted. In fig. 3(b), fussy fiber shows that there is an interconnected between PANI and GNPs[12]. Fig. 3(c) shows, that the PANI surface was coated by nanofiller and form a arge aggregate[13]. EDX is functioning to reveal elements such as Carbon(C), Nitrogen(N), Oxygen(O) with atomic 74.36, 7.48 and 14.74% respectively. There was a significant positive correlation with Danyun Lei et al.[14]. This special function of nanofiller was homogeneous in forming microcapacitor[7].



(a) (b)

(c) (d)

Figure 3 FESEM image of (a) PANI-DBSA without GNPs as nanofiller, (b) PANI/GNPs-DBSA with 0.25wt% GNPs loading, (c) PANI/GNPs-DBSA with 1wt % GNPs loading and (d) EDX spectrum of PANI/GNPs-DBSA with 1 wt% GNPs loading

4. CONCLUSIONS

In summary, the use of GNPs in the polymerization reaction has changed the morphological characteristics compared to pure PANI. The PANI surface coated by nanofiller acts as a binder and forms a large aggregate. The dispersion of nanoparticles has extended the chain length and provided a continuously interconnect structure. It gives homogeneous properties in producing a electrical conductivity. This approach will offer a valuable and promising tool for producing a high performance for supercapacitor electrodes.

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