Determination of the zeta potential of the surface of PTFE

ZETA POTENTIAL

Introduction

The measurement of surface zeta potential has previously been made using streaming potential [1, 2] including capillary flow techniques [3-5]. The streaming potential technique requires a specialist instrument dedicated solely to such measurements, and capillary flow is more suitable for fibrous samples, however accessories are available to measure flat surfaces.

In this application note, the surface zeta potential cell (figure 1) is used to study the surface potential of PTFE (polytetrafluoroethylene). The surface zeta potential cell is an accessory for the Zetasizer Nano instrument. The sample plate is held in place as shown and the vertical position of the plate moved with respect to the detection optics by the adjuster at the cell top. The cell is placed in a standard 12mm2 cuvette filled with the dispersant and tracer particles. The cuvette and cell are then placed in the temperature controlled Zetasizer cell area.

An electric field is applied and the subsequent motion of tracer particles, of arbitrary material dispersed within the electrolyte, is detected. The electrophoresis of the tracer particles and the electro-osmotic flow contribution from the wall can be described with a simple model and the surface zeta potential of the test plate can therefore be calculated [6].

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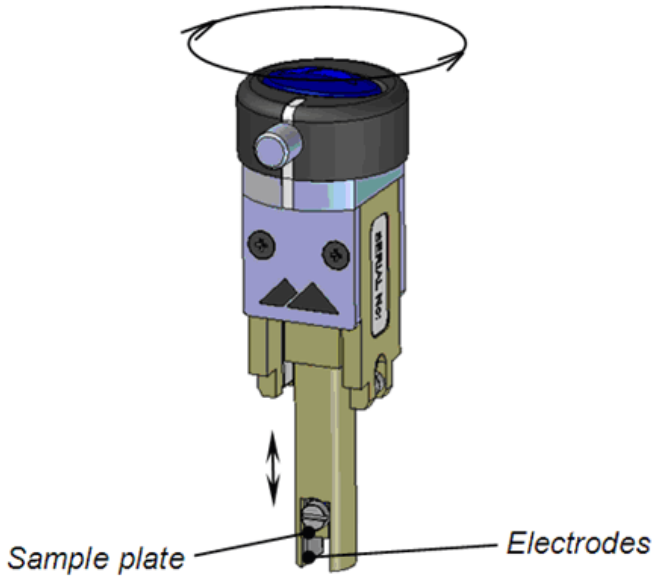

Figure 1: Schematic diagram of the surface zeta potential cell illustrating the location of the sample plate between the electrodes

Materials and Methods

pH 9.2 buffer, KCl, KOH and HCl were all obtained from Sigma-Aldrich (Dorset, UK). The PTFE was acquired from Goodfellows (Huntingdon, UK) and all test plate samples were cut to 4mm width, the spacing of the dip cell electrodes, <8.0mm in length and were generally no more than 1.5mm in thickness.

Two tracer particles were used, a carboxylated latex and a milk substitute. The latex is known to be particularly stable at pH 9.2 and the milk substitute is used as a general purpose pH titration test sample in the range pH 2 to 12. The 300nm carboxylated latex tracer particles were obtained from Invitrogen (Paisley, UK) and the Coffee Compliment milk substitute tracer particles were obtained from Premier Foods UK in predispersed form.

Results and Discussion

Result Reproducibility

The reproducibility of PTFE was investigated with 300nm carboxylated latex beads as tracer particles dispersed in pH 9.2 buffer. The latex is known to have a stable zeta potential of -68mV +/-10% at this pH and can be measured using laser Doppler electrophoresis for extended periods without degradation. The surface zeta potentials of various PTFE samples are shown in figure 2.

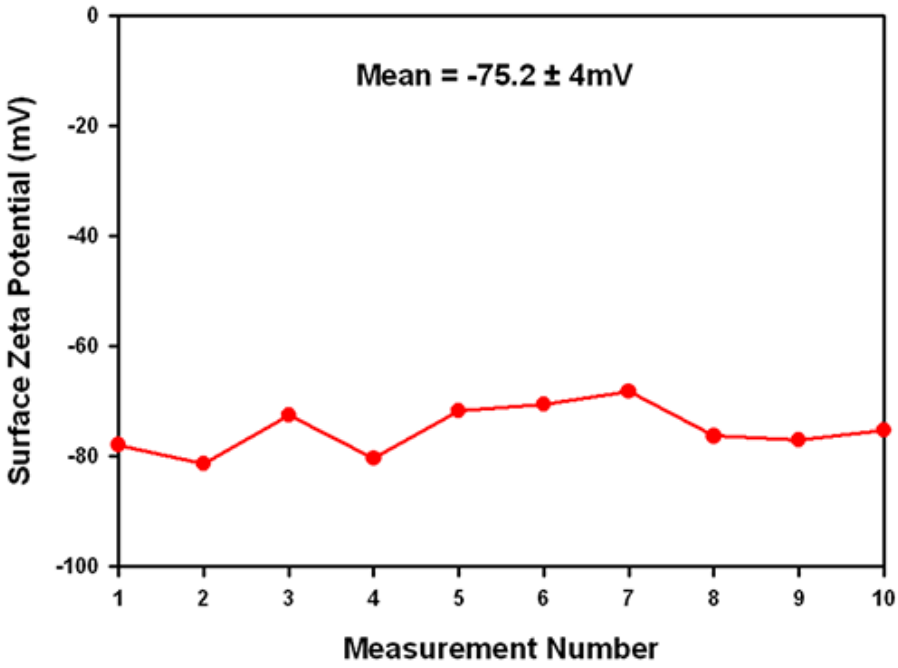

Figure 2: Surface zeta potential values obtained for 10 different samples of PTFE showing the reproducibility of the results

The average surface zeta potential result of -75.2mV +/- 4.0mV is in excellent agreement with literature values [2, 4, 5]. The Goethite, NIST traceable standard for dispersed zeta potential measurements quotes a pass/fail RSD of 10% [7] and the results obtained in this study show that the technique is capable of reproducing surface zeta potential measurements to better uncertainty than this standard. (4.0/75.2) x 100% = 5%.

Influence of pH

Titrations of surface zeta potential against pH are likely to be one of the primary applications for this technique. Therefore a series of measurements of PTFE were conducted in 1mM KCl and the pH varied using HCl and KOH. The milk substitute was used as a tracer for all measurements. Each pH point is a separate measurement sequence using the cell.

Figure 3 shows that the results are in good general agreement with streaming potential, dispersed particles of the same material and capillary electrophoresis [2, 4, 5] at all pH values tested in the region of the iso-electric point (IEP). There is less general agreement at higher pH values but this appears to be a general feature of all techniques. For the surface zeta potential cell data, the surface potential is expected to saturate at high (and low) pH as all available surface charge groups are ionized.

Conclusions

A new, simple technique for the measurement of surface zeta potential using laser Doppler electrophoresis has been presented. The results reported here have shown the technique to be characterized by a relative standard deviation in reproducibility of <10% for well-behaved systems, yielding accurate and reproducible surface potential values in excellent agreement with literature values from streaming potential, electro-osmotic (capillary) flow and particle dispersions for various surface types.

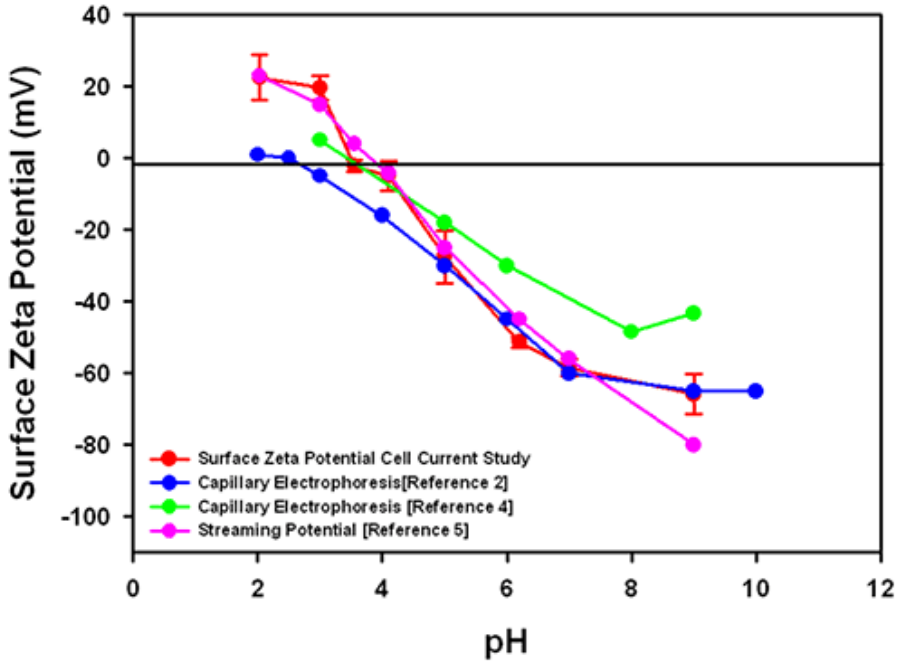

Figure 3: Comparison of the pH titration results obtained with the surface zeta potential cell with other techniques

References

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