SHIMADZU

Application News

Nano Particle Size Analyzer: SALD-7101 No. 7

Measurement of Needle-Shaped, Fiber-Shaped and Tubular Particles

Particle size distribution is normally expressed as particle amount (cumulative or differential) corresponding to a particle diameter scale. Using the Nanoparticle Size Analyzer SALD-7101 measurement principle “laser diffraction method”, particle size distribution is calculated based on the light intensity distribution pattern of the diffracted and scattered light, assuming that the particles are spherical in shape. Therefore, when using the SALD-7101, measurement is always conducted based on the assumption that the particles are always spherical.

Then, what kind of results would be obtained when measuring needle-shaped, fiber-shaped and tubular particles, as illustrated in Figures 1 and 2?

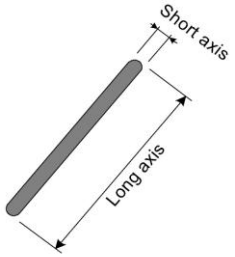

Figure 1: Example (1) of Needle-Shaped, Fiber-Shaped, Tubular Particles

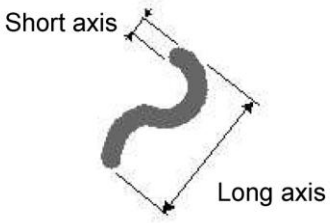

Figure 2: Example (2) of Needle-Shaped, Fiber-Shaped, Tubular Particles

Stated simply, the particle size distribution measurement result would appear as in Figure 3. This assumes that all of the particles being measured here are of exactly the same size and shape. In this case, the particle size distribution obtained as the result shows a comparatively wide distribution, with the short axis of the needle-shaped, fiber-shaped and tubular particles corresponding to the lower end of the distribution, and the long axis corresponding to the upper end of the distribution.

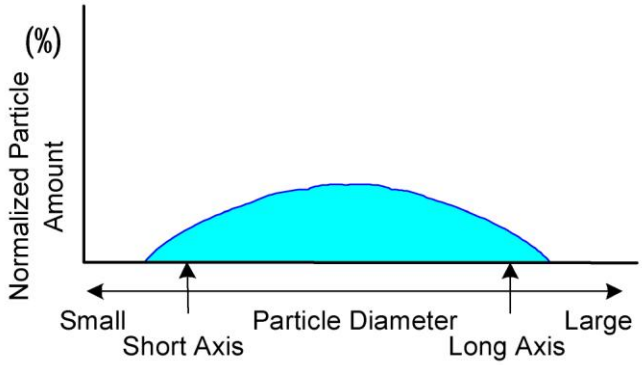

Figure 3: Particle Size Distribution in Measurement of Needle-Shaped, Fiber-Shaped and Tubular Particles

This is because it is assumed that the needle- and fiber-shaped and tubular particles are oriented randomly inside the cell, and moreover, even if they were oriented in a somewhat constant direction, since the optical sensors for detecting the diffracted and scattered light in the SALD-7101 are positioned to form a one-quarter circle optical system in Figure 4, detecting only the light that is diffracted and scattered in a fixed direction cannot be achieved anyway.

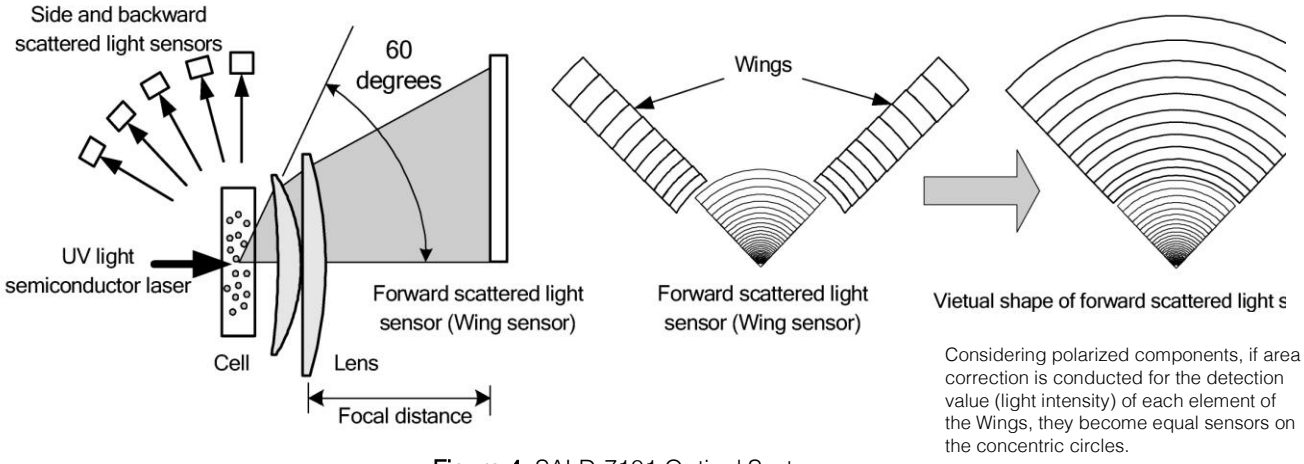

Figure 4: SALD-7101 Optical System

When the needle-shaped, fiber-shaped and tubular particles are present in various shapes and sizes, the measurement result distribution range spreads out from the smallest of the short-axis to the largest of the long-axis.

Therefore, even with such needle-shaped, fiber-shaped and tubular particles, as the variation of particle shape and size increases among the particles being measured, the distribution range widens, and conversely, the distribution range narrows with decreasing variation of size and shape. Moreover, as the shape and size become larger (longer), the particle size distribution shifts overall toward the large side, and conversely, as the shape and size become smaller (shorter), the particle size distribution shifts overall toward the small side.

Similarly, if agglutination of the needle-shaped, fiber-shaped and tubular particles occurs, the particle size distribution shifts overall toward the large side, and conversely, if the particles are well dispersed, the particle size distribution shifts overall toward the small side. In other words, it is possible to assess the dispersion / agglutination state of needle-shaped, fiber-shaped and tubular particles.

Thus, although a laser diffraction particle size analyzer cannot be used to obtain distribution information separately for the long-axis and short-axis of needle-shaped, fiber-shaped and tubular particles, important information on the characteristics of these particles can be obtained.

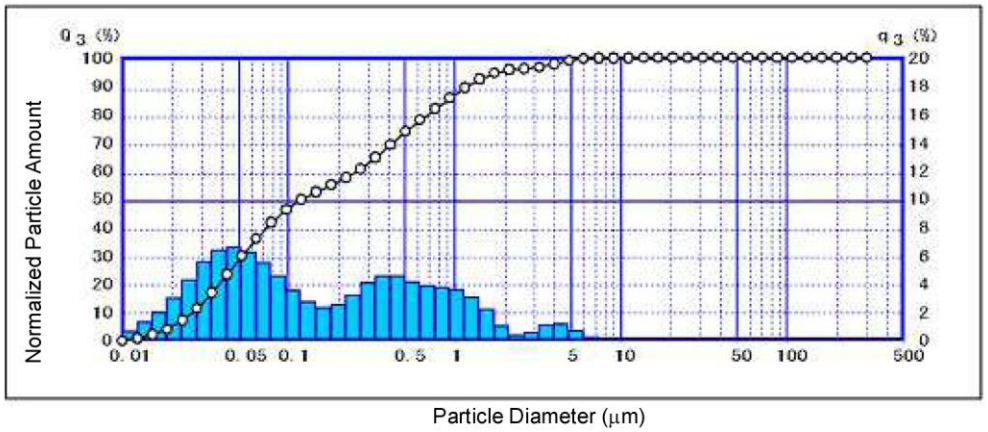

Figure 5: Measurement Results for Multiwalled Carbon Nanotubes

Figure 5 shows the measurement results for multiwalled carbon nanotubes using the SALD-7101. Due to the occurrence of complex agglutination among the particles, multiple peaks are present in the distribution profile. If the particles had been well dispersed, the peaks would have disappeared starting with the larger peaks.

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