OF2i: A new method for understanding polydisperse samples

One of the major challenges in particle characterization is the handling of highly polydisperse and multimodal samples, which are frequently encountered in industrial processes.

PSD of polydisperse samples

Here we demonstrate the OptoFluidic Force Induction (OF2i) method's capability to characterize complex polydisperse systems in a continuous and seamless measurement spanning approximately one hour.

Experimental setup

We prepared a dispersion initially consisting of polystyrene spheres (np = 1.59 [23]) with nominal diameters of 203, 600, and 1040 nm immersed in water (nb = 1.33), which span a broad size range.
During the monitoring process, two additional ensembles with nominal diameters of 401 and 789 nm were titrated into the initial dispersion at different times with a total delay of approximately ten minutes for each ensemble. This introduced dynamic changes in the dispersion.

Results

The results curves show results obtained by OF2i in a continuous measurement of polystyrene spheres over the monitoring period. In the scatter diagram (a) each data point represents an individually measured particle. Looking closer, we observe that there are three distinct particle populations from the very start of the measurement throughout the experiment, see also the three sharp peaks in the particle size histogram shown in (f), obtained after 15 minutes of measurement.

After about 17 and 27 minutes, respectively, two more populations emerge in the scatter plot as a consequence of the additional PS samples (401 nm, 789 nm) being added. These populations are monitored until the end of our measurement.
Again, the individual peaks can be clearly identified as shown in (e) and (d).

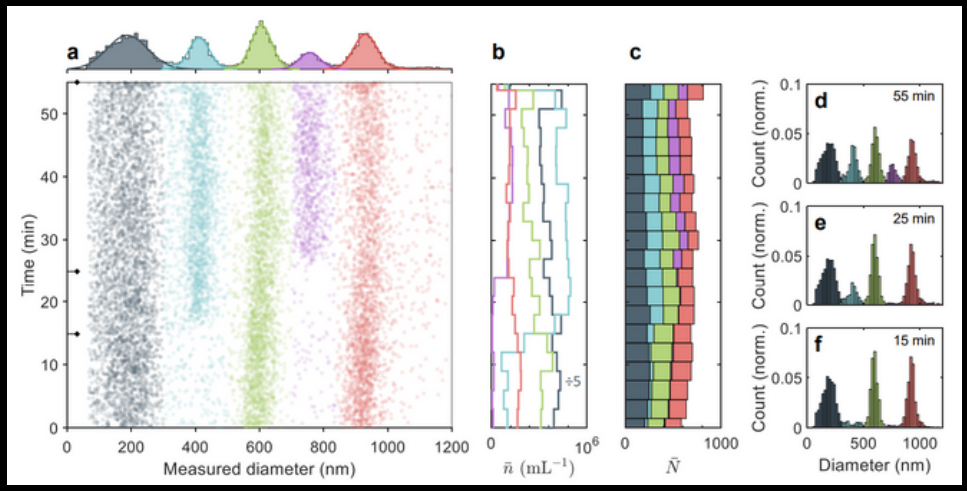

FIGURE 1: Continuous monitoring of a polydisperse sample by OF2i.

To identify the various contributions of each ensemble, a 1D GMM model with five components (full covariance) was applied to the total particle size histogram on top of (a). The corresponding contributions are highlighted by color and fitted by a Gaussian distribution (solid line). Note that some low counts in panel (f) are identified by the 1D GMM and are most likely due to particle agglomerates, see also the scatter diagram in panel (a).

Conclusion

From this experiment there are two takeaways:
(1) the continuous measurement of the polystyrene dispersion allows us to observe dynamic changes in the dispersion.
(2) the weakly focused vortex beam incorporated into the OF2i system enables parallel measurement of single particles over a broad size range, which makes it ideal for analyzing polydisperse systems.