Application Note – Colloid Analysis

C01 - Controlling the Efficiency of the Functionalization of Carbon Nanotubes by Ionic Charge Titration

Introduction

Many particulate systems depend on the stability and re-dispersion capability of the particle suspensions where the pH range is not too restricted. One method to achieve stability is to modify the interface with suitable ionic end groups. The higher the ionic charge density, the higher the repulsive force between the individual particles, thus overcoming Van der Waals attraction! Ionic repulsion is characterized by the electro-static particle interface potential (PIP) and by the total ionic surface charge. Both, pH stable regions and total ionic charge, can be easily controlled with **Stabino®** charge titrations.

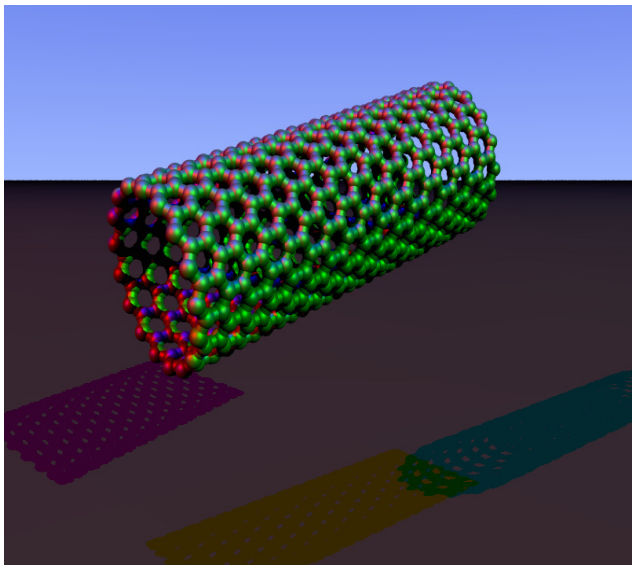
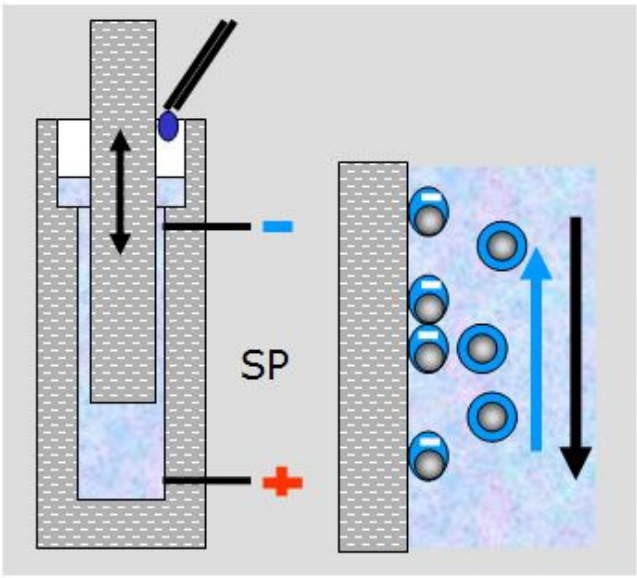


Figure 1: Carbon Nanotube

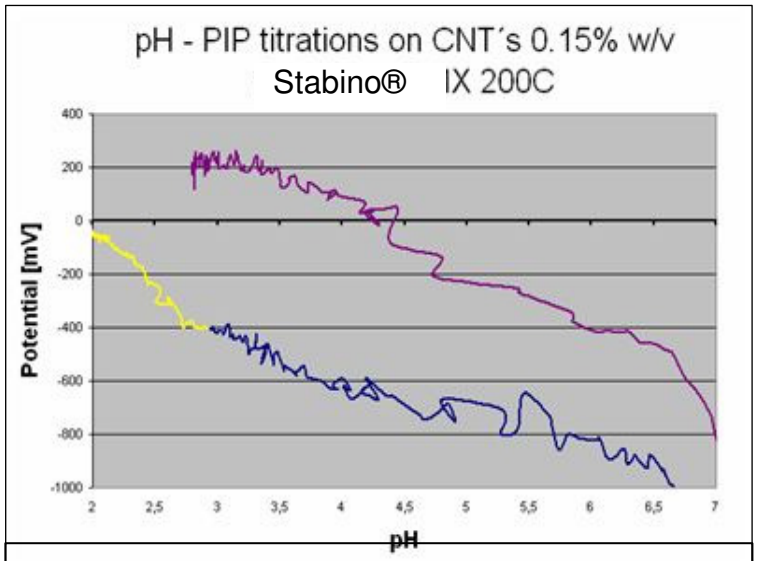
The Stabino® Experiment

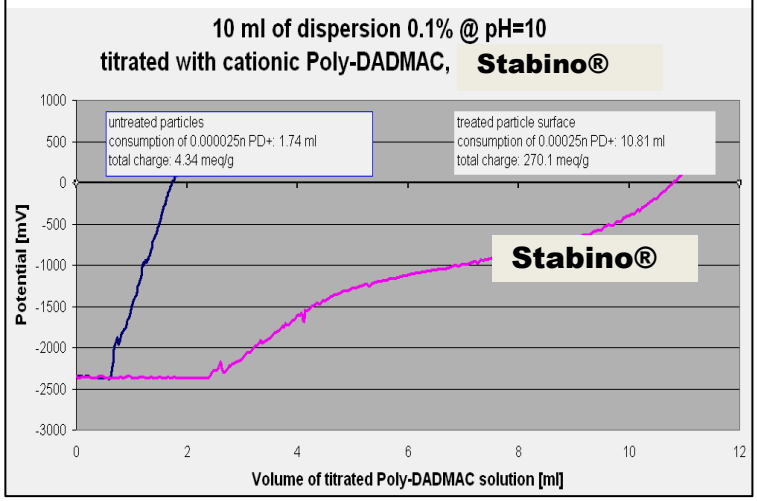
Titrations are performed on a 10 ml aqueous dispersion. The concentration range for titrations is 0.001% to 10% v/v whereas for individual potential measurements it can go up to 50% v/v. The oscillating piston induces the Streaming Potential SP, whilst mixing the titrand into the sample and preventing the suspension from sedimenting. The speed of the titration is optimised for sufficient mixing in the shortest time period.



The Results

First of all, pH – charge titrations on 0.15% w/v CNT dispersions were done to measure the iso-electric point IEP (see below). The D50 laser diffraction size of the CNT dispersion was 20 µm, measured with **Microtrac S3500**. The IEP of the untreated CNT (violet) was pH=4.3, whereas the IEP of the surface modified CNT (blue and yellow) was below pH=2. As **RESULT #1,** with treatment the stability range could be extended in pH by more than 2.





In the **Stabino®,** the ionic charge density is determined by performing polyelectrolyte titrations to the zero point of charge. Because of the anionic nature of the CNTs surface, the titration is done with a cationic polymer. 1 n of cationic Poly-DADMAC (PD) solution carries 1 eq of electronic charge. Assuming charge compensation of 1 to 1, the consumption of the PD is a measure of the total charge per gram sample.

The diagram on the right is self-explaining. It shows as a **RESULT #2,** that the treatment was very successful in the sense, that **the surface is functional to a high degree.**

Conclusion

In general, a titration shows how the sample reacts to changes in its environment. This is much more information than only the particle interface potential (Zeta potential) at one given state of the sample. In addition, the total charge reflects the charge density.

The **Stabino®** is designed for efficient particle charge and pH - charge titrations. No sample parameters are needed. Five titrations can be performed in one hour. The method has been applied to many colloid and particulate systems in the range between 1 nm and 100 µm. ZnO, CNTs, SiO_2 , Al_2O_3, proteins, are just a few examples.

Particle Metrix GmbH
Am Latumer See 13 • 40668 Meerbusch / Germany • Phone: +49 (0)2150/705679-0
info@particle-metrix.de • www.particle-metrix.de