Transparent Conducting Film for Flat Panel Display using CNT by Electrospinning

Jin- san Moon[1] , Jae-Hong Park[1] , Jae-Hee Han[1], Alexander. S. Berdinsky[1,3]
Jae-Do Nam[2] , Dae-Hoi Lee[2] , Ji-Beom Yoo[1*]
[1]Center for Nanotubes and Nanostructured Composites, Sungkyunkwan University, Korea;
[2]School of applied chemical engineering, Sungkyunkwan University, Korea
[3]Novosibirsk State Technical University, Russia
Phone : +82-31-290-7413 , E-mail : jbyoo@skku.edu

Abstract

We report the preparation and properties of polymer paste solutions with CNTs using conventional paste forming process. Electrospinning has been used for the fabrication of nano-fiber composite. In this process, dispersion of CNTs is very important matter. So, we emphasize the necessity of dispersion of CNTs in the solution and investigate effects of process parameters of electrospinning. The advantage of simple electrospinning process will be discussed..

1. Introduction

Carbon nanotubes(CNTs) are one of the most interesting materials in a few years. Their unique mechanical and electrical properties have inspired engineers for a range of variety applications. Because of electrical properties CNTs, such as high electrical conductivity, electromagnetic interference (EMI) and conducting electrodes.[1,2]

So, we try to investigate an application field of conducting film by electrospinning. Electrospinning has been regarded as an efficient method for the fabrication of nano-fiber composite. It is unique as a spinning process because it can generate polymer fibers ranging from 50 to 500 nm diameters.[3-4] Also, various polymers have been successfully electrospun in each suitable solvent and large area. Therefore, we combine the outstanding property of CNTs with electospinning process.

But, before the electrospinning , first of all, dispersion of CNTs in polymer solutions is very important. If CNTs dispersion into the solution doesn't go well, CNTs agglomerate each other in electrospun fiber. We emphasis the importance of CNTs dispersion in polymer solution before electrospinning process. The final aim in this study is to obtain conductive and transparent thin film.

2. Experimental

2-1. Dispersion of CNTs

We used CVD multi-walled CNTs from Iljin Nanotech Co., Ltd. TEM micrograph of CNTs is shown in Fig 1. Zeta potential of the MWNTs in dilute aqueous solution with different surfactants (Gum Arabic and SDS) and terpineol suspensions (0.001wt%) was measured. All of the solutions were ultrasonicated for 30 min before the measurements.

Figure 1. TEM micrograph of CNTs

2-2. Electrospinning

For the electrospinning of CNTs fibers, CNTs was dissolved in a mixed solvent of Ethyl Cellulose(EC) and N,N-dimethyl acetamide (DMA) and terpineol. DMA is contained a small portion in the terpineol. The EC concentration ranged from 8 to 20 wt%. For electrospinning, polymer solution with dispersed MWNTs (3~5wt%) was put into the syringe. In electrospinning process two electrodes were used. One electrode was placed into the solution and the other onto the collector. Ejected fibers from the sharp needle appear due to high voltage of the collection screen. Device for electrospinning is shown in Fig 2. The distance between the needle and the collecting electrode ranged from 10 cm to 20 cm. Applied voltage is 10~20kV. Flow rate of solution ranged from 1.3 ml to 3 ml. The morphology of electrospun fiber can be changed by applied voltage and distance between two electrodes.

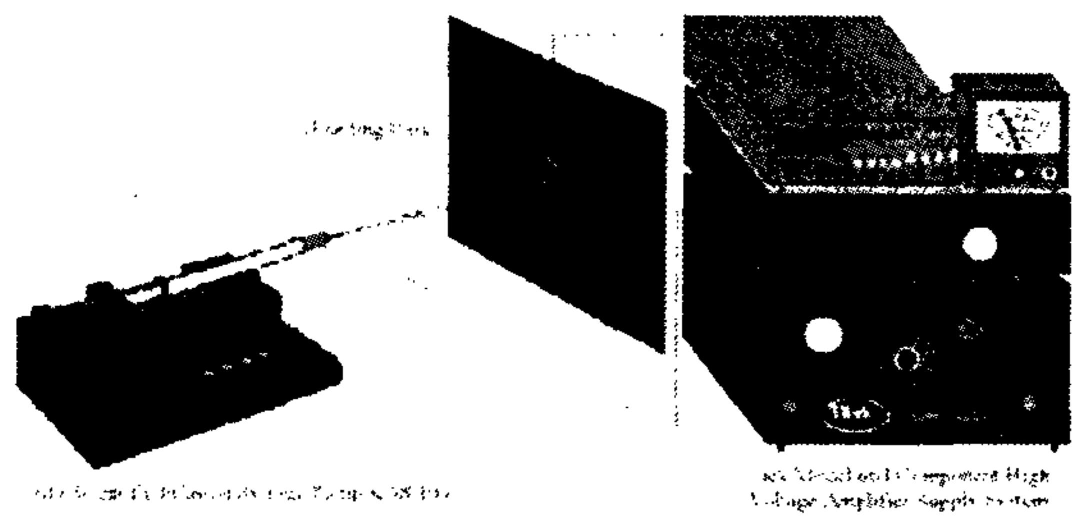

Figure 2. Diagram of electrospinning apparatus

3. Results and discussion

2-1. Dispersion of CNTs

Zeta potentials of the CNTs dispersion as a function of pH without any surfactant and with SDS and Gum Arabic are given Figure. 3.

Preliminary, we controlled Ph value of pristine MWNT in DI water. According to pH change, zeta potential severely varies. Zeta potential fixs the boundary between negative and positive at the pH 7. (Figure 3)

Next, we measured zeta potential of in aqueous solution with different surfactant. Solution of Gum Arabic is lower zeta potential than SDS suspension. It is evident that the Gum Arabic is more stable than SDS. Maximum zeta potential is −38mV and 45mV, respectively.

Zeta potential with different Gum-Arabic concentration is shown in Figure 4. Zeta potential continually decrease until at the 0.001wt% of Gum-Arabic. But, zeta value gets worse over 0.001wt%. Consequently, the concentration of surfactant has a great infullence in dispersion of solution till 0.001wt%. However, an increase in quantity of surfactant has a bad influence.

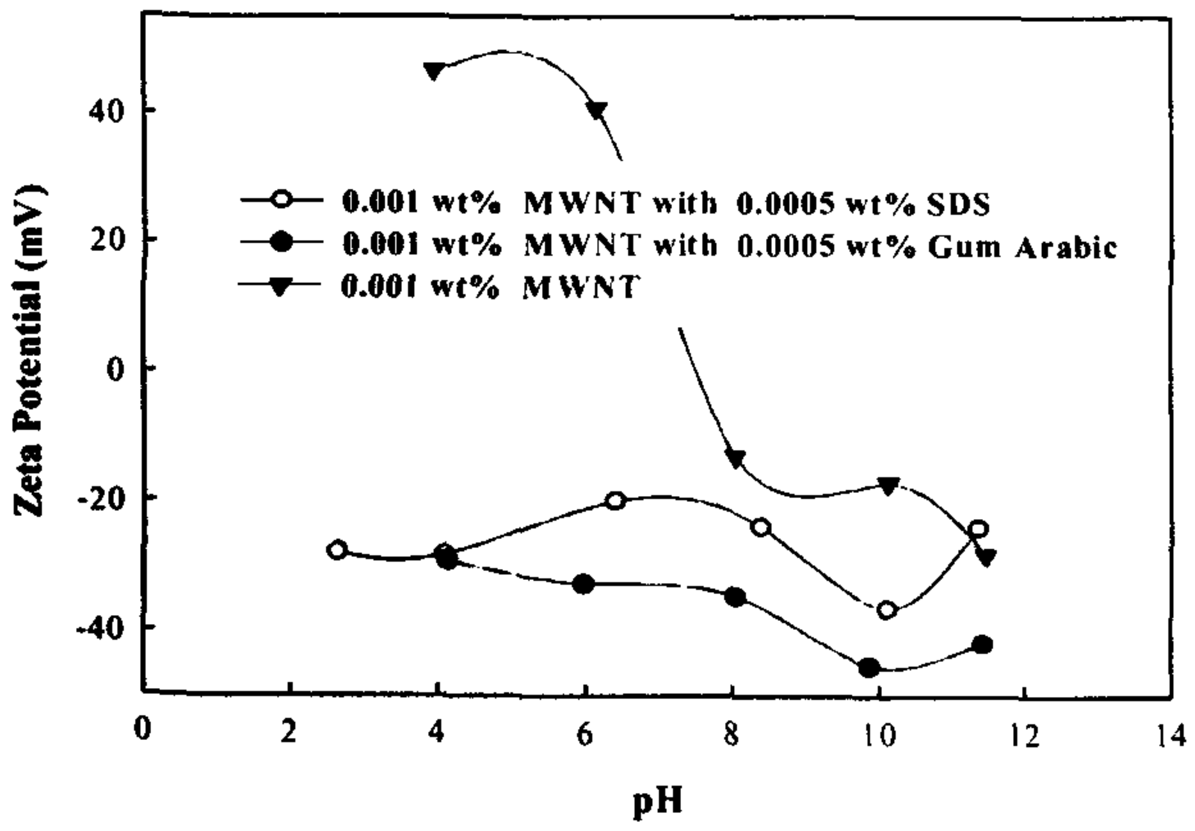

Figure 3. Zeta potential of MWNTs in aqueous solution with different surfactants

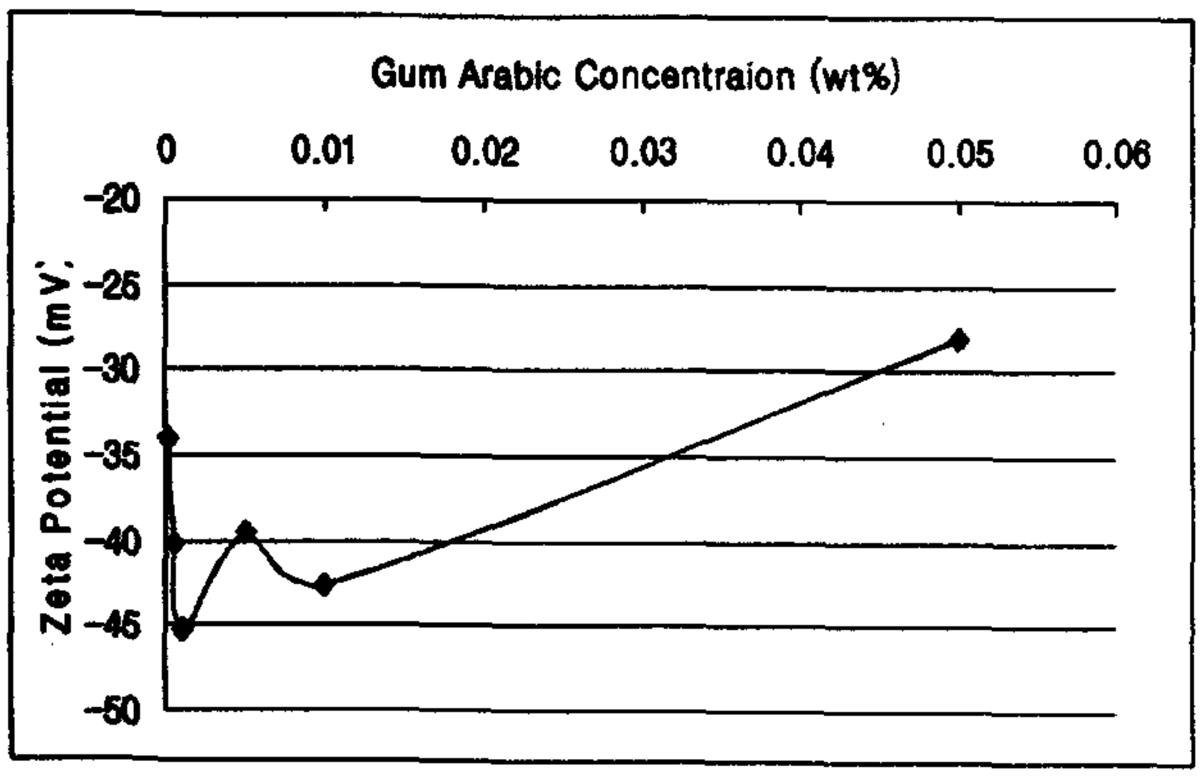

Figure 4. Zeta potential of MWNTs in aqueous solution with different Gum Arabic concentration

2-2. Electrospinning.

Solutions of EC were made with individual solvents of acetone, DMA and terpineol. When DMA and terpineol solution was used, very big beads are found around wide domains. The cause of beads will be various. Polymer concentration into the solution affects the fornation of the beads. Fong recognized that higher polymer concentration resulted in fewer beads. And Doshi and Reneker [5] pointed out that by reducing surface tension of a polymer solution, fiber could be obtained without beads. Perhaps, inthis case due to the higher surface tension of terpineol, many beads would have broken. But, if space between two electrodes increase from 5 cm to 10 cm, size and amounts of beads decreased.(Figure. 5). Figure 6 show that D-band and G-band of CNTs find out 1354cm^{-1} and 1576cm^{-1},respectively. We noticed that CNTs were included in the fiber.

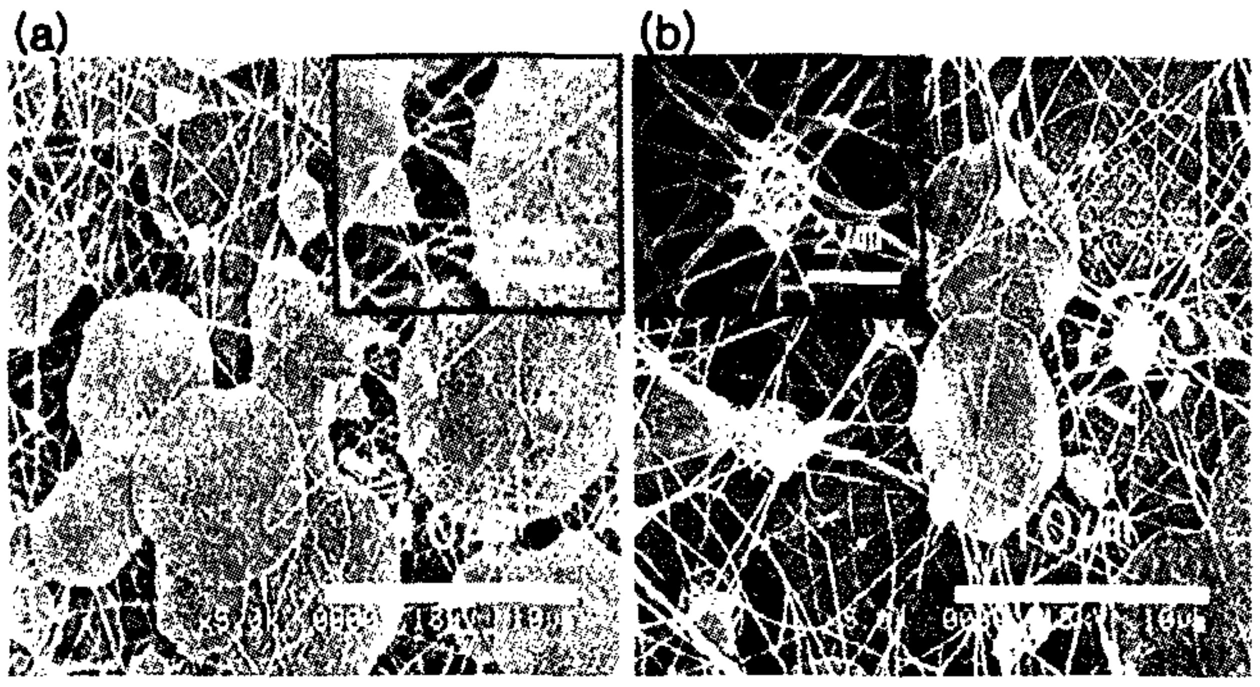

Figure. 5. SEM micrographs of the electrosun fiber. (10kV)

EC and MWNTs are contained in the solvent of DMA and terpineol. Distance between electrodes (a) 5 cm ,(b) 10 cm

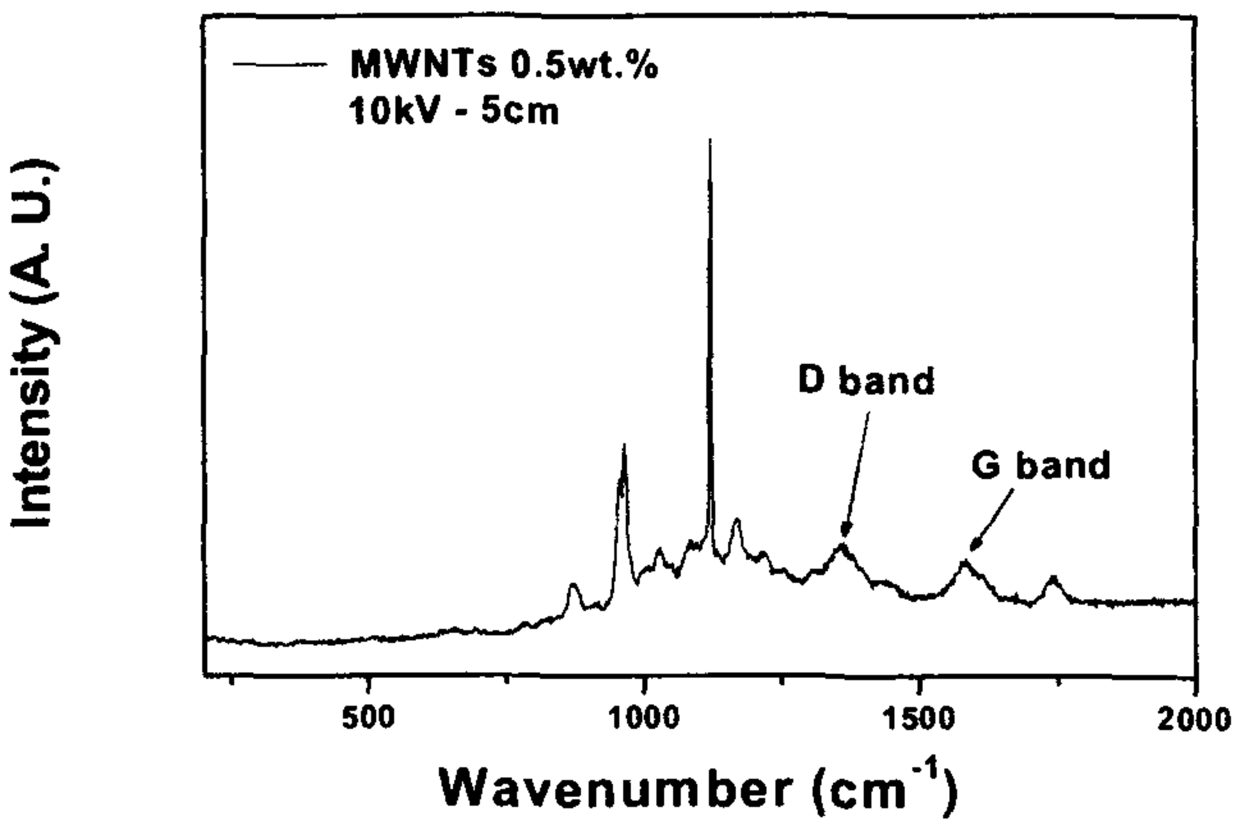

Figure 6. Zeta potential of MWNTs in aqueous solution with different surfactants

Figure 7. show out of use of terpineol. The change of morphology in comparison with Figure 5 was clearly distinguished. In propotion as electrode's distance increase decrease a diameter of fiber and beads become larger. When the

applied voltage is constant, the electrostatic force will be decrease as distance increase. As a result, stress on the jet decreases and size of bead increase.

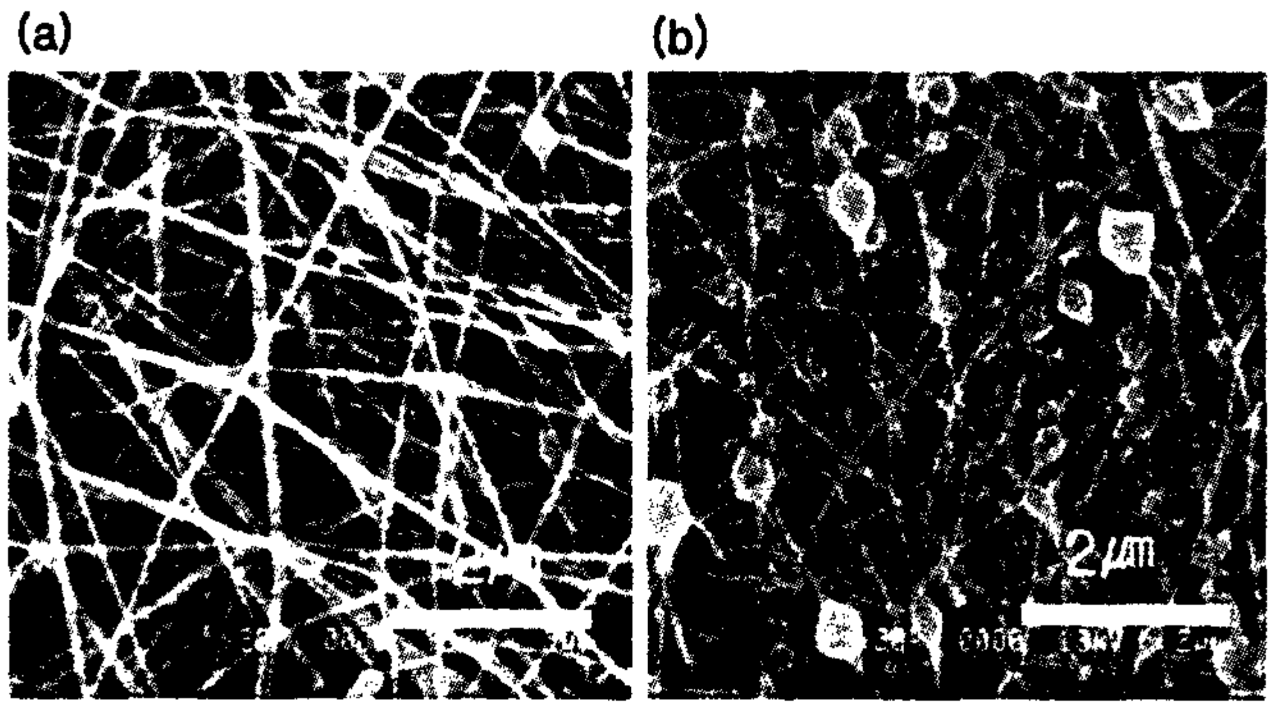

Figure. 7. SEMs of electrospun EC. (only use DMA and acetone, 10kV) Distance between electrodes (a) 10 cm, (b) 30 cm

4. Conclusion

Dispersion of CNTs is important thing for effective electrospinning. Zeta potential with and without surfactant in aqueous solution is measured. Zeta potential of dispersed solution with pH control abruptly change through a wide range. Gum Arabic is a little more stable than SDS solution and both of two solutions extremely have a value at pH 10. Zeta potential continually decreases until at the 0.001wt% with different concentration of surfactant but increase over the 0.001wt%.

First, we can find out CNTs into the electrospun fiber. However, because of concentration of polymer solution, distance between the two electrodes, CNTs dispersion of solution, wide beads appeared onto the fiber.

So, we will try to use a dispersed aqueous solution by electrospinning, other conducting polymer for making a conducting film.

5. References

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