Tool to quantify ionic activity of macromolecules and charge density on particle interfaces

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A new analysis tool is presented for the formulation of ionic macromolecules and charged particle interfaces. Ionic activity of macromolecules can be determined by titrating the ionic interface potential against a polyelectrolyte solution of known elementary charge content ("polyelectrolyte titration"). In figure1 a polyelectrolyte titration is presented as an example. By entering the weight, volume and molecular weight of the sample, a result is obtained in $Cmol^{-1}$. The ionic loading of particles is measured by the same titration procedure. The result in volume consumption is recalculated as weight specific [Cg^{-1}] or surface specific [$Cm^{-}2$] charge. The latter is achieved by measuring the sample simultaneously with a DLS dynamic light scattering size probe.

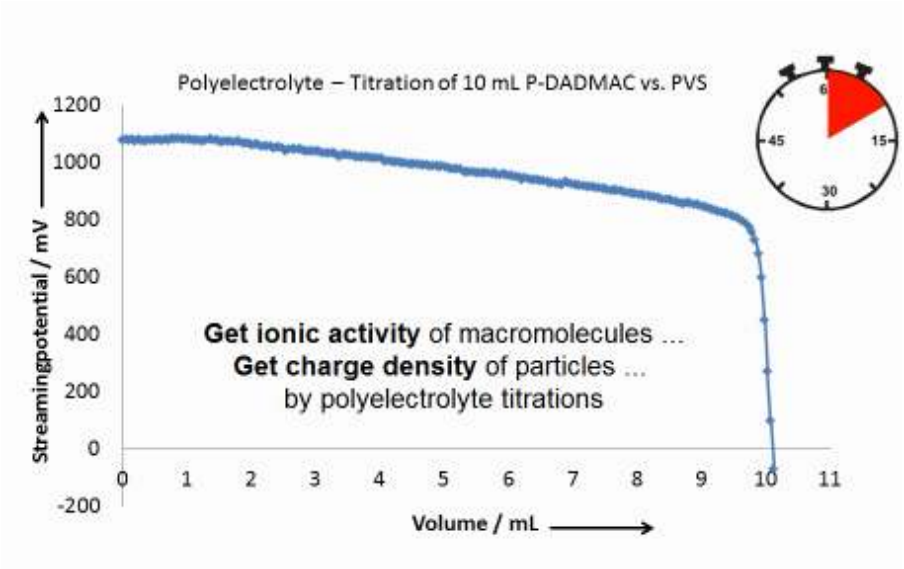

Fig. 1: A polyelectrolyte titration of a cationic polymer vs an anionic polyelectrolyte solution with known charge content. Depending on the calibration, the scaling of the potential can be in streaming potential – as shown here - or in zeta potential units – as shown in fig.2 -.

The charge tiration is based on the streaming potential method offering a quickly reacting electrical signal. It is designed for formulation work, where reactions of ionic interfaces to environmental conditions like pH, ionic surfactants, salt or conductivity can be studied very efficiently. All polar media based samples, black and transparent, of low and high conductivity, from sub-nanometer up > 100 µm can be analyzed with this method. An upper concentration limit of 40%v gives room for many studies of undiluted samples.

As the size and concentration range of both methods, in-situ DLS sizing and streaming potential charge titration, almost overlap, the combination of both pairs ideally. From 180° DLS hydrodynamic size analysis, sample concentration and specific surface charge are derived. In many cases it helps to determine the critical coagulation point. A typical example of charge and size measured versus pH is shown in figure 2. It shows at which condition coagulation starts.

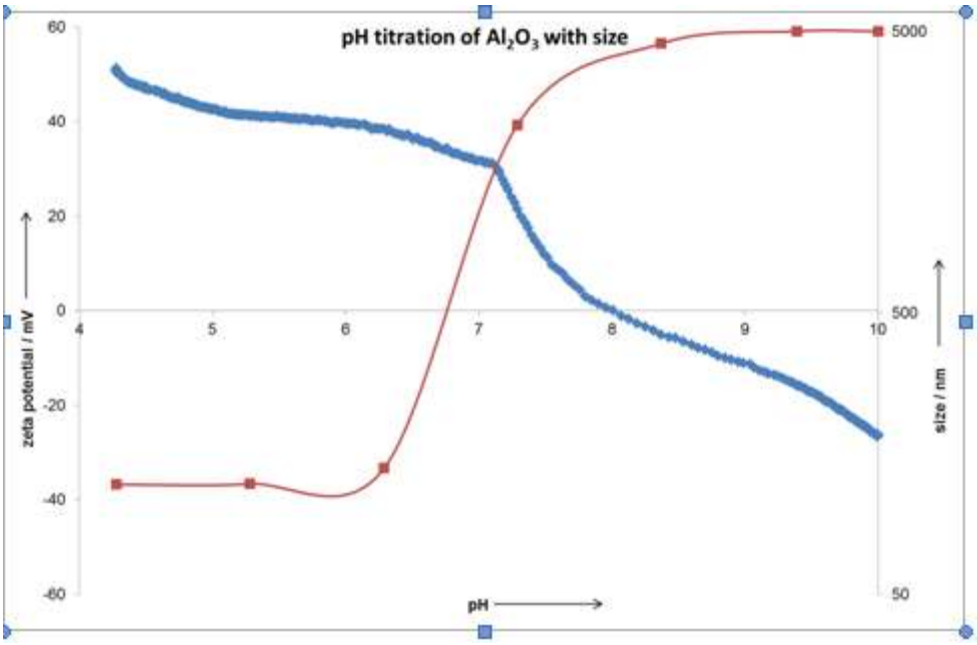

Fig. 2: During a pH - charge titration on a 1%w Al_2O_3 titration, DLS size was measured in-situ. The size result demonstrates coagulation far before the isoelectric point is reached. The titration started at pH = 4.3.

The streaming potential method although proven in wet paper process analytics, is less known in other applications. Nevertheless it is very useful und capable of making new discoveries. In combination with the proven 180° DLS probe it offers even more ways for charge and size mapping of colloid samples.

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