

**Fourteen Peaks?!**  
**Particle Size Analysis of a Mixed Sample of Polystyrene Latex Standards**

**Outline**

Certified National Institute of Standards and Technology (NIST) traceable polystyrene latex (PSL) size standards made by Thermo Fisher Scientific Inc. (TFS) were used to evaluate the resolution of the centrifugal sedimentation method. Mean diameters of the PSL standards have been calibrated with microscopy methods. Size distribution and uniformity were measured with electrical resistance analysis or optical microscopy. Fig. 1 shows the photograph of PSL particles. They have excellent roundness with a full particle size distribution. A mixed sample of fourteen sizes of monodispersed PSL was used to evaluate the resolution and quantitative capability of the centrifugal sedimentation method.

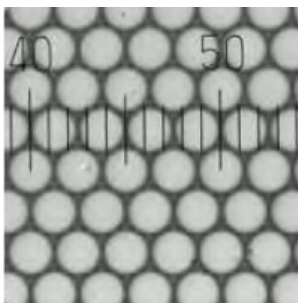


Fig. 1 Photograph of PSL particles that is used with permission from Thermo Fisher Scientific Inc.

**Method**

Apparatus: HORIBA Partica CENTRIFUGE  
Measurement mode: Line-start  
Sample volume: 10  $\mu$ L  
Samples: TFS\_No.4230A: PSL/De-ionized(DI) water, Nominal size: 30  $\mu$ m, Mean: 29.75  $\mu$ m, 1%, 5 drops  
: TFS\_No.4220A: PSL/DI water, Nominal size: 20  $\mu$ m, Mean: 20.06  $\mu$ m, 1%, 5 drops  
: TFS\_No.4210A: PSL/DI water, Nominal size: 10  $\mu$ m, Mean: 10.02  $\mu$ m, 1%, 5 drops  
: TFS\_No.4209A: PSL/DI water, Nominal size: 9.0  $\mu$ m, Mean: 8.956  $\mu$ m, 1%, 1 drop  
: TFS\_No.4K-06: PSL/DI water, Nominal size: 6.0  $\mu$ m, Mean: 6.007  $\mu$ m,  $1 \times 10^7$  particles/mL, 1 drop  
: TFS\_No.4K-03: PSL/DI water, Nominal size: 3.0  $\mu$ m, Mean: 3.002  $\mu$ m,  $5 \times 10^7$  particles/mL, 1 drop  
: TFS\_No.4202A: PSL/DI water, Nominal size: 2.0  $\mu$ m,

Mean: 2.020  $\mu$ m, 1%, 1 drop  
: TFS\_No.4018A: PSL/DI water, Nominal size: 1.8  $\mu$ m, Mean: 1.745  $\mu$ m, 1%, 1 drop  
: TFS\_No.4016A: PSL/DI water, Nominal size: 1.6  $\mu$ m, Mean: 1.592  $\mu$ m, 1%, 1 drop  
: TFS\_No.4013A: PSL/DI water, Nominal size: 1.3  $\mu$ m, Mean: 1.361  $\mu$ m, 1%, 1 drop  
: TFS\_No.4011A: PSL/DI water, Nominal size: 1.1  $\mu$ m, Mean: 1.101  $\mu$ m, 1%, 1 drop  
: TFS\_No.3500A: PSL/DI water, Nominal size: 500 nm, Mean: 508 nm, 1%, 1 drop  
: TFS\_No.3150A: PSL/DI water, Nominal size: 150 nm, Mean: 152 nm, 1%, 1 drop  
: TFS\_No.3100A: PSL/DI water, Nominal size: 100 nm, Mean: 100 nm, 1%, 1 drop  
Calibration sample: TFS\_No.4100A: PSL/DI water, Nominal size: 1.0  $\mu$ m, Mean: 1.030  $\mu$ m, Density: 1,050 kg/m<sup>3</sup>  
Particle: PSL (Solid concentration: 1%, Refractive index: 1.579, Average density of mixed PSL particles: 1,050 kg/m<sup>3</sup>)  
Medium: 2-6% sucrose density gradient solution (Average refractive index: 1.336, Average density: 1,007 kg/m<sup>3</sup>)  
Particle size distribution (PSD) base: Volume based  
Calculation setting: Custom mode  
Extinction coefficient correction: ON  
Smoothing: OFF

**Results**

A 1- $\mu$ m PSL/water dispersion of 10  $\mu$ L volume was collected with a micropipette and injected into a cell cap of a cell filled with density gradient liquid for calibration. Thereafter, as per the above list, one or more drops of the fourteen PSL/DI water dispersions having different particle sizes were mixed well. A volume of 10  $\mu$ L was collected from this mixture with a micropipette, injected into a cell cap and sample measurement was performed by Partica CENTRIFUGE. As shown in Fig. 2, a volume-based PSD with fourteen peaks was obtained. The mode diameters of the peak are 0.109  $\mu$ m, 0.163  $\mu$ m, 0.511  $\mu$ m, 1.034  $\mu$ m, 1.323  $\mu$ m, 1.549  $\mu$ m, 1.734  $\mu$ m, 1.981  $\mu$ m, 2.947  $\mu$ m, 5.888  $\mu$ m, 8.657  $\mu$ m, 9.641  $\mu$ m, 19.094  $\mu$ m and 27.734  $\mu$ m.

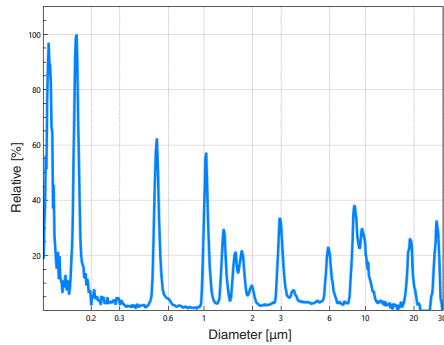


Fig. 2 Volume-based PSD (x-axis: log scale)

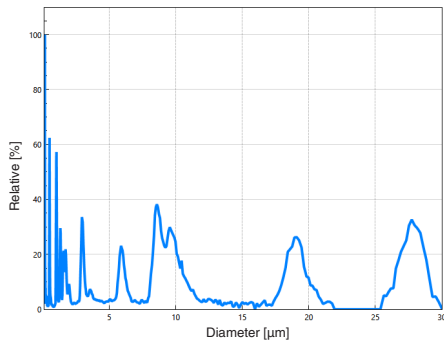


Fig. 3 Volume-based PSD (x-axis: linear scale)

## Conclusion

When a mixed sample produced from fourteen particle size standards between 100 nm and 30  $\mu\text{m}$  was measured by the line-start method, a PSD with fourteen nice peaks classified by the centrifugal force was observed. Additionally, the peaks appeared almost at the same size position as the nominal value of the particle size standards. Three modes of calculation can be set in the software - QC mode, R&D mode, and Custom mode. Performing extinction correction in custom mode can improve quantitative analysis and the area ratio of a separated peak of a mixture will correspond to its own existing mixing ratio in it. If high resolution is required as in the above case, it is possible to calculate without the smoothing process to increase the resolution. Using this, it is possible to obtain a result matching to an objective by customizing the calculation settings. With reference to Fig. 3, the peaks corresponding to standards of nominal sizes of 10  $\mu\text{m}$ , 20  $\mu\text{m}$  and 30  $\mu\text{m}$  all have an area of about five times that of the 6  $\mu\text{m}$  standard peak. The evaluation of the mixed PSL sample has confirmed that the centrifugal sedimentation method of Partica CENTRIFUGE has high resolution, good accuracy, and strong quantitative capability.