HORIBA Scientific

Application Note

Sizing Silica Particles by DLS

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The utility of silica nanoparticles is often determined by the particle size. Dynamic light scattering provides fast, accurate and repeatable nanoparticle size information and therefore is an important tool for the nanoparticle technologist. Here, two different size silica particles are characterized with the SZ-100 in order to demonstrate the accuracy and utility of the instrument.

Introduction

As you listen to music on your mp3 player while sipping a cold beer (please drink and size responsibly), you might take a moment to contemplate the truly tiny silica nanoparticles that make this possible. Silica nanoparticles were used to clarify your beer. And the silicon wafers from which critical components in your mp3 player were made were polished flat with the aid of silica chemical mechanical polishing (CMP) nanoparticle slurries.

In both of these applications (and many more), the size of the silica nanoparticles is critical to their utility. In beer clarification the silica is used to bind suspended haze-creating particles (often protein or yeast) together creating large flocs that can be removed by settling or filtration resulting in a clear liquid. The silica particles used for CMP must not be so large that they scratch the delicate silicon wafers. But, they must be large enough to remove material quickly and economically.

Dynamic light scattering (DLS) is the technique of choice for analyzing the size of nanoparticles (1). The measurement is fast, often taking only a few minutes. Measurements are repeatable; for many samples, the coefficient of variation (COV) on the so-called z-average size is better than 5%. Measurements are precise; changes in the z-average size of only a few percent can be discerned.

In this application note, the particle sizes of two different silica dispersions are analyzed to demonstrate the utility of the SZ-100 for both suppliers and users of such materials.

Figure 1: SZ-100 Nanoparticle Size Analyzer.

Materials and Methods

Sample 1 was Ludox TM 50, a colloidal silica of nominal size 30 nm (narrow size distribution). Sample 2 was a more broadly distributed and larger-sized (nominal 500 nm) aqueous SiO_2 suspension. Both materials were obtained from Sigma Aldrich. Each suspension was diluted with 10 mM KCl (aq) before measurement.

Figure 2: Fumed silica. The small size, hardness and inert nature of silica make it a very versatile and useful material for a wide range of applications and ideal for size analysis by DLS with the SZ-100.

Dynamic light scattering data was collected and analyzed with an SZ-100 particle size analyzer. Measurements were repeated five times in order to calculate the coefficient of variation (standard deviation over mean of the measurements).

Figure 3: Sand dune. These larger silica particles, while beautiful in the aggregate, are typically analyzed by laser diffraction (HORIBA LA-950) or image analysis (HORIBA PSA300).
Image courtesy of Florence Devouard and Wikimedia Commons.

Results and Discussion

The z-average diameters obtained with the SZ-100 are listed in tables 1 and 2.

	Mean determined z-average size (nm)	COV (%)
Dynamic Light Scattering with SZ-100, laboratory 1	34.4	0.7
Dynamic Light Scattering with SZ-100, laboratory 2	34.6	0.3

Table 1: Measurement of the Ludox TM 50 colloidal silica. Here, results from two different laboratories are compared. The agreement is excellent highlighting the measurement reproducibility of the SZ-100 providing the user with confidence in multiple site installations. The SZ-100 has standardized measurement protocols which automate measurement and calculation to ensure maximum operator-to-operator and site-to-site reproducibility.

	Particle Diameter (nm)	COV (%)
Manufacturer certificate (by disc centrifuge)	462	4.7
Dynamic Light Scattering with SZ-100	484	2.7

Table 2: Measurement results for nominal 500 nm silica suspension. The two different techniques agree to within 5%, which is very good. Evident from the COV values, the measurement repeatability of the SZ-100 is superior to that of the disc centrifuge.

Conclusions

The results of these measurements show that the SZ-100 can be used to characterize silica and other nanoparticle materials.

References

(1) ISO 22412:2008 Particle Size Analysis – Dynamic Light Scattering

(2) www.sigmaaldrich.com