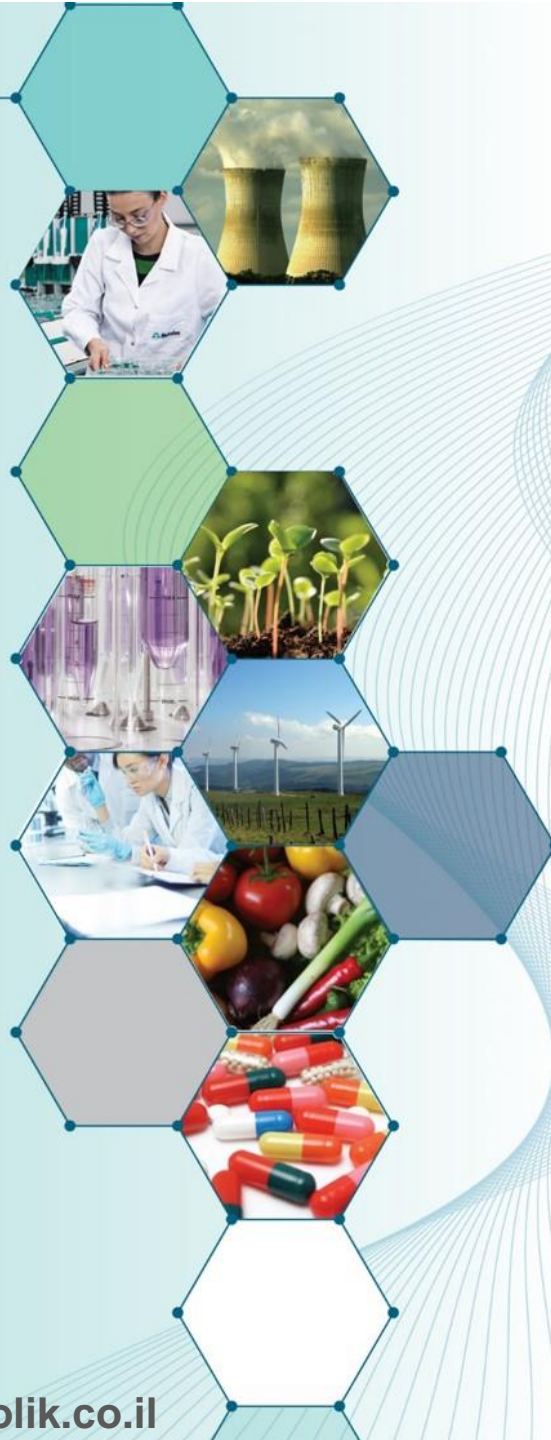




Zeta Potential - "Charge Stability"

Formulation Dispersion Stability Symposium

Adi Ben-Yaakov
Head of Application Services
Physical Characterization Department



Agenda



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- › Zeta Potential Overview
- › Measuring Zeta Potential
- › Case Studies





Zeta Potential
Overview

Why to Measure Zeta Potential?



- Important for multi-component and formulated products such as:
Pharmaceuticals, Vaccines, Cosmetics, Paints, Food, Emulsions...
- Provides information about:
Stability, Chemistry & Interfacial properties
- Reduce product variability
- Improving product's stability and shelf-life

If used
by
.....

Best
Before
.....

Use by
.....

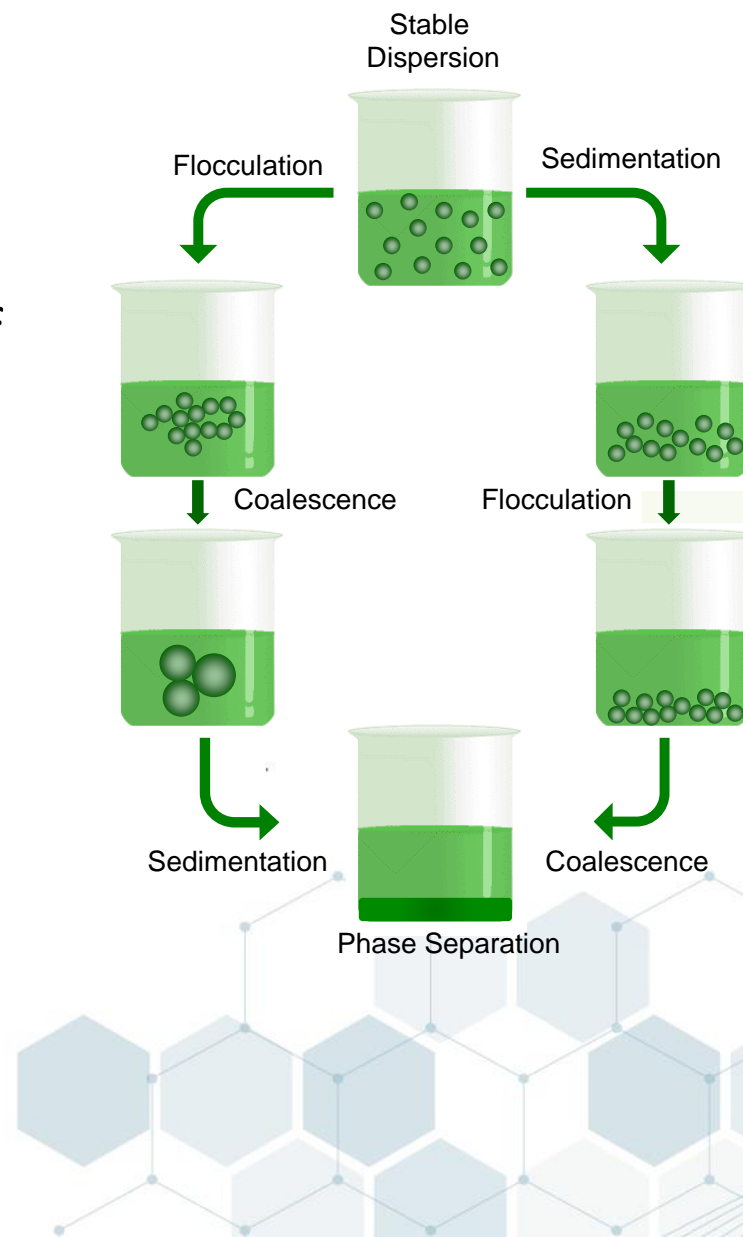
Expiry
date
.....

"I should
definitely ask
an expert.."



Colloidal Stability

- Colloidal stability determined by the sum of **attractive** forces and **repulsive** forces

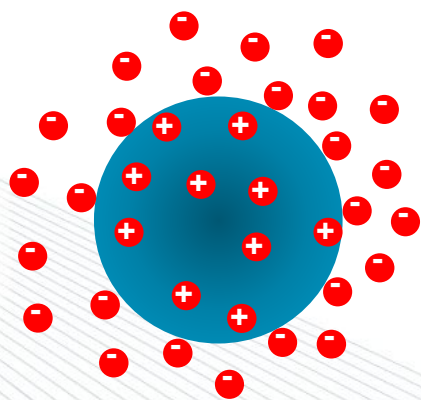


Maintaining Colloidal Stability

Two mechanisms can be used to maintain colloidal stability:

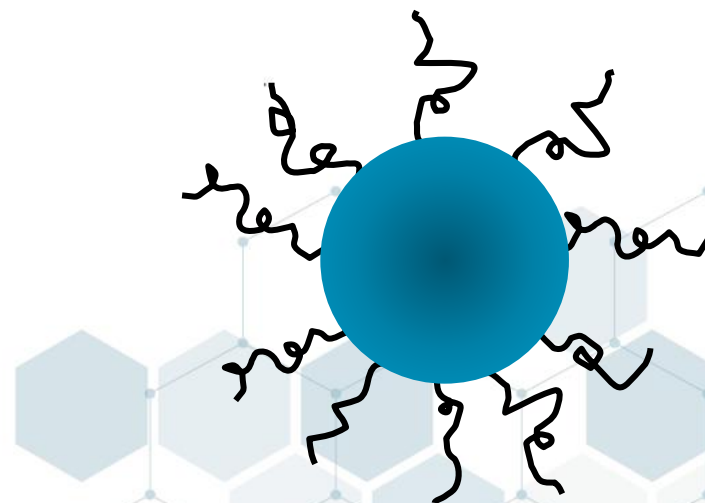
Electrostatic

- › Easy to measure (zeta potential)
- › Reversible
- › May only require change in pH or ion concentration



Steric

- › Simple, but limited options
- › Irreversible
- › An extra component



Zeta Potential



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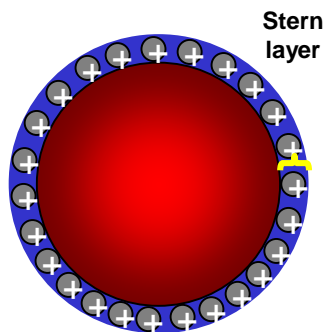


Negatively
Charged
Particle



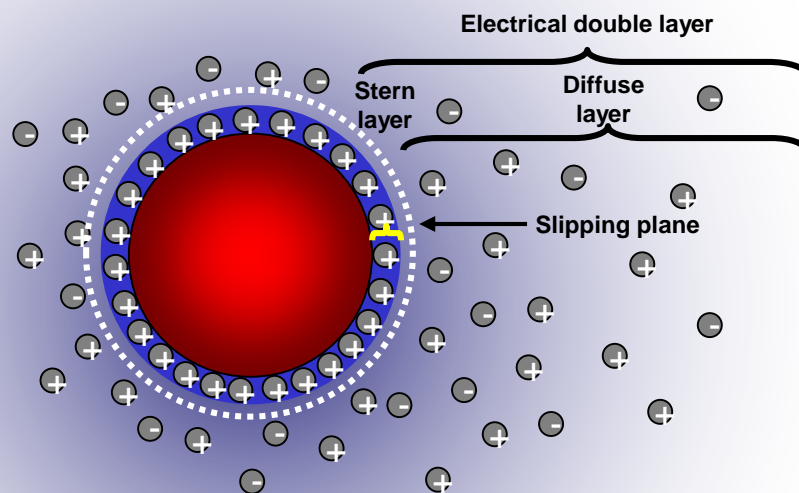
Zeta Potential

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Zeta Potential

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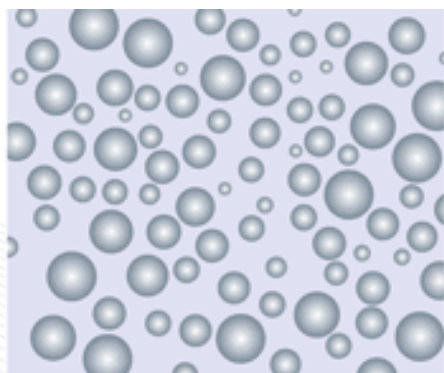
Zeta Potential = Electrical potential at the slipping plane

Zeta Potential

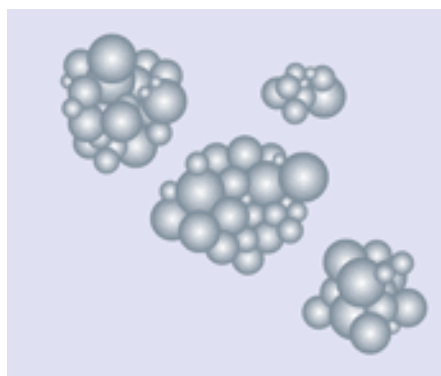


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- › Measure of the electrostatic or charge repulsion present in a sample
- › Magnitude indicates the **potential stability**
- › Dependent upon the chemistry of both the **particle/molecule surface** and **dispersant**
- › Aqueous dispersion stability dividing line $\approx \pm 30\text{mV}$



High zeta potential = stable dispersion



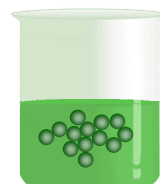
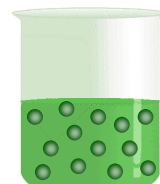
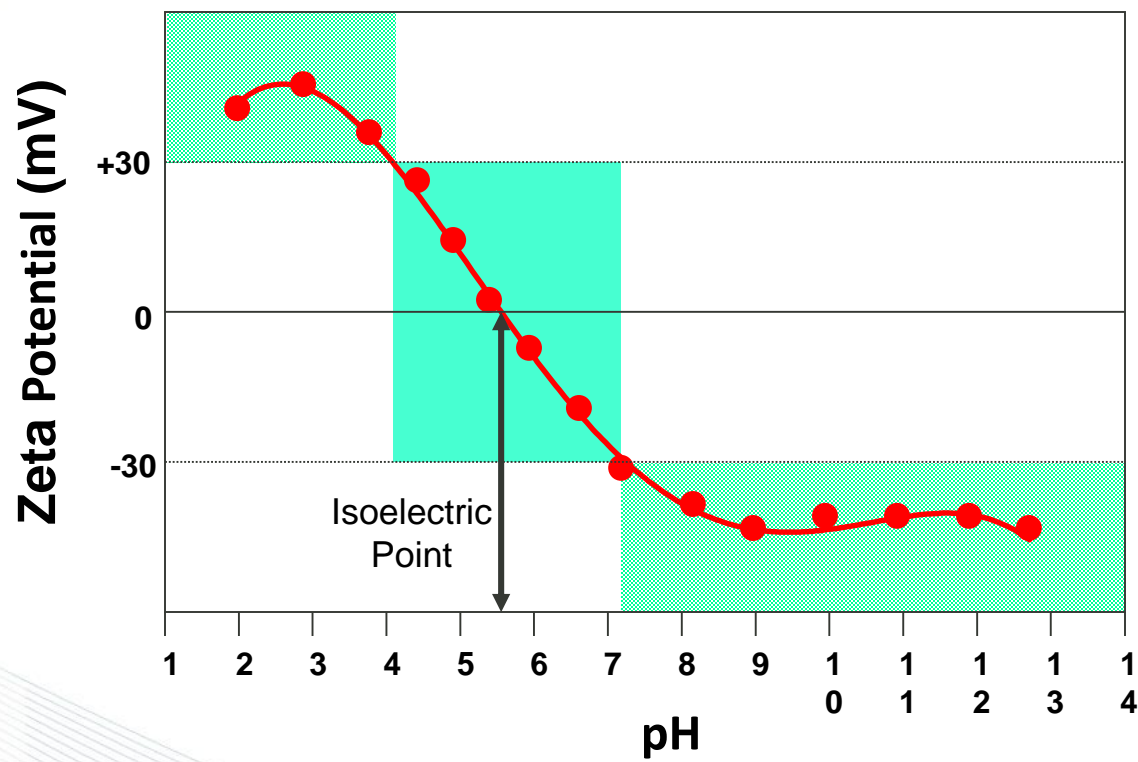
Low zeta potential = colloidal instability

Factors Affecting Zeta Potential

- › Changes in pH
- › Ionic strength (concentration and/or type of salt)
- › Changes in the concentration of an additive (eg coagulant, surfactant)

pH

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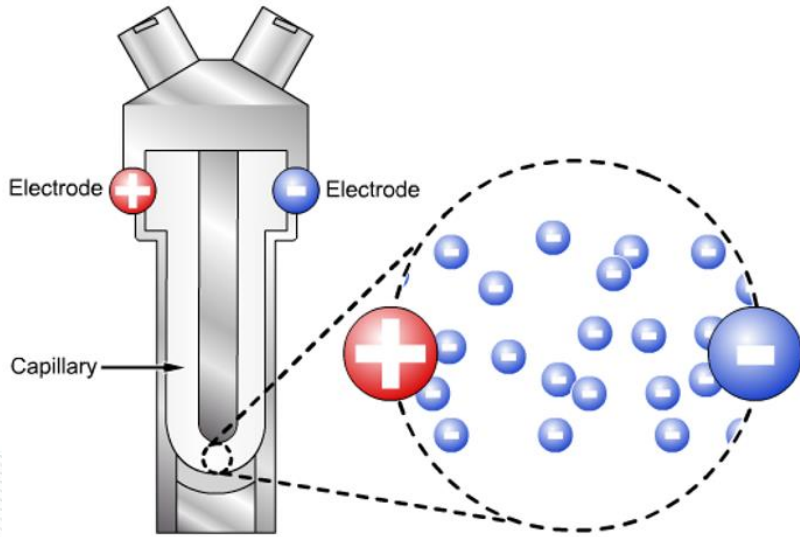
Measuring
Zeta Potential

Measuring Zeta Potential

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Electrophoresis

Movement of a charged particle relative to the liquid it is suspended in under the influence of an applied electric field



Particle velocity dependent on:

- **Zeta potential**
- Field strength
- Dielectric constant of medium
- Viscosity of the medium



Stability
Case Studies

Paints



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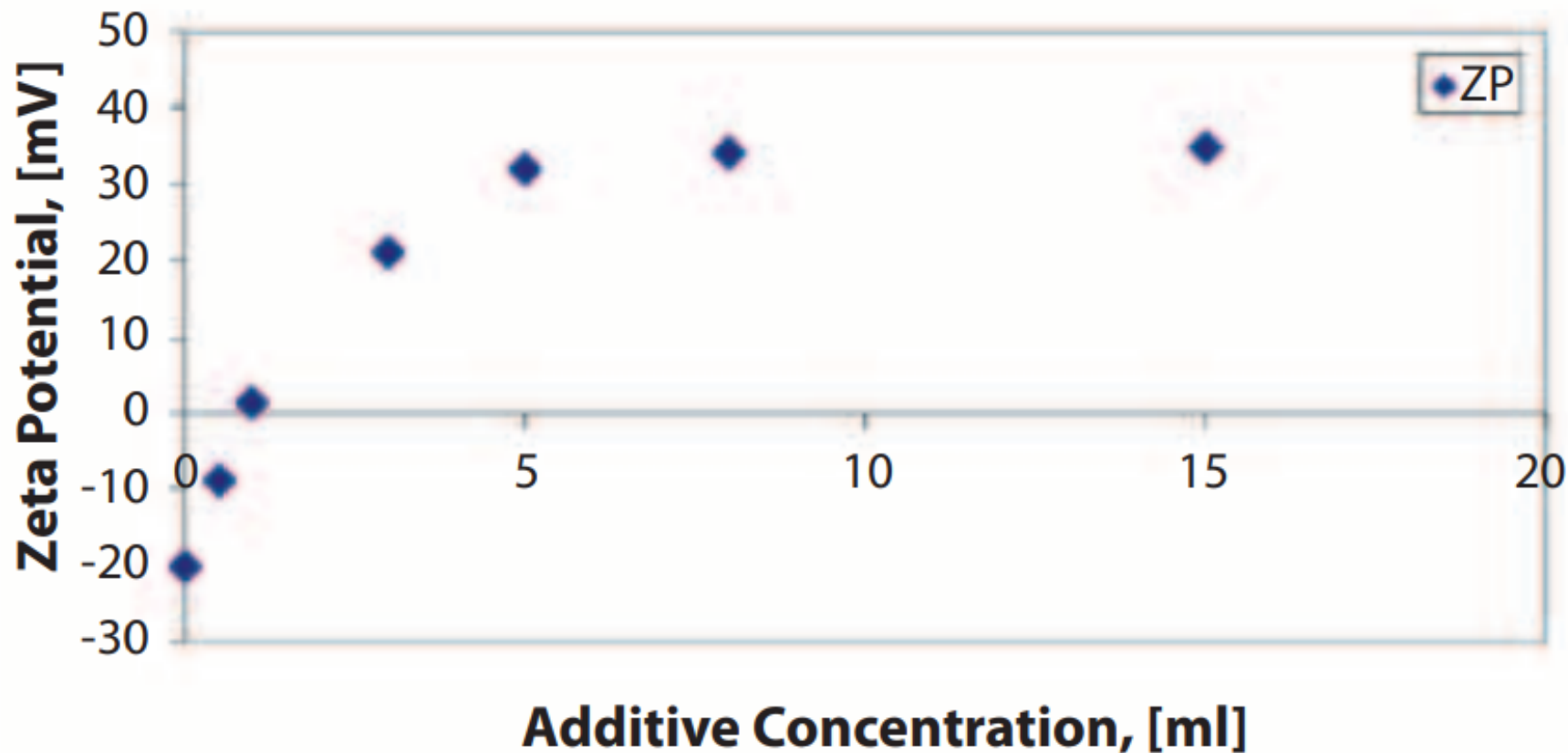
- Paint products are multi-component systems
- The rate and uniformity at which these coatings wet spread and coalesce into a film should be controlled
- Pigments, emulsion, surfactants, thickeners, processing aids..
- These elements affect the surface chemistry of the solids
- **The role of these components can be studied by ZP**



Paints

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Zeta Potential Vs. Processing Aid Adsorption



Paints



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- Paint properties can be controlled by its components
- Zeta potential measurements provide insight into the stability of the pigments in the paint
- **Zeta potential helps in controlling product's quality**



Water Treatment



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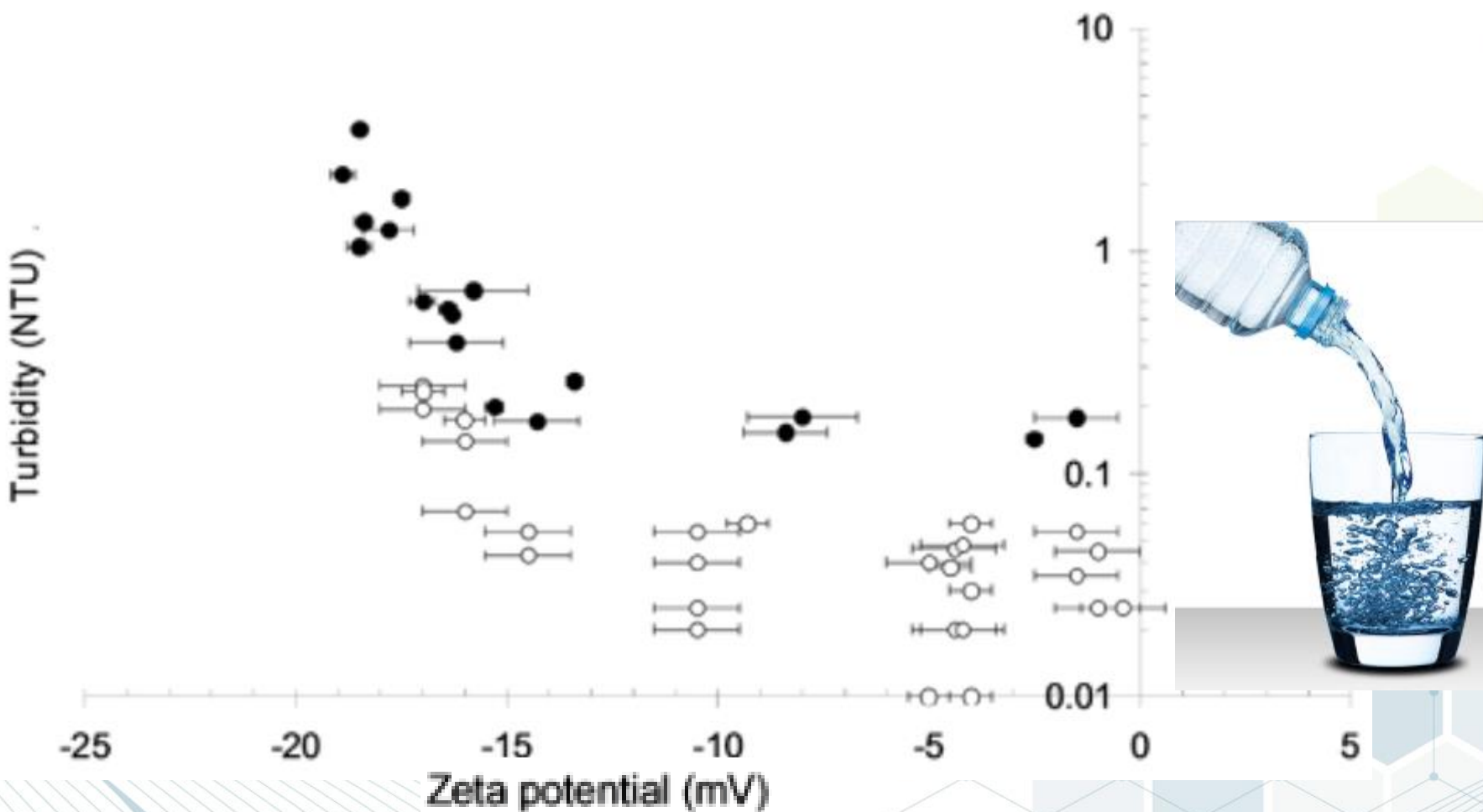
- Water treatment is related to physical processes such as sedimentation and filtration
- These processes depend on the principles relating the size, density and the charge of the particles to be removed
- In waste water processes, surface forces play a vital role in controlling the removal of particles
- **Zeta potential** is known to be a key factor in understanding flocculation and sedimentation.



Water Treatment

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Turbidity Vs. Zeta Potential



Water Treatment



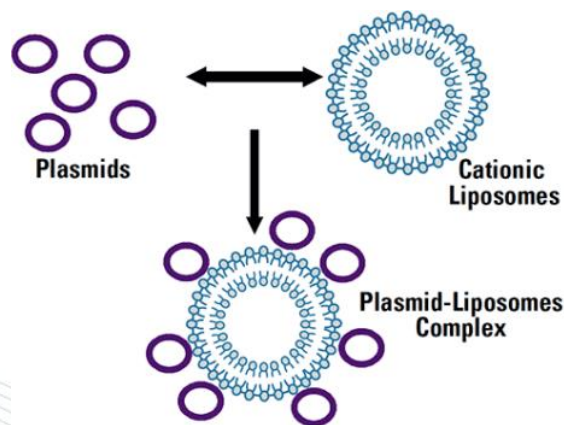
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- Water treatment efficiency can be controlled by ZP measurements
- ZP enables water treatments plants with scientific confidence and saves them money

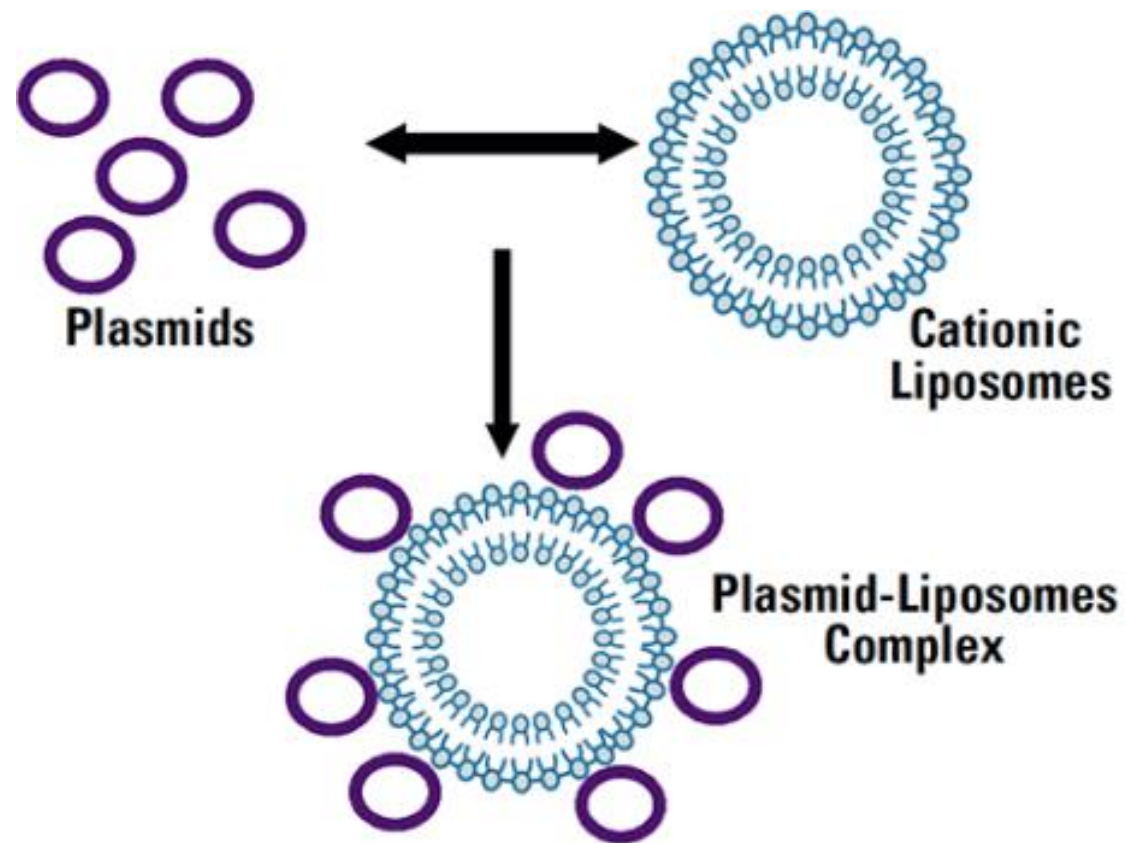


Liposomes – Gene Therapy

- Gene therapy is the process by which genetic material is delivered to patients for a therapeutic purpose.
- Vectors are delivery vehicles - usually a virus or a liposome - used to transport the genetic material to target cells in the body.



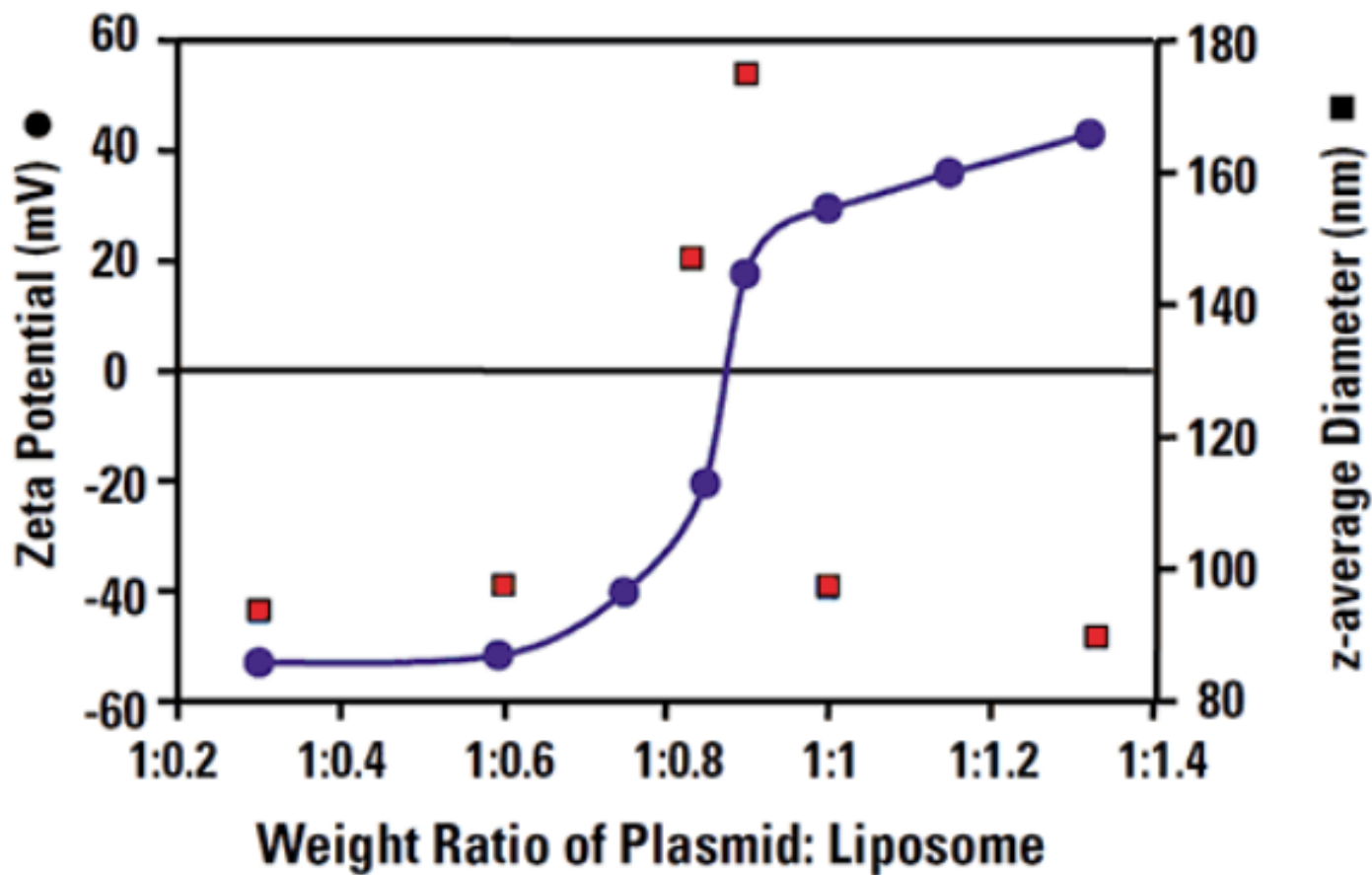
Liposomes – Gene Therapy



- Cationic liposomes are complexed with DNA – Plasmids
- The liposome:Plasmid ratio is essential for optimal transfection

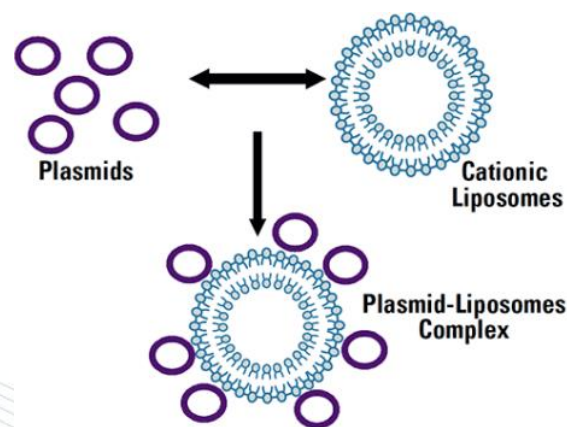
Liposomes – Gene Therapy

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Liposomes – Gene Therapy

- ZP measurements can be used to optimize the ratio of liposomes with plasmids
- Zeta potential with DLS sizing measurements allows characterization of plasmid: liposome complexes



Cosmetics – Topical Formulation



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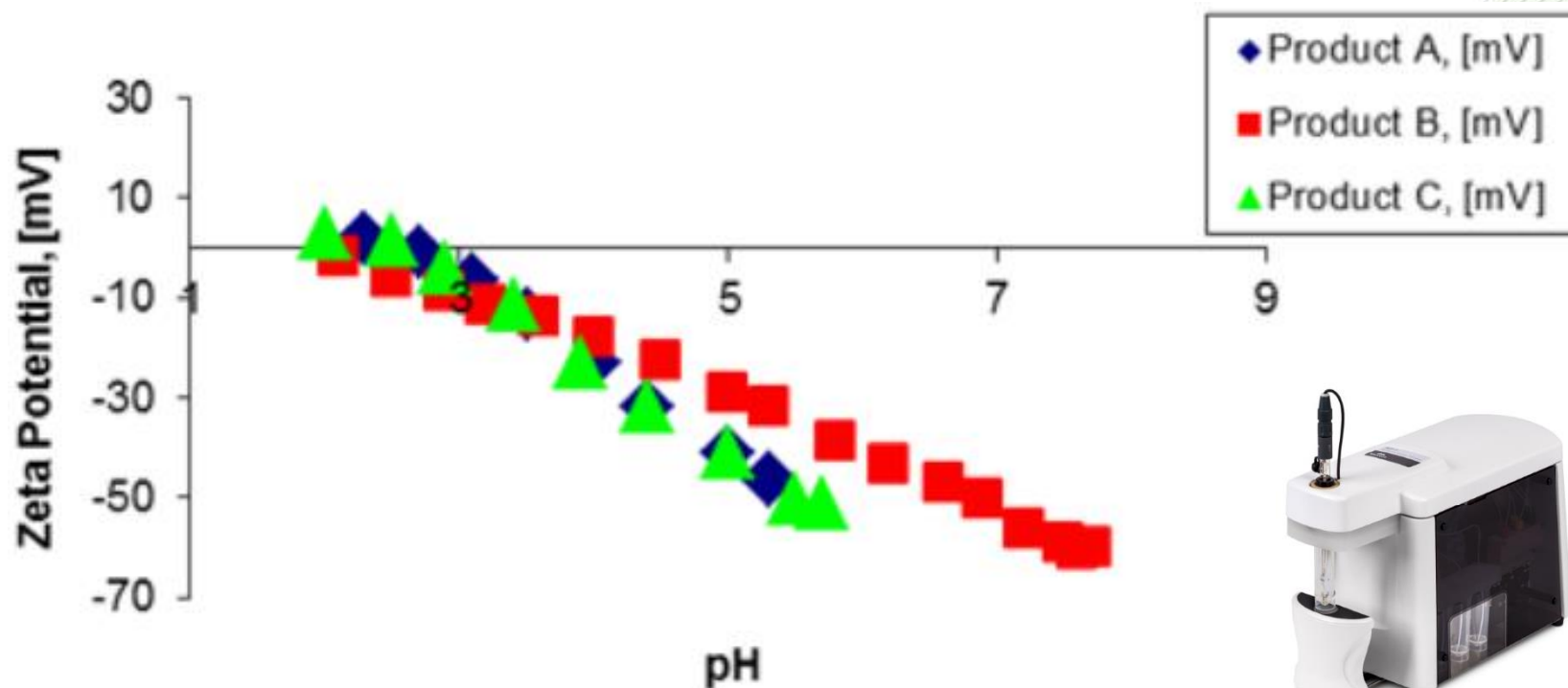
- Understanding variations in zeta potential of raw materials can optimize manufacturing process
- Variables include: chemical composition, temperature, homogenization and cooling rate
- An encapsulated Retinol (Vitamin A) system used in dry skincare product formulation



Cosmetics – Topical Formulation

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Titration of Retinol Dispersion



Measurements were made with diluted samples in different pH

Cosmetics – Topical Formulation



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- ZP identifies the surface chemistry that will give optimum functionality
- Understanding the surface chemistry allows the formulator to determine what the potential reactivity might be
- ZP measurement provides quality assurance for the final product



Any questions?



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Summary



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- › The higher the value of ZP the more stable the dispersion
- › Understanding the role of components / excipients
- › Measuring ZP can predict the stability of your product
- › ZP is useful in identifying instability as well



Thank you

Adi Ben-Yaakov
Application Services
Physical Characterization Dept.

Email: Adi@golik.co.il Phone: 054-888-2620

