HORIBA Scientific

partica CENTRIFUGE

Applications Data Sheet

Cellulose Nanofiber
ADS156

Particle Sizing of Cellulose Nanofiber

Outline

Nanocellulose is a fibrous substance derived from wood and is attracting attention as a cutting-edge material. Cellulose nanofibers (CNF) manufactured by TEMPO oxidation are cellulose fibers that have added carboxy groups at high density. This type of CNF is made with high efficiency and is characterized by a very thin and uniform fiber width of about 3 nm. It is useful as food additives, biodegradable food packaging, pigments, selective delivery/separation, cell engineering, nanocomposites, and other medical and pharmaceutical products. To utilize nanocellulose, it is important to understand the fiber diameter and dispersion state. To do so, it is necessary to have an analytical method that can quickly evaluate a wide ranges of particle size distribution, from well-dispersed particles to agglomerates at high resolution.

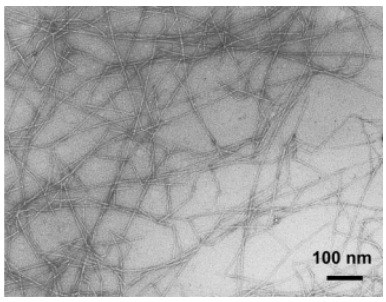

Fig. 1 TEM image of CNF
Source: Saito et al., Biomacromolecules, Volume 8(8), page 2489 (2007), Figure 8

Method

Apparatus: HORIBA Partica CENTRIFUGE
Measurement mode: Homogeneous
Samples: CNF dispersion (RHEOCLYSTA™ I-2SX, Standard grade
Particle: TEMPO type CNF (Solid concentration: 2%, Refractive index: 1.840, Density: 1,500 kg/m³)
Medium: De-ionized water (Refractive index: 1.333, Viscosity: 0.797 mPa·s, Density: 996 kg/m³)
Particle size distribution (PSD) base: Volume based
Calculation setting: Custom mode
Extinction coefficient correction: OFF/ON
Smoothing: 4

Results

The purple line in Fig. 2 shows the volume-based PSD measured by Partica CENTRIFUGE, calculated without extinction coefficient correction. It has a median diameter of 151.1 nm and a mean diameter of 156.8 nm, resulted from agglomerated particles. The blue line shows another volume-based PSD calculated with extinction coefficient correction. It has a median diameter of 4.6 nm and a mean diameter is 5.0 nm, resulted from individual dispersed particles.

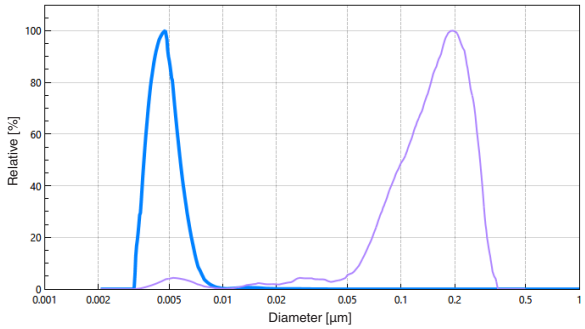

Fig. 2 Volume-based PSD

Conclusion

We believe that the CNF dispersion state is affected by fiber width, not fiber length. In addition, since the measurement result of un-agglomerated CNF is less than the lower detection limit specified by ISO 13318-2_2007, care must be taken when handling the particle size result. In other words, it is believed that such small particles cannot be calculated using the classical Stokes equation because they are significantly affected by Brown diffusion. However, based on this measurement result, it is possible to measure dispersed ones together with the liquid dispersant at the same time. It is possible to improve quantitation by extinction coefficient correction. Thus, this method can be used for evaluation of the dispersion state of CNF.

*RHEOCRYSTA is a trademark and brand of DAI-ICHI KOGYO SEIYAKU CO., LTD.