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APPLICATION NOTE

Using the BeNano 180 Zeta to Measure the Zeta Potential of Silica Suspension

Zhibin Guo, Hui Ning
Application Research Lab, Bettersize Instruments Ltd.

Introduction

Nanoscale silicon dioxide has significant versatility. It can be used as an abrasive when polishing the semiconductor surface, and coating material due to excellent surface performance. Widely applied in the area of rubber, plastic, steel, and solar energy, it improves the reinforcement, shear resistance, and thixotropy, etc.

In 1968, with the development of chemistry, Stober found that nano-silica spheres, whose particle size is near to monodisperse ones, can be obtained at room temperature by stirring the mixture of ammonia in different proportions and the tetramethylsilane dispersed in ethanol solution. There are lots of situations that the nano-silica is dispersed in liquid when using. Therefore, the measurement of zeta potential is essential, due to the purpose of understanding the stability of the system and improving the quality of products.

In this application note, we use the BeNano 180 Zeta nanoparticle size and zeta potential analyzer from Bettersize to measure the zeta potential of nano-silica from different batches dispersed in the aqueous environment.

Theory and Instrumentation

The BeNano 180 Zeta (Bettersize Instruments Ltd.) is equipped with a solid state laser with a wavelength of 671 nm and a power of 50 mW as the light source. By applying an electric field on the sample, the charged particles are driven to electrophoresis. When the laser irradiates the sample, the frequency of the scattered light shift from the origin due to the electrophoretic movement of the particles. An avalanche photodiode (APD) detector is used to collect scattered light signals at 12°. With using phase analysis light scattering (PALS) technology, the BeNano 180 Zeta is capable of detecting the zeta potential of samples even with low electrophoretic mobility.

Experiment

Zeta potential of four nano silica slurry sample were measured at original concentration (solid content of 10%) and 30-times dilution in water.

Each sample was measured at least three times to ensure the repeatability of the results and obtain the standard deviation of the results.

Results and Discussion

With PALS technology, the zeta potentials of four nano-scaled silica suspensions are obtained. Figure 1-4 shows the phase plot of each measurement, the slope of which refers to the frequency shift caused by electrophoresis. As can be seen in the figures, each phase plot has a clear slope and shows a good signal-to-noise ratio.

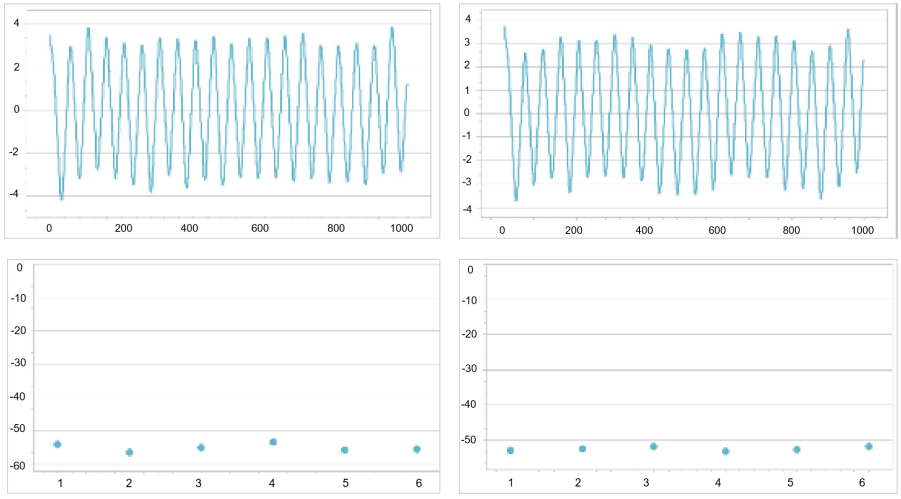

Figure 1. The phase plot and zeta potential trend of sample 1# with original concentration (left) and diluted by 30 times (right)

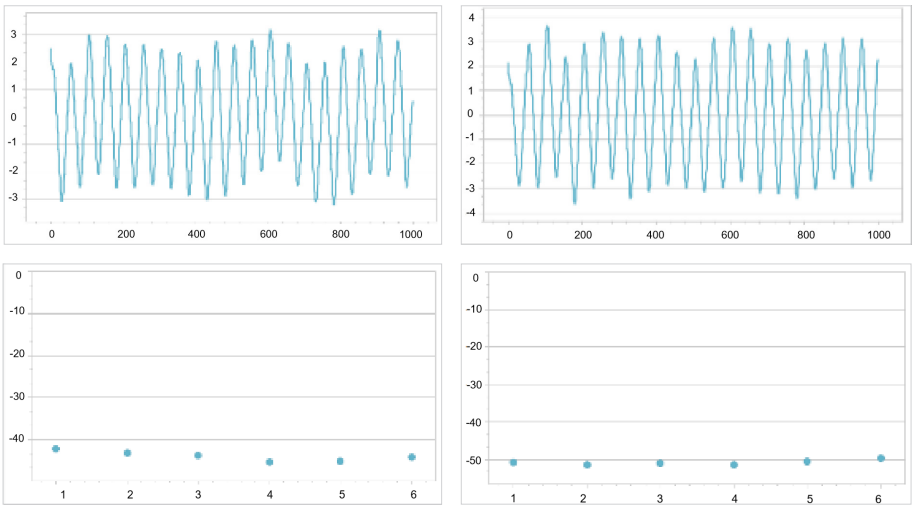

Figure 2. The phase plot and zeta potential trend of sample 2# with original concentration (left) and diluted by 30 times (right)

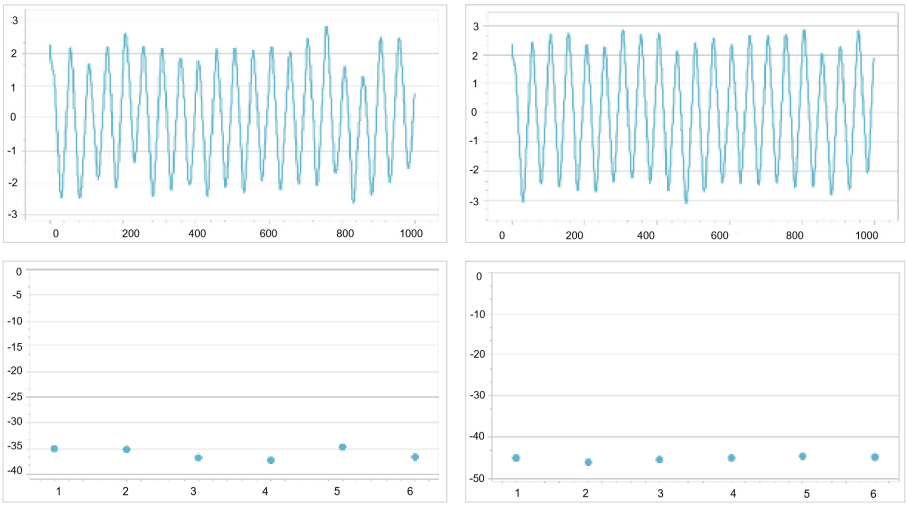

Figure 3.The phase plot and zeta potential trend of sample 3# with original concentration (left) and diluted by 30 times (right)

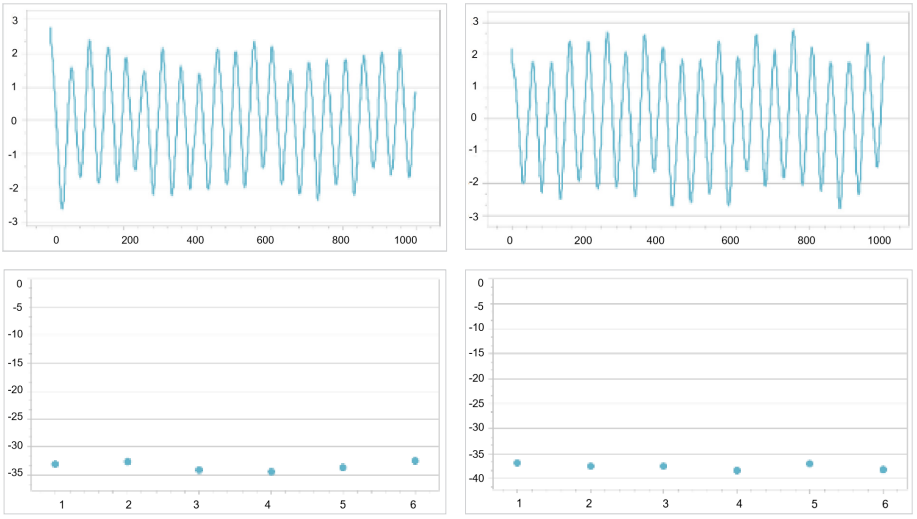

Figure 4. The phase plot and zeta potential trend of sample 4# with original concentration (left) and diluted by 30 times (right)

As can be seen, the zeta potentials are negative, demonstrating negative charge on the particle surface. The consistent zeta potential trends as well as relatively small standard deviations show the excellent result reproducibility.

Table 1. The zeta potential results of silica samples

Sample	Zeta potential (stock solution) (mV)	Zeta potential (30 times dilution) (mV)
1#	-55.08±1.18	-52.48±0.56
2#	-43.90±1.2	-50.85±0.64
3#	-35.98±1.07	-45.22±0.50
4 #	-33.40±0.77	-37.52±0.56

Given that the zeta potentials of all samples are high (>30 mV), the samples are less likely to form aggregates under this circumstance. By comparing with each result, we can conclude that sample 1# and sample 2# have the highest zeta potentials, following by sample 3#, and the lowest sample 4#. Hence, sample 1# and 2# are, quite possibly, most stable among four silica suspensions. In addition, after being diluted 30 times, sample 2# and 3# have much larger absolute values of zeta potentials, thereby indicating better stabilities than those of stock solutions.

Conclusions

Zeta potential measurements of four nano-silica suspensions, with high concentration and 30-times dilution by pure water, were well carried out with the BeNano 180 Zeta. The results show good repeatability and, most importantly, allows for stability comparison between different batches or formulations so as that product quality can be controlled and monitored in a quantitative way.

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Bettersize Instruments Ltd.

Further information can be found at

https://www.bettersizeinstruments.com

Email: info@bettersize.com

Address: No. 9, Ganquan Road, Lingang Industrial Park, Dandong, Liaoning, China

Postcode: 118009

Tel: +86-415-6163800

Fax: +86-415-6170645

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