MANUFACTURING AND CHARACTERISTICS ANALYSIS OF PU/MWNT FILM FOR ELECTROSTATIC DISSIPATION

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Introduction

This study surveys the characteristics of the nanocomposite film for PU/MWNT with electrostatic dissipation (ESD) functions by dispersing multi-wall carbon nanotubes (MWNT)[1] in dimethylformamide (DMF) and combining it with polyurethane. MWNT types were selected by 4 types and the MWNT containment, which is a condition of dispersion, was divided into 4 kinds (0.5, 1, 2, 5wt%), and dispersion time was set to 2 periods (30 minutes, 120 minutes) to manufacture PU/MWNT film. The dispersion property of PU/MWNT film was measured with a UV-Vis spectrometer, and the mechanical property of film was measured with Instron. In addition, electrical conductivity of PU/MWNT film was measured using a conductivity measurer and their characteristics according to manufacturing conditions were comparatively analysed.

Experimental

Materials

4 types of MWNT made from 3 Korean companies were used. Table 1 shows the MWNT characteristics. DMF was used as MWNT dispersion solvent and polyurethane (PU, No. 972DF, 1 liquid type, Cytec. Industries Inc.) was used as the high molecule matrix for PU/MWNT film manufacture.

Table 1 Characteristics of MWNT

	Dia.(nm)	Length(μm)	Purity(%)	Remark
S1	5~15	~10	90	A company
S2	5~15	~10	>95	B company
S3	10~15	10~20	95	C company
S4	10~15	~200	95	C company

Manufacturing of PU/MWNT film

Table 2 shows the dispersion conditions for manufacturing PU/MWNT film. DMF was used as a dispersion solvent, and the 4 types of MWNT content shown in Table 1 were chosen as 0.5, 1, 2, and 5wt%. Dispersion time was 30 minutes and 120 minutes respectively, and the ultrasonic dispersion device (Sonics & Materials Inc., USA) was used to manufacture dispersion solution. MWNT dispersion solution was mixed with polyurethane by 1:9 ratio of the weight of polyurethane to produce the PU/MWNT film and mixed for 1 hour at room temperature with a mixing speed of 350 rpm. Then the film maker, Baker Applicator (YBA-4 type) was used to make the film with PU/MWNT paste and then dried for 60 seconds at 150℃

Table 2 Dispersion condition of MWNT

MWNT wt(%)	Dispersion time
0.5	
1	30 min.
2	120min.
5	

Measurement of the characteristics of the PU/MWNT film

Table 3 shows analysis method of PU/MWNT film characteristics.

Table 3 Measured characteristics of PU/MWNT film

Measuring item	Measuring device
Dispersion property	UV-Vis spectrometer
Tensile property	Testrometric MICRO 350
Volume resistance	KEITHLEY 8009
Surface of film	SV-550 (SOMETECH)

Results and Discussion

Reflection rate of the PU/MWNT films

Fig. 1 shows the reflection rate of the films treated with dispersion time 30 minutes, MWNT content 1wt% with various MWNT types.

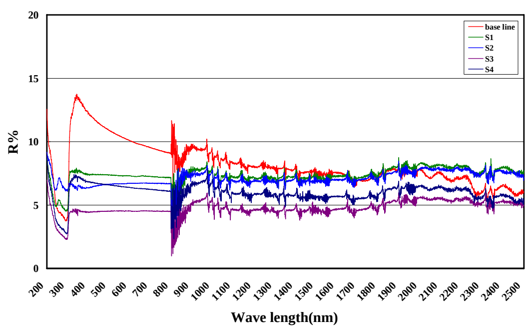

Fig. 1 Reflection rate of the PU/MWNT film according to the MWNT types.
(dispersion time 30min., contents of MWNT 1wt%)

It shows that the reflection rate of the film mixed with carbon nanotube has a low value comparing with non dispersed PU film. The reflection rate of film according to MWNT content was shown around 6-7% for samples S1, S2 and S4, and was shown as 4% for sample S3, which was comparatively lower than those of the MWNT dispersion films. It can be predicted that MWNT dispersion is spread out on film when the reflection rate is lower. This can be confirmed by eye observation, too.

Fig. 2 shows tensile property of PU/MWNT film. It is shown that the tendencies of the Young's modulus and tenacity according to the dispersion conditions are not apparent, but for sample S3, the difference according to MWNT weight is lower than those of other samples, which shows that dispersion is stable.

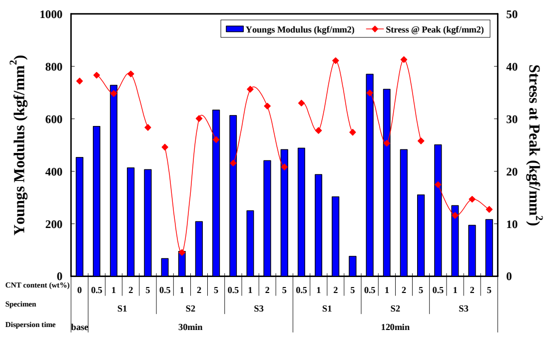

Fig. 2 Tensile properties of the PU/MWNT film according to the dispersion condition.

Conductivity of the PU/MWNT films

Fig. 3 shows the resistance value of film that was dispersed for 120 minutes according to MWNT content. According to MWNT content, it can be seen that sample S3 has a low resistance value of less than 10^7ohm·cm compared to samples S1 and S2. It can be concluded that sample S3 has greater conductivity since conductivity value is higher when resistance value is low.

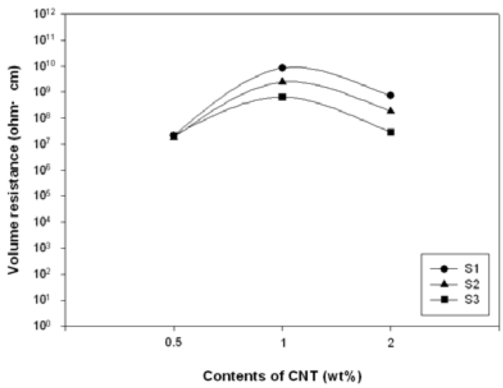

Fig. 3 Resistance values of the PU/MWNT film according to the dispersion condition.

The surface observation of the PU/MWNT films

Fig. 4 shows a photograph of the PU/MWNT film surface. The photograph shows that the cohesion part of sample S3 is less than other films and dispersion is better, and this is apparently shown through eye observation. The dispersion of PU/MWNT film according to dispersion time is not shown and it is shown that the more the MWNT content the less dispersion of MWNT which makes CNT more cohesive and tangled together. This is because the van der waals combination power of carbon nanotube molecules makes nanotubes tangle, not disperse[2].

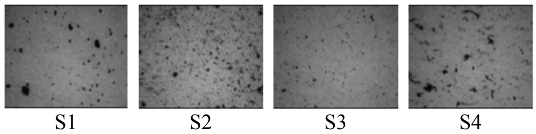

Fig. 4 Photograph of surface of the PU/MWNT film. (dispersion time 120min., contents of MWNT 1wt%)

Conclusion

The various PU/MWNT films with different dispersion conditions to develop electrostatic dissipation film with conductivity were made and a comparative analysis made the following results. Dispersion was better when MWNT content was low. Sample S3 mostly had a low reflection rate in most dispersion conditions. PU/MWNT film did not show any tendency of the tensile property according to different dispersion conditions. The higher the MWNT content was, the lower resistance was, which makes low electrical conductivity. For film that was treated with a dispersion time of 120 minutes, sample S3 had lower resistance value than samples S1 and S2 as 10^7ohm·cm or under. As a result of photographing of the surface of PU/MWNT film according to MWNT type, sample S3 had less cohesive areas of carbon nanotube, and had better dispersion. As a result of analyzing carbon nanotube characteristics according to dispersion conditions, S3 showed best dispersion and conductivity.

Acknowledgements

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