HORIBA Scientific

Application Note

Evaluation of Carbon Nanotube Dispersions

AN232

Evaluation of Diameter (Thickness) and Aggregation/ Dissociation State of Carbon Nanotube Dispersions

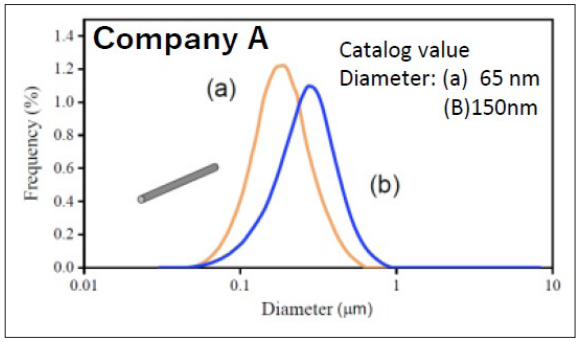
Introduction

Carbon nanotubes (CNTs) are thin, light, and flexible string-like materials with a minimum diameter of less than 1 nm that are composed entirely of carbon atoms. Because of their high electrical conductivity, thermal conductivity, and heat resistance, CNTs are being developed for a variety of applications as next-generation materials. On the other hand, CNTs easily aggregate, so it is essential to understand and control the state of aggregation in order to achieve the expected performance.

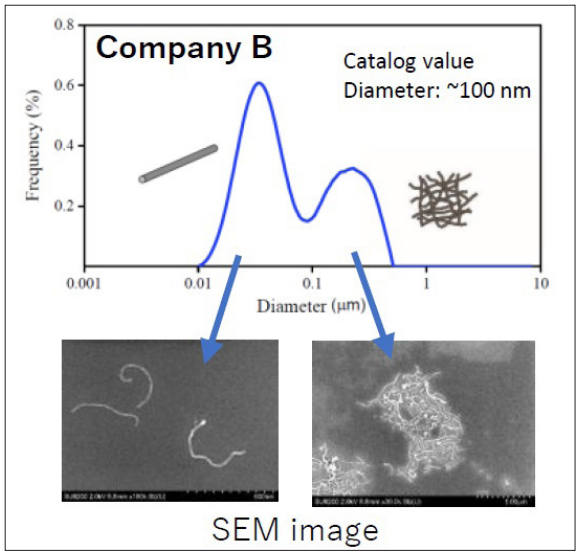
For this purpose, an analytical method that can quickly evaluate wide particle size distributions (PSD) from isolated dispersion to aggregation, with high resolution, is necessary. CNTs from 3 companies and 4 kinds of CNTs, whose diameter and length in the isolated dispersed state are shown as catalog values, were measured with the centrifugal nanoparticle analyzer Partica CENTRIFUGE.

Measurement Condition

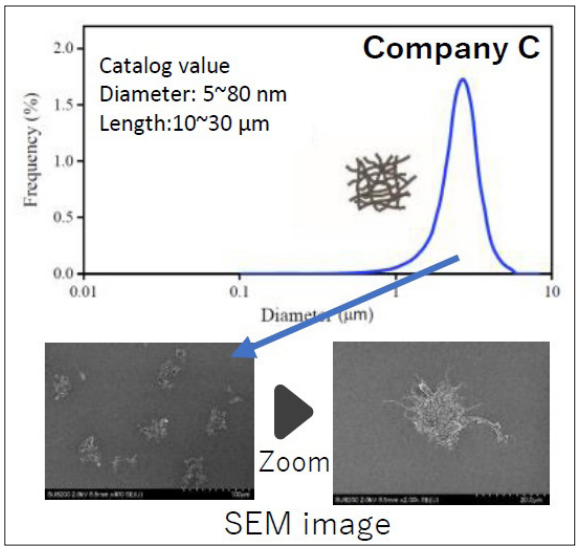
Sample	CNT (Density: 1800 kg/m^3, RI: 1.84-0.00i) Concentration: 0.02~0.2wt%
Dispersant	Water (Density: 996 kg/m^3, RI: 1.333)
Method	Line start • 8-24% sucrose density gradient solution • Sample volume: 50 µL
PSD Basis	Volume
Calculation Setting	Custom, Smoothing: 4, Turbulence correction: OFF, Kamac: ON



Both types of CNTs made by Company A were found to be isolated and dispersed and the CNTs with different diameters had different particle size distributions. The measured particle size also depends on the length of the CNTs, which indicates that the difference in diameter of the isolated CNTs can be analyzed.



The measurement of CNTs made by Company B resulted in a two peak particle size distribution. A and SEM observation showed both isolated and aggregated CNTs. It suggests that the particle size distribution represented each component.



As a result of measuring CNTs made by Company C, only the particle size distribution that seems to be derived from aggregated CNTs was obtained, and SEM observation showed that there were almost no isolated CNTs, but only aggregated CNTs. The particle size distribution shows the state of the CNTs.

Conclusion

Partica CENTRIFUGE can distinguish the difference in diameter of isolated CNTs in dispersions and the state of aggregation/disintegration, contributing to the performance evaluation and quality control of CNT dispersions.

*This measurement was performed at the HORIBA-AIST Collaborative Research Laboratory.