Particle charge electrically and optically measured - an analysis of efficiency

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Abstract

The knowledge of the electrostatic interface charge potential known as zeta potential (ZP) is important for the functionalization of particles and for the control of the affinity of surfaces to particles and macromolecules. The ZP measurement via an optical electrophoresis set-up is well known but can become a tedious task, as zeta potential as a single point parameter is not sufficient for the understanding of new formulations. The presence of polyelectrolyte, salt concentration and pH have influence on the ZP, making titrations necessary in order to get a reliable charge finger print. In optical electrophoresis, such charge titrations require external sample mixing and subsequent long equilibration times for each titration step before the sample can be measured. Due to the time consumption (~1h) and complexity of titrations, such studies were either performed by random sampling or even omitted. The presented oscillating streaming potential (OSP) method offers an electrical signal pick-up, which releases particle interface potentials within seconds. As the titrand solution is mixed into the sample beaker directly, titrations are finished in minutes (fig. 1). All in all, the efficiency of the OSP method invites to do charge measurements and titrations.

Opposite to conventional techniques, the sensitivity of the OSP method is high for nano-particles and polyelectrolytes which are frequently used in coat surfaces. The sensitivity of OSP can be explained by the increased specific surface compared to microparticles. An example of protein titration is demonstrated in figure 2.

The extension of the working range to polymer solutions closes an important gap in colloid science. Due to lack of sensitivity, such measurements are not possible with optical zeta potential measurement methods. Combined with a dynamic light scattering sensor the OSP procedure offers the determination of the specific surface charge [C/m²]. Charge and size measurements exhibit a large working range in size and concentration, <1 nm up to 6.5 µm and 0.001% v/v to 40% v/v, respectively, making OSP a flexible technique suitable for a broad range of applications.

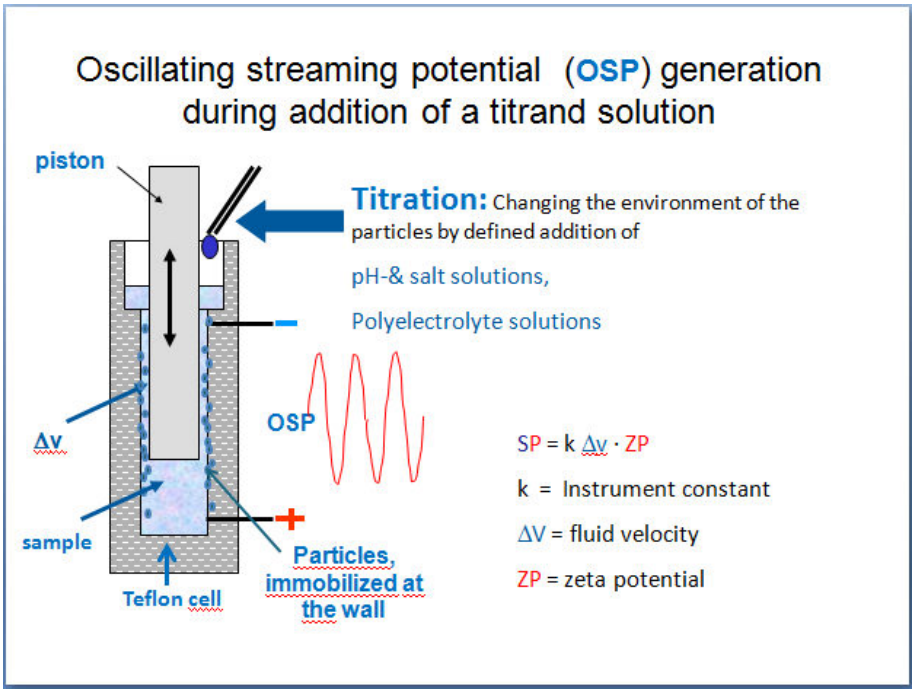

Fig. 1: Principle of efficiency: Oscillating streaming potential between the pick-up electrodes. The signal is generated from ions at the interface of particles immobilized at the Teflon measurement cylinder. The signal is instant and responds immediately (in s) to the addition of titrand solutions.

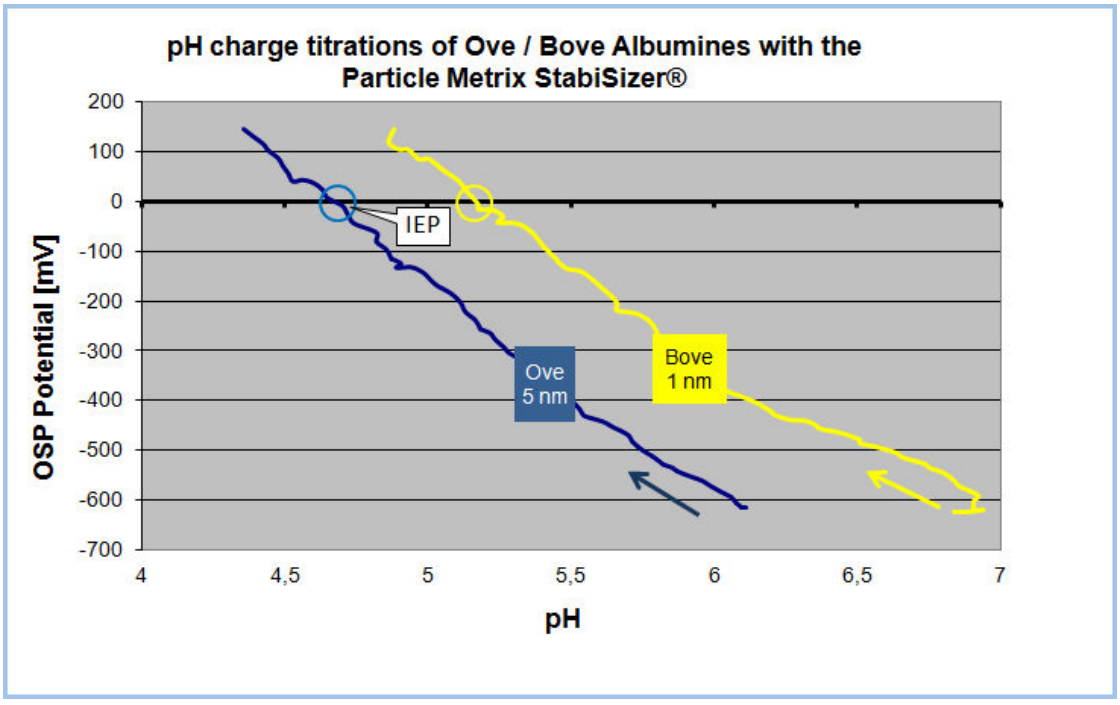

Fig. 2: pH charge titrations on 1 nm BOVE albumin and 5 nm OVE albumin over the isoelectric point (IEP). The concentration of the samples was 1%. One titration took less than 10 minutes.