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Static or dynamic light scattering?

The particle (or droplet) size of suspensions and emulsions are commonly analysed by light scattering techniques - either static (laser diffraction) or dynamic (Brownian movement). Depending on the concentration of the sample, its size range and distribution width one of these techniques is preferred.

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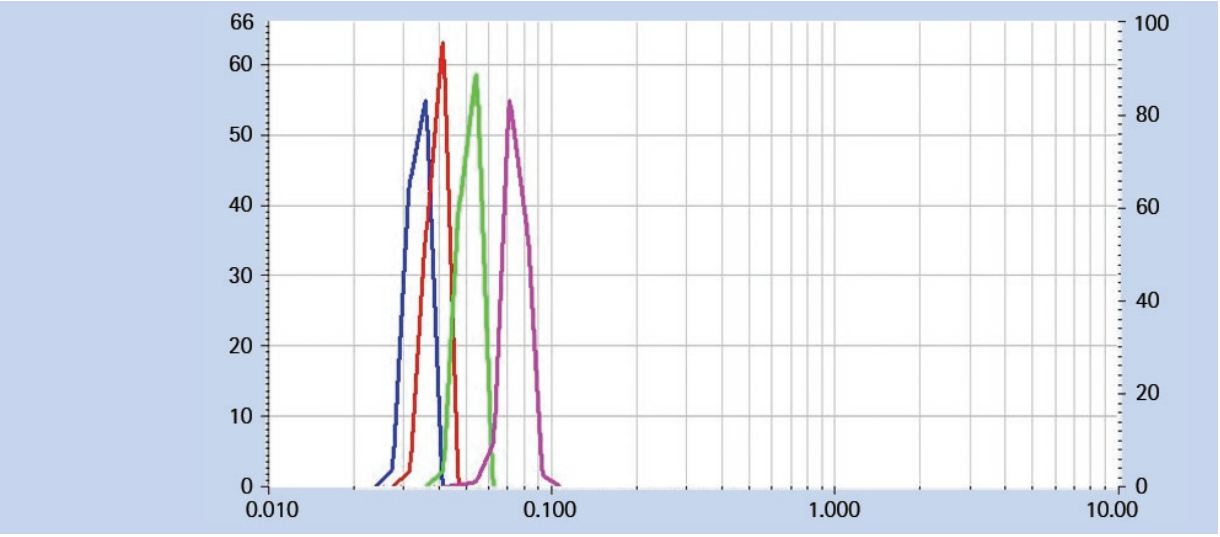
MERCK

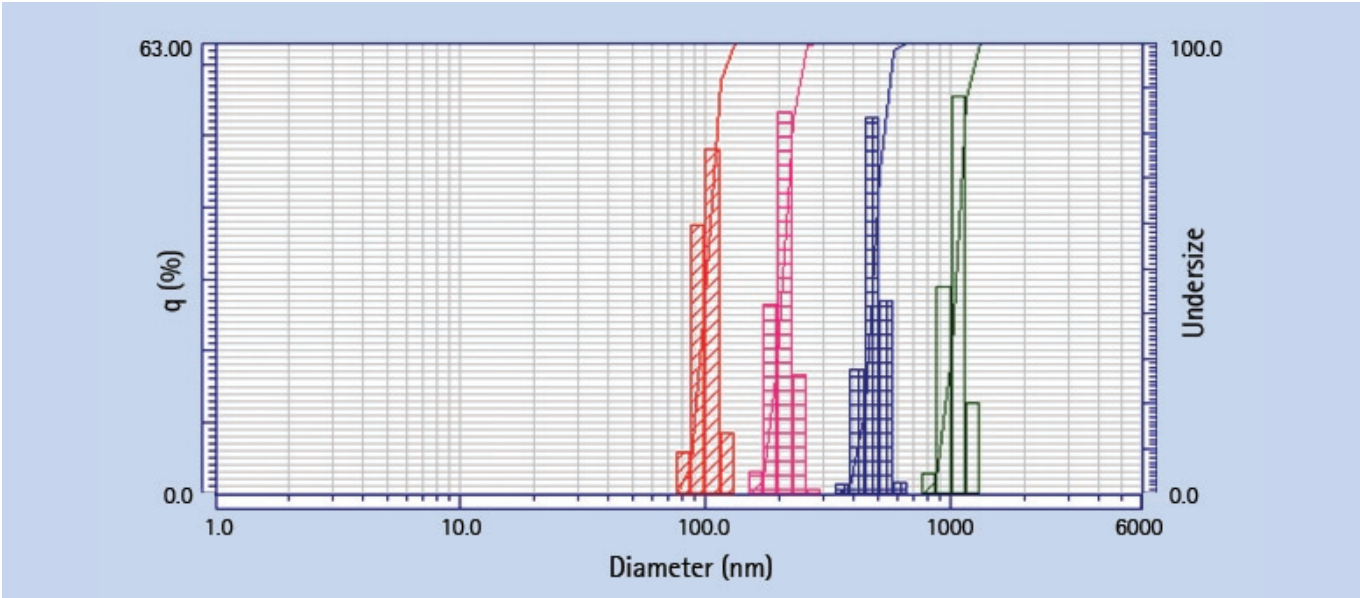
Description of static light scattering (SLS)

Samples are dispersed in a liquid. A pumping system transports the suspended particles or droplets through of laser beam. The interaction of laser light and particles generate a light scattering pattern which is characteristic of the particle or droplet size.
With the latest optical technology developments, as found in the Horiba LA950, it is possible with static light scattering to cover large range of particle size from 10nm to 3mm with an excellent precision and resolution.
Within the instrument, methods can easily be developed to meet customer's needs, for example the choice of wet or dry analysis and the wish to disperse samples or not.
Parameters like the ultrasonics, circulation/agitation speeds as well as solvent compatibility can be quickly changed to optimise the dispersion of the particles or the droplets within the analysed sample - an important factor for sub-micronic sizes.
The ease of use and analysis speed makes this technique suitable for both R&D and quality control.
Below an example of Horiba LA950 resolution is shown on polystyrene latex standards centred at 30nm, 40nm 50 and 70 nm.



Dynamic light scattering (DLS)

Dynamic light scattering is based on the Brownian motion of particles and the Doppler Effect and can determine the particle size distribution over a range of 1nm to 6µm. A sample particle (or droplet), exposed to laser light, diffuses light of a changed frequency. This frequency change compared to the original light varies directly with the velocity (the diffusion coefficients) of moving particles. Analysis of the frequency changes thus gives the sample PS distribution.
The technique requires accurate temperature and liquid viscosity control. Thanks to its integrated temperature control sensor and optional viscometer, the HORIBA LB550 instrument offers the possibility to control these parameters in real time. The viscosity issue becomes even more critical as the analysed sample concentration is increased.
Here below some examples of data obtained on white latex of MERCK at different size: 100nm, 200nm 500nm, 1µm on HORIBA LB550 system:



Comparison between SLS and DLS

We can get excellent data correlation between SLS and DLS if certain precautions are taken with respect to the sample dilution, the control of dispersion stability, the particle size range and its distribution width.

Below is a table summarising the data obtained on both LB550 and LA950 with the latex products of the MERCK company:

Reference	Expected size/tolerance	950 Data	LB550Data
K010	76-125 nm	103 nm	102 nm
K020	176-225nm	207 nm	208 nm
K050	476-575nm	478 nm	482 nm
K100	900-1100nm	1010 nm	1050 nm

For particles of sub-micronic sizes, dynamic light scattering technique can be a more suitable method compared to laser diffraction. The photomultiplier detector used in the DLS technique is more sensitive than those found in the laser diffraction system and, hence very small sizes, can be more reliably measured. With the SLS technique as found in the HORIBA LA950, it is nevertheless possible to measure such small sub-micronic sizes but the sample concentration must be increased in order to augment the intensities of the diffused signals.

Another advantage of the DLS technique is that particle size can be measured at higher sample concentrations than with SLS. Thus, sample dilution becomes less of a critical issue with dynamic scattering. In certain cases, dilution is known to modify sample size for example re-agglomeration and flocculation effects. The HORIBA LB550 analyser can typically measure suspensions whose concentration vary from a few ppm to 40 in weight percentage whereas with laser diffraction the concentration is limited to 0.1 in weight percentage.

Conclusion

Static and Dynamic Light Scattering techniques can provide accurate and repeatable data for a large diversity of products including white mono-dispersed latex and can be used as a key tool for both R&D and quality control.

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