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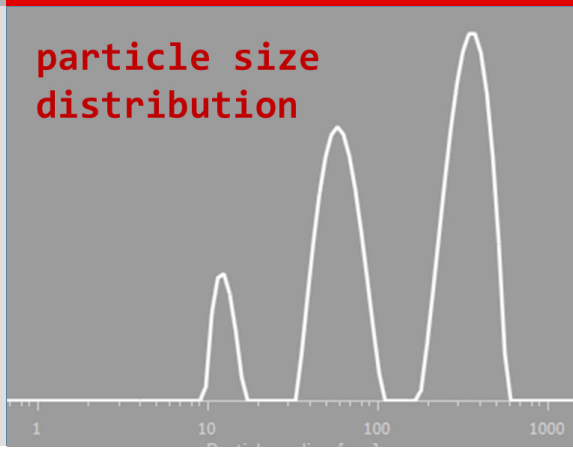
# Simultaneous Resolution of Three Particle Sizes in a Single Suspension by Using DLS

**Keywords:**

dynamic light scattering, polystyrene latex particles, particle size




## 1 Introduction

Dynamic light scattering (DLS) is a technique for determining the size of particles in a liquid suspension. Such particles undergo random or Brownian motion, the speed of which is directly related to the size of the particles; the smaller the particles, the faster they move. When light passes through a particle suspension, the movement of the particles produces fluctuations in the intensity of scattered light. Detection and analysis of the light-scattering fluctuations allows us to calculate the particles' radius.

Polymer latex spheres can be used to verify DLS performance because they are available as well-characterized dispersions of near-perfect spheres. While DLS is a well-established technique for determining the average radius of a monodisperse sample, it is a significant challenge to distinguish particles with different sizes in a single suspension. The ability to resolve multiple particle sizes depends on several factors, including the sizes of the particles, their relative scattering intensities, the polydispersity of their size distributions, the quality of the sample preparation, and the quality of the data.

Here, we resolve multiple particle sizes in suspensions of two and three different-sized particles by using the Litesizer™ 500.

## 2 Experimental

### 2.1 Materials

Three suspensions of polystyrene latex particles (Thermo Scientific) from 22 nm to 700 nm were prepared as follows:

- Sample 1: A suspension of 22 nm and 500 nm particles in a 4:1 ratio in 10 mM NaCl
- Sample 2: A suspension of 22 nm and 100 nm particles in a 20:1 ratio in 10 mM NaCl.
- Sample 3: A suspension of 22 nm, 100 nm and 700 nm particles in a 3:1:1 ratio in deionized water.

### 2.2 Method

All DLS measurements were carried out with back-scattering (175°) detection at 25 °C. The number of runs, attenuation filter, and focus position were automatically optimized by the instrument. The model used for analysis was "narrow". When analyzing DLS data, there are usually two possible models that can be applied; "general" or "narrow". If the sample is unknown, or a single broad peak is expected, the general model should be used. If one or more peaks are expected, the narrow model should be applied. Therefore, in our experiments here, the narrow model was applied.

## 3 Results and Discussion

The size (radius) distribution of sample 1 (polystyrene latex particles of radius 22 nm and 500 nm in a 4:1 ratio) is shown in Fig. 1.

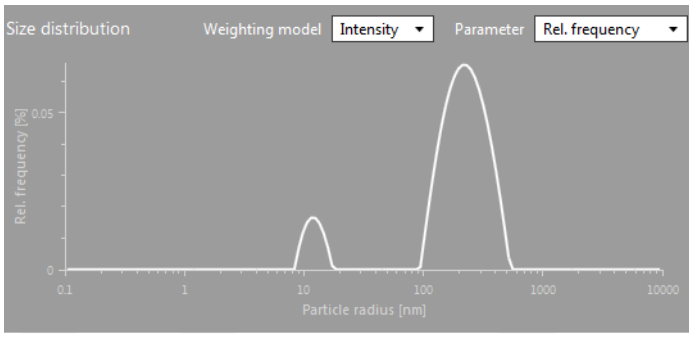



*Fig. 1 Size distribution of sample 1: polystyrene latex particles of radius 22 and 500 nm in a 4:1 ratio.*

Two well-resolved peaks can be seen, representing the two particle sizes. The polydispersity index was 25.7 %, as shown in Fig. 2. In general, if the sample contains only one particle size, the polydispersity index will be <10 % for latex

standards. A polydispersity index of >10 % generally indicates a mix of particle sizes. Also displayed in Fig. 2 is the number of processed runs, which was 6. This indicates that sufficient data was acquired after only six runs, with a total measurement time of one minute.

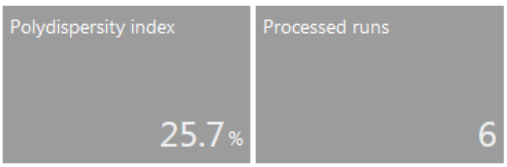



*Fig. 2 The polydispersity index and the number of processed runs.*

A second bi-disperse sample was analyzed with a smaller difference between the particle sizes—22 and 100 nm in the ratio 20:1—can be seen in Fig. 3. Again, two distinct peaks can be clearly seen, which correspond to the two particle sizes, 22 nm and 100 nm.

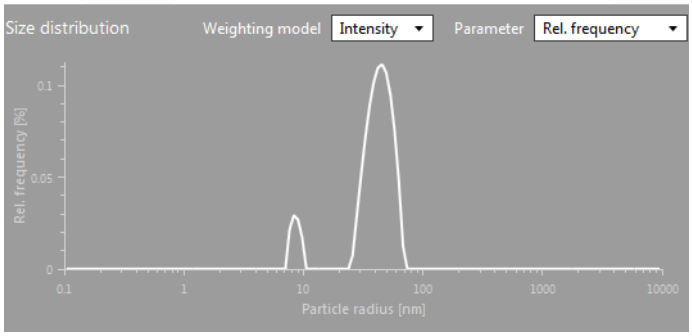



*Fig. 3 Size (radius) distribution of sample 2: polystyrene latex particles of 22 and 100 nm in the ratio 20:1.*

Although many bi-disperse samples have been successfully characterized with various instruments on the market, to our knowledge there have been no reports of a mix of three particle sizes with a high level of accuracy. We report here the precise and accurate characterization of three particle sizes in a single suspension by using the Litesizer 500. The size distribution of a suspension of three polystyrene latex particles—22, 100 and 700 nm—in a ratio of at least 3:1 (sample 3) is presented in Fig. 4, revealing three well-resolved peaks corresponding to the three particle sizes. The polydispersity index was 27.8 %, consistent with a mix of particles. As for the bi-disperse samples, data acquisition was complete within one minute.

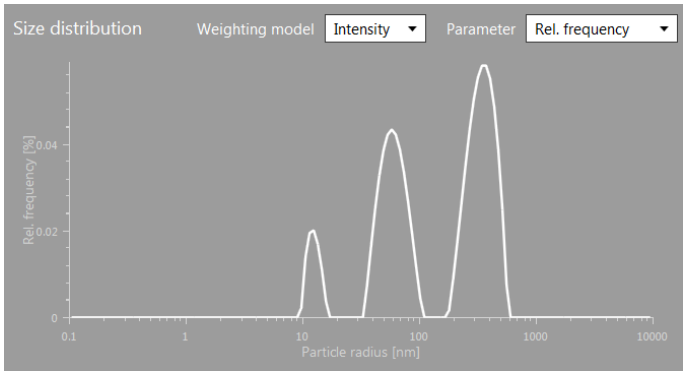



*Fig. 4 Size (radius) distribution of sample 3, a tridisperse polystyrene latex sample containing particles of 22, 100 and 700 nm in the ratio 3:1.*

## 4 Summary

Dynamic light scattering has been used to characterize three blends of bi- and tri-disperse polystyrene latex particles with the Litesizer 500.

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