HORIBA Scientific

partica CENTRIFUGE

Applications Data Sheet

Carbon Nanotube
ADS166

Particle Size Analysis of Carbon Nanotube with Porosity Correction

Outline

Carbon nanotubes (CNT) are attracting attention and being utilized as cutting-edge materials, including battery materials, due to their lightness, strength, and current density resistance. Various applications have been developed based on these characteristics. They are known to have very high electrical conductivity, thermal conductivity and heat resistance. Usually, electrical conductivity and thermal conductivity of a material can be improved by mixing CNT into it. Examples of such materials are resin, rubber, ink, paint, and others. Material strength can also be increased with the addition of CNT. As can be seen from Fig. 1, CNT are agglomerated and exist in a bundled/clustered form. This form has a very high porosity.

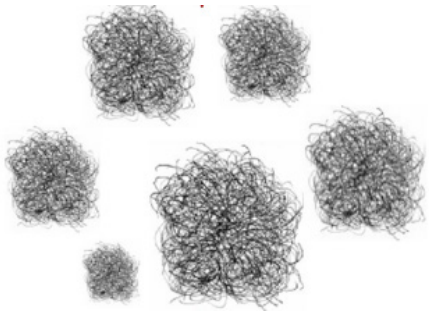

Fig. 1 Image of CNT
Source: K. Kobayashi et al., "Controlling the structure of arborescent carbon nanotube networks for advanced rubber composites", Composites Science and Technology 163 (2018) P12, Fig.1

Method

Apparatus: HORIBA Partica CENTRIFUGE
Measurement mode: Line-start
Samples: CNT/1% sodium deoxycholate aqueous solution
Particle: CNT (Solid concentration: 0.01%, Refractive index: 1.500, Density: 1,780 kg/m³)
Medium: 2-6% sucrose density gradient solution (Average Refractive index: 1.336, Average density: 1,007 kg/m³)
PSD: Volume-based
Calculation setting: Custom mode
Extinction coefficient correction: ON
Porosity correlation: ON

Results

Fig. 2 shows the result of the CNT dispersion measured by a laser scattering diffraction analyzer, Partica LA-960V2. It has a volume-based PSD with a mode diameter of 0.06 µm. Fig. 3 shows the result of the same sample measured by Partica CENTRIFUGE with centrifugal sedimentation method. The purple line in Fig. 3 has a mode size of 0.009 µm. When recalculated with porosity correction, the PSD (blue line) shifted to the right with a mode diameter of 0.06 µm at a porosity of 98.5%. This result after porosity correction is equivalent to the result measured by the laser scattering diffraction method.

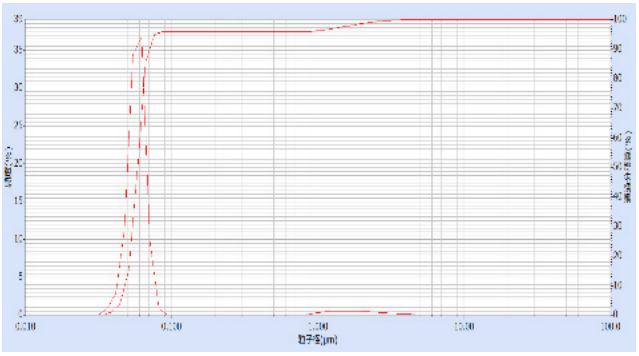

Fig. 2 Volume-based PSD by LD

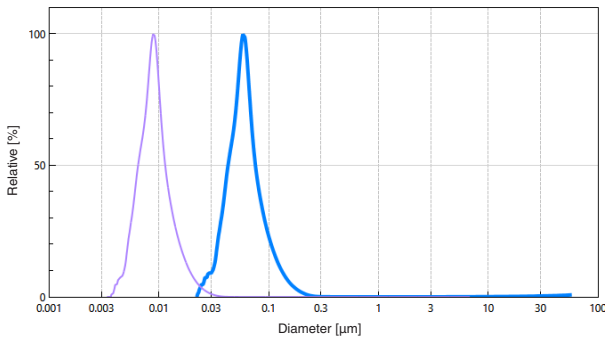

Fig. 3 Volume-based PSD

Conclusion

For the measurement of entangled rod-like or fibrous particles such as CNT, if pores are not accounted for, it will result in a much smaller size distribution. The measurement accuracy can be improved by considering the porosity factor by assuming the pores are filled with the solvent. In addition, if the crushed particles (fine fraction) are desired, operating in QC mode is recommended.