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Application News

SALD™-2300 Laser Diffraction Particle Size Analyzer

Particle Size Evaluation in Hair Conditioner —Undiluted Measurement of Highly Concentrated Emulsions—

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User Benefits

- The SALD-2300 can measure the particle size distribution in undiluted solutions.
- Enables the understanding of the effect of dilution on the particle dispersion state.

■ Introduction

Emulsions are liquid mixtures of two immiscible solvents, such as oil and water, consisting of a dispersion of microparticles of one liquid in the other. Familiar examples of emulsions include hair conditioners, suntan lotion, and mayonnaise. The effectiveness of cosmetics, the texture of food products, and other characteristics can vary depending on the size of the particles in the emulsion. Therefore, product quality and other features can be quantitatively evaluated by measuring the particle size distribution in emulsions.

However, due to the thermodynamic instability of many emulsions, slight differences in how they are prepared can change their state or stability. This article describes an example of using a Shimadzu SALD-2300 laser diffraction particle size analyzer (Fig. 1) to measure undiluted and diluted emulsions.

Fig. 1 Shimadzu SALD™-2300 Laser Diffraction Particle Size Analyzer

■ Instrument

The SALD-2300 offers four types of sampling units for measuring samples in a variety of states and for various objectives. First, a batch cell was used to measure diluted samples. The batch cell is filled to its approximately 12 mL capacity with sample solution, and then the sample is measured as a stirring plate moves up and down (Fig. 2a). However, measuring concentrated samples in a batch cell with a long optical path length can be difficult due to multiple scattering effects. In such cases, concentrated samples can be measured by sandwiching them between glass plates, as shown in Fig. 2b, to significantly shorten the optical path length. The high-concentration sample measurement system is based on that technique. It includes glass microscope slides, a cell with an indentation for holding samples, and an adjustable optical path length for measuring a wide range of concentrated samples.

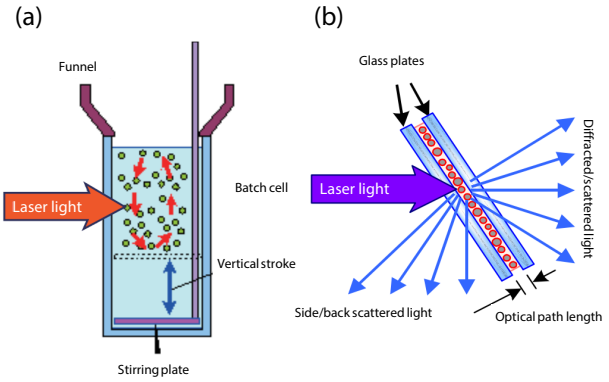

Fig. 2 Illustration of Measurement Unit
(a) Batch Cell and (b) High-Concentration Sample Measurement System

■ Samples and Method

Two commercially available hair conditioners, A and B, were used as samples. To measure diluted samples, the batch cell was filled with pure water, and then a suitable quantity of diluted sample solution was added for measurement (Fig. 3a). To measure undiluted solutions each sample was placed at the center of a microscope slide (Fig. 3b), sandwiched with the other microscope slide (Fig. 3c), placed in the high concentration sample measurement unit, and measured. Measurement parameters are shown in Table 1.

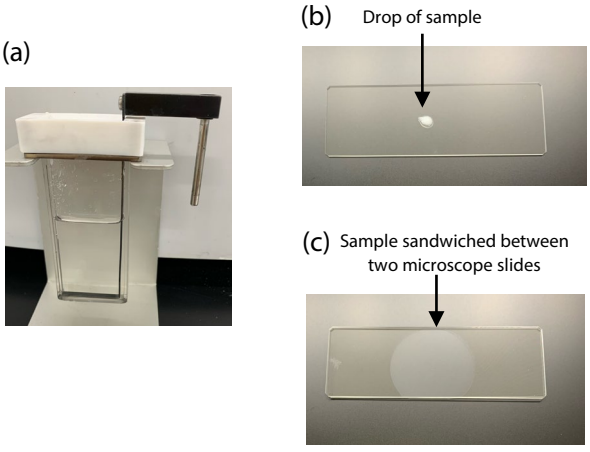

Fig. 3 Sample Preparation

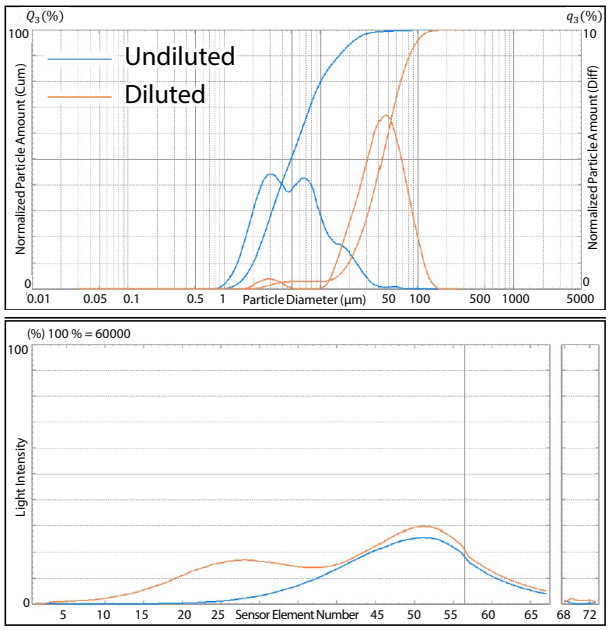

Fig. 4 Conditioner A (Undiluted/Diluted) Particle Size Distribution (Upper) and Light Intensity Distribution (Lower)

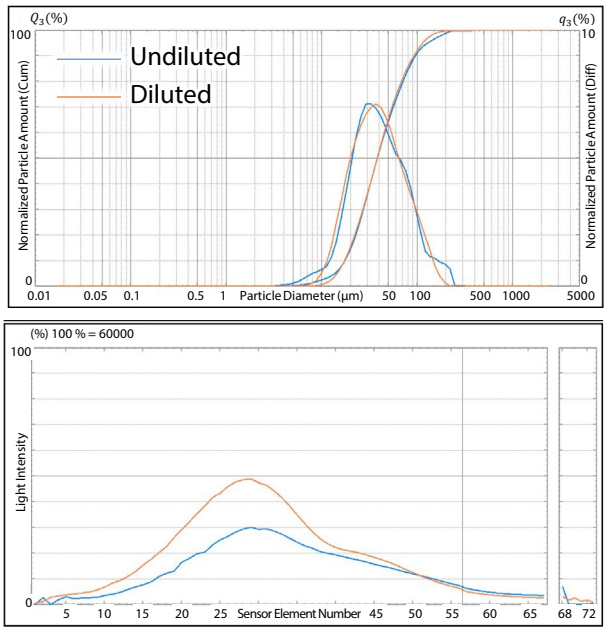

Fig. 5 Conditioner B (Undiluted/Diluted) Particle Size Distribution (Upper) and Light Intensity Distribution (Lower)

Table 1 Particle Size Distribution Measurement Parameters

	Undiluted Sample Measurements	Diluted Sample Measurements
Instrument Used	SALD-2300	
Unit Used	High-Concentration Sample Measurement System	Batch cell
Cell Used	Microscope slides	-
Dispersing Solvent	-	Purified water
Dispersion Method	-	Stirring
Dispersing Agent	-	None
Filter	A: ND-4 B: ND-2	-
Refractive Index	1.65 - 0.20 i	

Table 2 Median Particle Diameter (μm) in Conditioners (Undiluted/Diluted)

Measurement Method	Conditioner A	Conditioner B
Undiluted	4.872	37.864
Diluted	42.264	37.758

■ Measurement Results and Discussion

Results from measuring undiluted and diluted samples of conditioners A and B are shown in Fig. 4 and 5 and Table 2.

The particle size distribution patterns differed significantly between undiluted and diluted samples for conditioner A. Compared to the 4.872 μm median diameter in the undiluted sample, the medium diameter in the diluted sample was 42.264 μm, indicating that the diluted sample has a larger median particle size. The particle size distribution patterns also varied significantly. Furthermore, a comparison of diffracted/scattered light intensity clearly shows that the distribution starts at a smaller sensor element number for the diluted sample, which indicates that it contains coarser particles. These results show that the dilution operation increases the particle size. Presumably, it is caused by changes in the thermodynamic state or stability of the emulsion due to dilution operations.

In contrast, there are almost no differences in the particle size distribution patterns for conditioner B. There is almost no difference in the median diameters either, which are 37.864 μm for the undiluted sample and 37.758 μm for the diluted sample.

The above results show that dilution operations can change particle size distributions in some emulsions but cause almost no change in others. Though not described in this article, there are some emulsions with particle size distributions that become smaller when diluted. Therefore, considering that dilution operations can potentially affect particle size distributions in hair conditioners and other concentrated emulsions, it is important to measure emulsions in their undiluted state to determine how dilution affects particle size.

■ Conclusion

The results showed that dilution operations can potentially change the particle size distribution in hair conditioners. The high concentration sample measurement unit provides an effective way to measure undiluted samples for evaluating particle size distributions or understanding how dilution affects particle dispersion in hair conditioners and lotions, ointments, and other concentrated emulsions.

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