Dispersion technology for CNTs with nano pre-mixer

T. Takatsuka, Y. Iida

THINKY USA, takatsuka@thinky.co.jp

ABSTRACT

Carbon nanotubes (CNTs) and other strongly aggregated materials by van der Waals force exhibit excellent material properties even with fewer amounts when they are sufficiently deagglomerated and dispersed. The operating principle of the nano pre-mixer, PR-1 (THINKY, Japan), is to irradiate ultrasonic simultaneously from two directions, side and bottom, to disperse the CNTs while rotating the enclosed container at high speed. Using PR-1, a test was conducted to disperse single-wall carbon nanotubes (SG101) to primary fiber. In order to specify the optimum operating conditions for different material volumes when dispersing CNTs, the rotation speed and processing time against the volume were examined and evaluated with the resistivity meter Loresta-GP, CPS Disc Centrifuge DSC 24000 UHR, and LUMiSizer.

As a result, the optimum rotation speed for each volume (10 ml: 500 rpm, 50 ml: 150 rpm, 280 ml: 80 rpm), and the optimum processing time of 4 hr, storage stability of 2 hr were specified.

Nano pre-mixer, PR-1

Keywords: carbon nanotube, ultrasonic, dispersion

1 MATERIALS AND METHODS

Manufacturing instruments: The nano pre-mixer PR-1 (Thinky Co. Ltd., Tokyo, Japan) was used to disperse CNTs.

Materials: Multi-wall carbon nanotube, Flotube 9000 of CNano Co., Ltd. Single-wall carbon nanotube, ZEONANO^{TM}SG101 of Zeon Nano Technology Co., Ltd. (Tokyo, Japan). Sodium deoxycholtae of Tokyo Chemical Industry Co., Ltd. (Tokyo, Japan). 10 ml, 50 ml, and 280 ml container of Maruemu Co., Ltd. (Osaka, Japan).

Measurement of resistivity: The CNT dispersing conditions, such as rotation speed and material volumes were studied in order to determine the optimal conditions using Flotube 9000. CNTs and toluene of each volume were tested at 80, 150, 200, 300, 400, and 600 rpm, respectively. After dispersing CNTs, ethyl cellulose was added to make a CNT sheet. The volume resistivity of the CNT sheet was measured with a 4-terminal probe.

Measurement of dispersibility and storage stability: Five ml of 1 mmol sodium deoxycholtae dispersing agent was added to 5 mg of SG101, and the final concentration of 1 mg/ml was prepared. The test was conducted under ultrasonic output of 70 W x 2, 40 kHz and the rotation speed at 500 rpm for 1, 2 and 4hr.

2 RESULT

From the results of volume resistivity, we found that there is an optimum rotation speed for each container. They were 500 rpm for 10 ml, 150 rpm for 50 ml, and 80 rpm for 280ml container. (Fig.1).

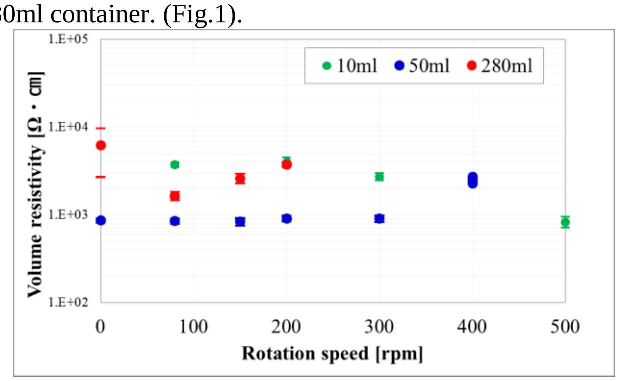

Figure 1: Volume resistivity of dispersed CNT

Morphological observation of CNTs (SG101) after dispersion was performed by SEM (Fig.2). Agglomerated CNTs are dispersed with the passage of time due to dispersion treatment by PR-1, and from the results of CPS, we found that it was dispersed to about 9.2 nm after 4 hr of treatment (Fig.3). Dispersions of 1, 2 and 4 hr were also performed, and the storage stability was evaluated by accelerated test using a centrifugal sedimentation, LUMiSizer (Fig.4). The result revealed that the sample of 2 hr dispersion treatment had the best storage stability.

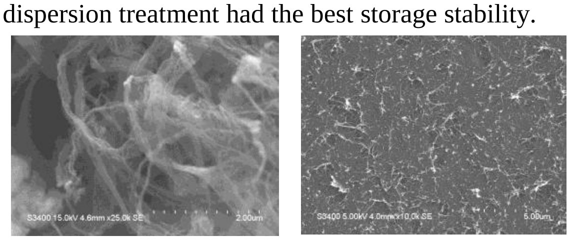

Figure 2: SEM images of CNT (Left: original Right: dispersed)

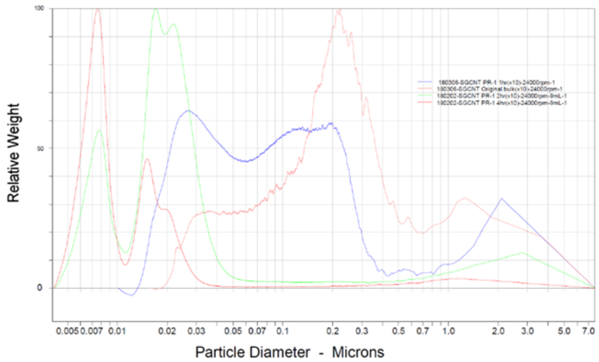

Figure 3: Particle size of dispersed CNT (CPS)

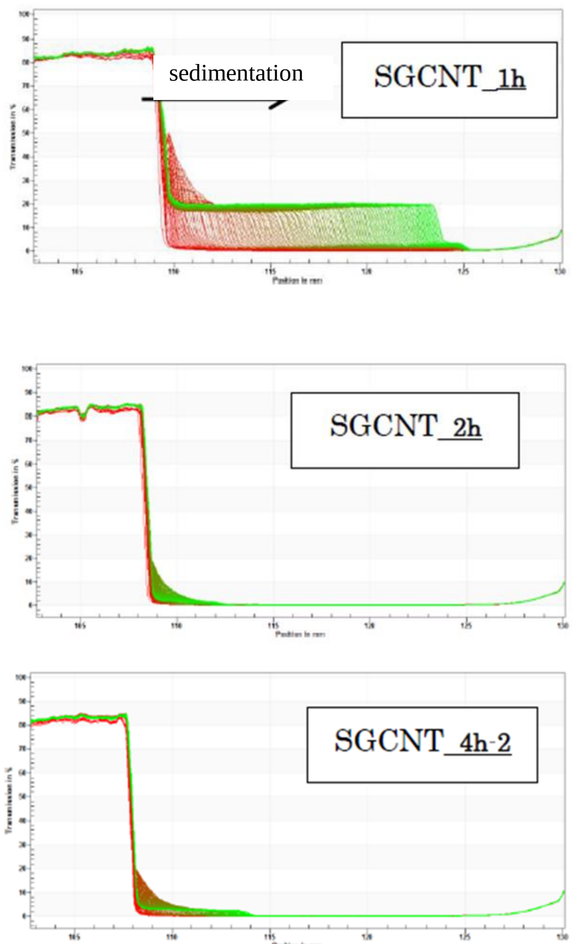

Figure 4: Storage stability test (Lumisizer)

3 CONCLUSION

PR-1 disperses with the optimum rotation speed according to the size of containers (volume of materials) and a CNT sheet of low resistivity is able to be prepared. When the processing time is long, CNTs are dispersed more; however, when it is overdispersed, the storage stability deteriorates.

Therefore, it is critical for CNT dispersion to adjust the rotation speed and processing time to obtain an optimal result.