LIFETIME OF ZETA POTENTIAL CELLS

There are several zeta potential cell options for the SZ-100V2 including disposable plastic cells intended to last for several measurements before being replaced. This study investigates how many measurements could be made before the cell required replacement. After 800 measurements the experiment was stopped, but the same cell was then used for other, more difficult studies (zeta potential of proteins).

Introduction

Zeta potential is a scientific term for electrokinetic potential in colloidal systems. It is the potential in the interfacial double layer (DL) at the location of the slipping plane versus a point in the bulk fluid away from the interface. In other words, zeta potential is the potential difference between the dispersion medium and the stationary layer of fluid attached to the dispersed particle. Zeta potential can be measured using electrophoretic light scattering (ELS) by applying an electric field on a suspension of particles, measuring the motion of the particles, and determining the mobility, μ, as shown in equation 1.

$$\mu = \frac{\Delta\omega\lambda_0}{4\pi nE\sin(\frac{\theta}{2})\sin(\frac{\theta}{2}+\xi)}$$

Equation 1

Electrophoretic mobility can then be used to calculate zeta potential, ζ,using equation 2.

$$\mu = \frac{2\zeta\varepsilon}{3\eta_o} f(\kappa r)$$

Equation 2

The SZ-100V2 determines particle motion by measuring a frequency shift due to movement created by the induced electric field. This is a simple measurement requiring only a few seconds for some samples, and perhaps longer for others depending on the signal strength which is dependent on several factors including particle size, material type, and concentration. The time required for the measurement is typically experimentally determined through a repeatability study of the specific sample. Most users are satisfied if the repeatability varies less than 10% over a series of at least 3 measurements.

The SZ-100V2 disposable zeta potential cells include electrodes used to induce the applied electric field. The electrodes can be coated with either gold or carbon, depending on the samples analyzed. Gold electrodes can degrade when analyzing certain samples such as high salt concentration, or organic materials like proteins. When gold plated electrodes degrade they appear blackened, as seen in Figure 1, and are then typically discarded and a new cell is chosen for future measurements.

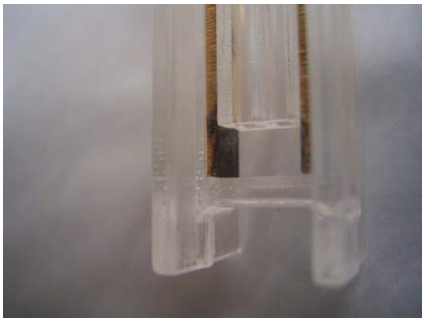


Figure 1: Blackened gold coated electrode

The SZ-100V2 is the first system to introduce carbon coated electrodes (see Figure 2), providing significantly longer lifetime. This patented technology is unique to HORIBA.

Figure 2: Carbon coated electrode

Experimental

A coffee creamer was prepared to use as a real world emulsion sample to test the lifetime of a randomly chosen disposable zeta potential cell with carbon coated electrodes. An initial experiment determined that measurements as short as 10 seconds each could generate acceptable repeatability – around plus/minus 10% from a mean value. This initial study was performed on an older emulsion sample that had been prepared a day before. After the 10 second sample time was chosen, the first 100 measurements were made overnight.

All measurements were made on the SZ-100V2 (Figure 3) using the instrument settings shown below:

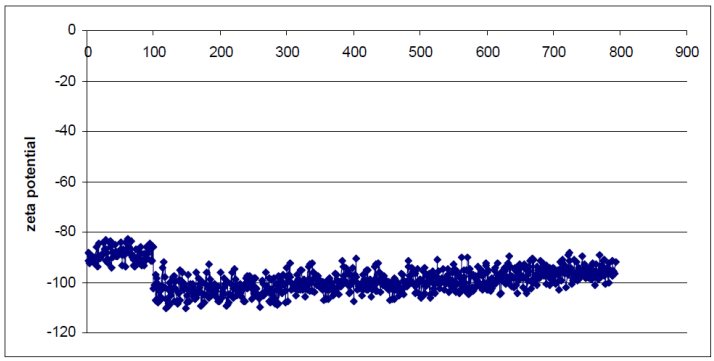
Temp:	25°C
Duration:	10 sec
Delay between measurements:	10 sec
Calculation:	Standard
Henry Coefficient:	Smoluchowski

Figure 3: The SZ-100V2 Nanoparticle Analyzer

After the first 100 measurements were completed a fresh emulsion sample was prepared and measurement sets in batches of 100 each were taken. After 800 measurements were completed the experiment was discontinued, although the cell was still functioning properly.

Results

Graph shows a plot of zeta potential vs. analysis number for the data collected in this study.



Graph 1: Zeta potential vs. analysis number

Table 1 shows basic statistics for the analyses on the second emulsion preparation (results 101 – 800).

Mean	-96
Min	-91.5
Max	-109
St dev	5

Table 1: Result summary

Discussion

A step function change in results is clearly visible after the first 100 measurements. This is caused by the change to a fresh preparation of the emulsion sample. A drift to smaller magnitude values is visible after the first 200 measurements, indicating some change in the measurement, but results remained quite acceptable for quick, easy measurements, which was the goal of this study. After this study was concluded the same cell was used for over 45 measurements of the zeta potential of BSA protein. At the end of the protein measurements the cell was still functioning.

Conclusions

Switching to carbon coated electrodes significantly increases the lifetime of the disposable zeta potential cells over other widespread designs. The emulsion used was an easy sample, generating a strong signal, but represents a real world sample. The quick 10 second measurements were shorter than many other test protocols, but were acceptable for this sample. The SZ-100V2 proved to be a workhorse instrument for quick, easy, repeatable zeta potential measurements. Longer cell lifetime also greatly reduces operating expenses, a major advantage only the SZ-100V2 carbon coated cells can provide.