Zeta potential

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Abstract

Describes the nature of the electrostatic potential near the surface of a particle,

called the zeta potential. Explains how the zeta potential is determined by measuring

the velocity of the particles in a electric field.

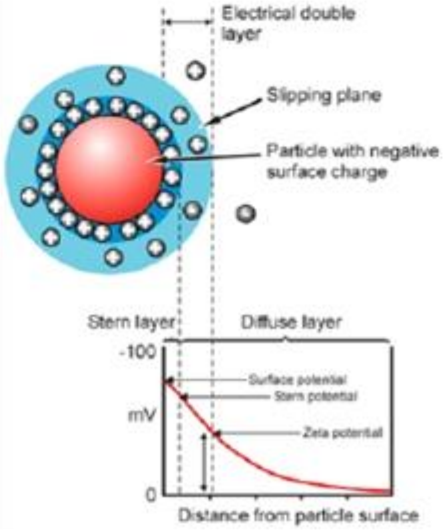
Introduction

- The particles in a colloidal suspension or emulsion usually carry an electrical charge . Maybe its nagative or positive.
- Sometimes the surface of the particles contains chemical groups that can ionize to produce a charged surface. Sometimes the surface itself preferentially adsorbs ions
- of one sign of charge in preference to charges of the opposite. the amount of charge on the particle surface is an important
- particle characteristic because it determines many of the properties of the
- suspension or emulsionsign.

Charge Distribution

- Although we speak of the particles as being electrically charged it is important to realize that the charge on the surface of each particle is the surrounding solution counterbalanced by charges (ions) of opposite sign in .The charges on the particle surface are normally considered to be attached rather firmly to it and to remain there more or less indefinitely (though they may be exchanging with charges of similar type in the solution). The surrounding (balancing) charge, by contrast, is much more loosely associated with the particle .

figure 1


Electrical double layer
Slipping plane
Particle with negative surface charge
Stern layer
Diffuse layer
-100
mV
0
Surface potential
Stern potential
Zeta potential
Distance from particle surface

- The oppositely charged ions (called counter-ions) tend to congregate around the
- particle and very few negatively charged (co-ions) can get close to the surface
- because of the repulsion from the charges on the particle. Farther away from the
- particle the co-ions suffer less repulsion and eventually, at distances of at most a few
- tens of nanometres, the numbers of cationic and anionic charges are evenly balanced.

Measuring the Charge

- There are various ways to measure the particle charge but it must be recognized that
- the different methods do not always measure the same quantity. One of the most
- effective methods is to apply an electric field to the suspension and to measure how
- fast the particles move as a result. That process is called electro-phoresis. The
- bigger the charge they carry, the faster the particles will move.

- It turns out, however, that in such an experiment one does not usually observe all of the particle charge. The electric field pulls the particle in one direction but it will also
- be pulling the counterions in the opposite direction. Some of the counterions will
- move with the particle (those within the dotted circle, say) so the measured charge
- will be a net charge taking that effect into account

- The electrostatic potential near the particle surface is shown in Fig(1) It changes very quickly (and linearly) from its value at the surface through the first layer of counterions and then changes more or less exponentially through the diffuse layer.
- .That surface, which separates the bound charge from the diffuse charge around the particle, marks where the solution and the particle move in opposite directions when an external field is applied. It is called the surface of shear or the
- slip surface.
- The electrostatic potential on that surface is called the zeta potential .
- The velocity (in metre/second) for a unit field strength (1 Volt
per metre) is called the
- electrophoretic mobility, and is given the symbol μE. It is related to the zeta potential .the equation of velocity
- U=V/E
- V=velocity of movment
- E=electic field

- When the charge is measured in this way it reflects more realistically what one particle "sees" as it approaches another particle and that is what determines the properties of the suspension. If the repulsion between approaching particles is large enough they will bounce away from one another and that will keep the particles in a state of dispersion. If the repulsive force is not strong enough, the particles will come
- together and may stick in a permanent doublet. Then other particles may come along and also be caught in the growing aggregate.

- The suspension is then unstable and the aggregates will quickly settle out from the surrounding medium. If one is relying on the electric charge alone to keep the system in a disperse state then the zeta potential will usually need to be kept above
- 25 mV (positive or negative). On the other hand, if one wants to separate the particles and remove them from the surrounding fluid, it will pay to reduce the magnitude of the zeta potential.
- Equation of zeta potential: =□

Factors effecting of zeta potential

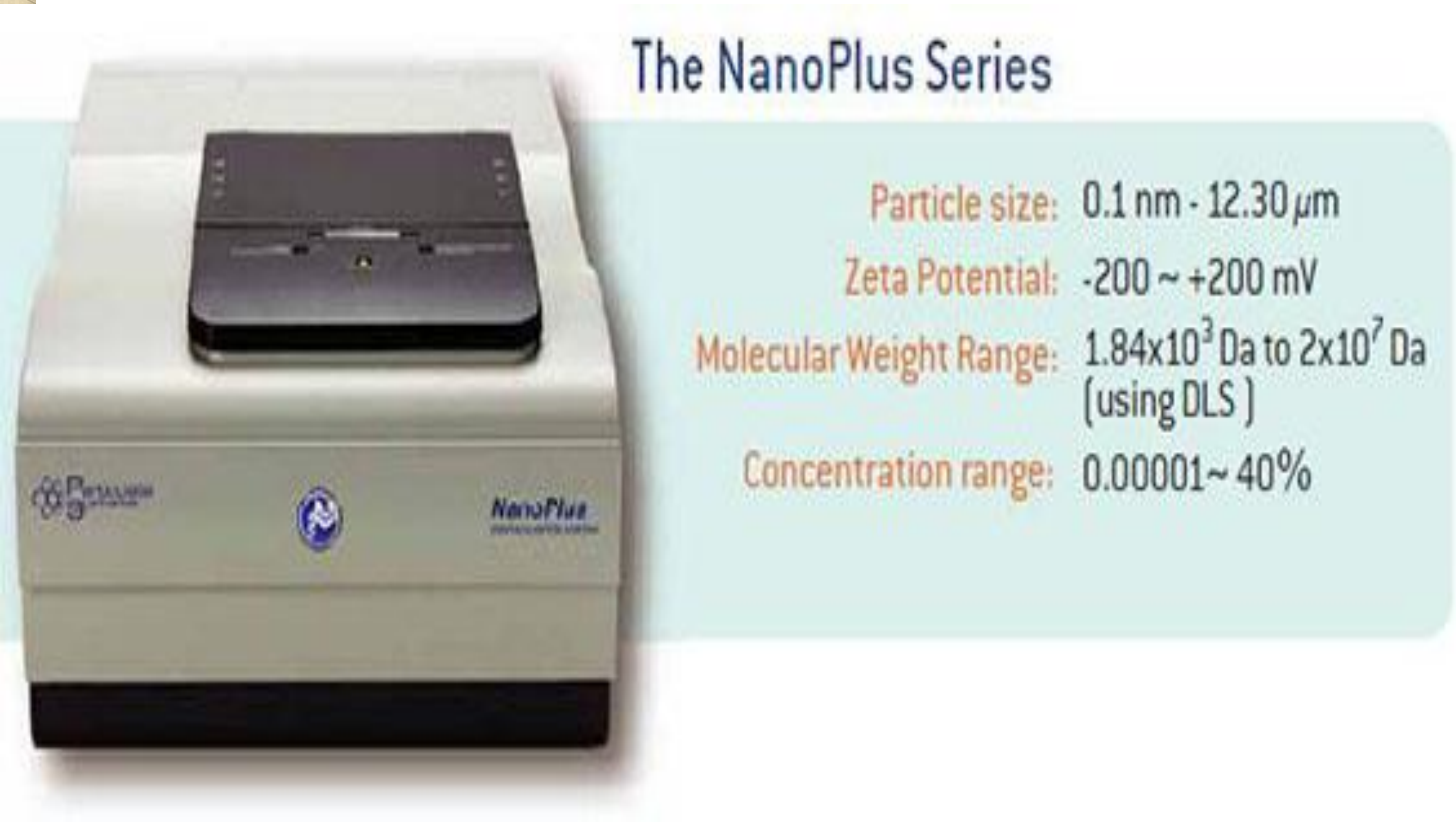
- ***<u>1-Nanoparticle concentration</u>***

- NP concentration should be maintained in a range that allows to obtain a high signal to noise ratio, avoiding multiple scattering interferences . If the NP dispersion is too concentrated, although a movement can be detected and measured, it may provide interpretation issues while converting electrophoretic mobility to zeta potential values due to multiple scattering phenomena and to the limitation of NP mobility (no Brownian motion)

2-Nanoparticle size

Zeta potential measurements are relevant only in samples with size the sub-5μm region . If sedimentation or significant aggregation of the sample occurs before or during the measurement, the system is not suitable for zeta potential measurements, since NP electrophoretic mobility is strongly compromised. The lower limit for the measurement of electrophoretic is determined by the signal to noise ratio, which is a complex function of size, concentration and refractive index of the NP dispersion. Therefore is impossible to give an unambiguous statement of the lower size measurable

- ***3-liquid meduim***
- meduim is Minimum of level of conductivty of the that an electric requierd is requierd in solution ,so field can be applied in the cell without inducing electrode polarization which causes voltage irregularities
- ***4-measurment of PH***
- zeta potential is a function of the particulate system as a whole (NPs + environment) and varies with the characteristics of the dispersive medium. Zeta potential values
- for a specific sample strongly depend on the pH and on the conductivity of the dispersive



The NanoPlus Series

Particle size: 0.1 nm - 12.30 μm

Zeta Potential: -200 ~ +200 mV

Molecular Weight Range: 1.84×10^3 Da to 2×10^7 Da (using DLS)

Concentration range: 0.00001~ 40%