

Measuring The IsoElectric Point (IEP)



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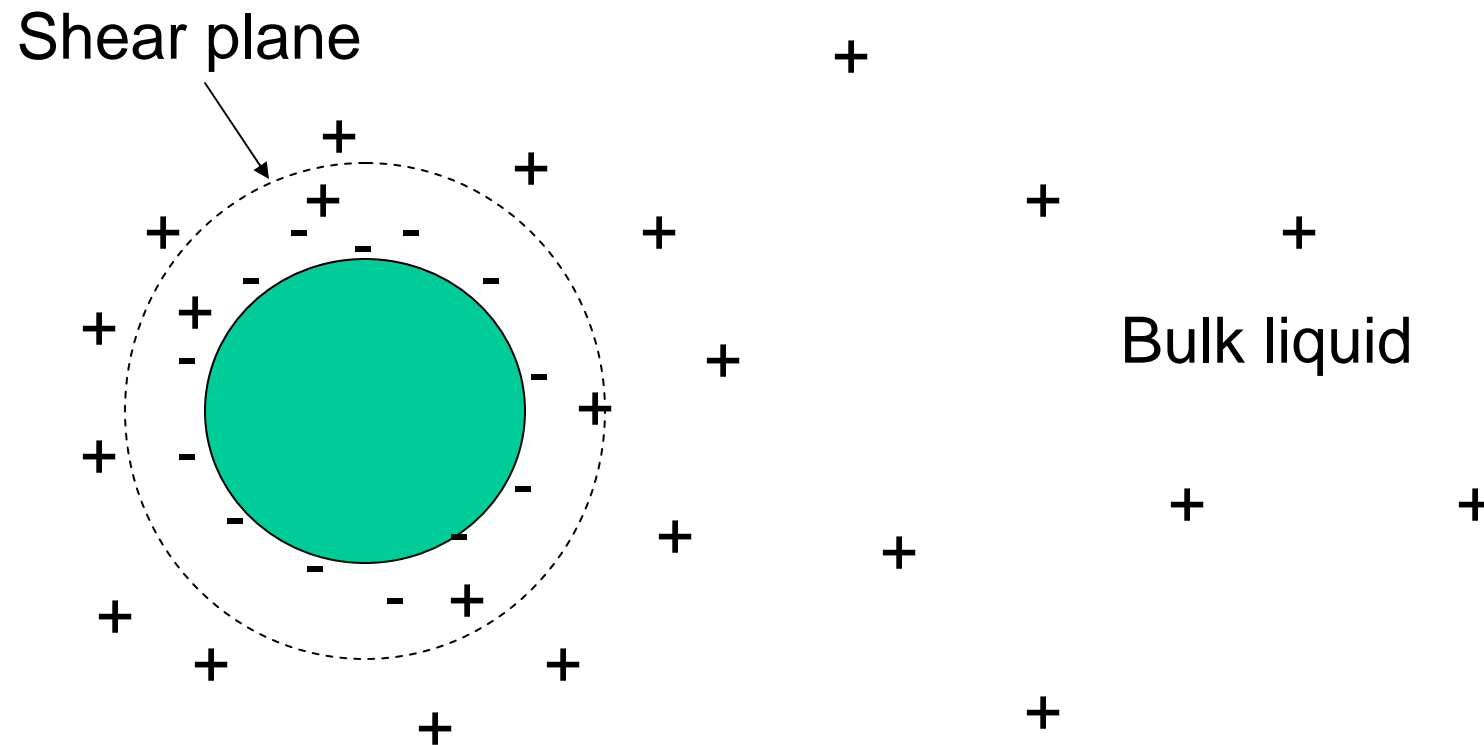
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What is the Isoelectric Point?

- The Isoelectric Point is the point at which the zeta potential (surface charge) is zero.
- Achieved by the addition of
 - potential forming ions
 - Specific adsorption of charge modifying agents

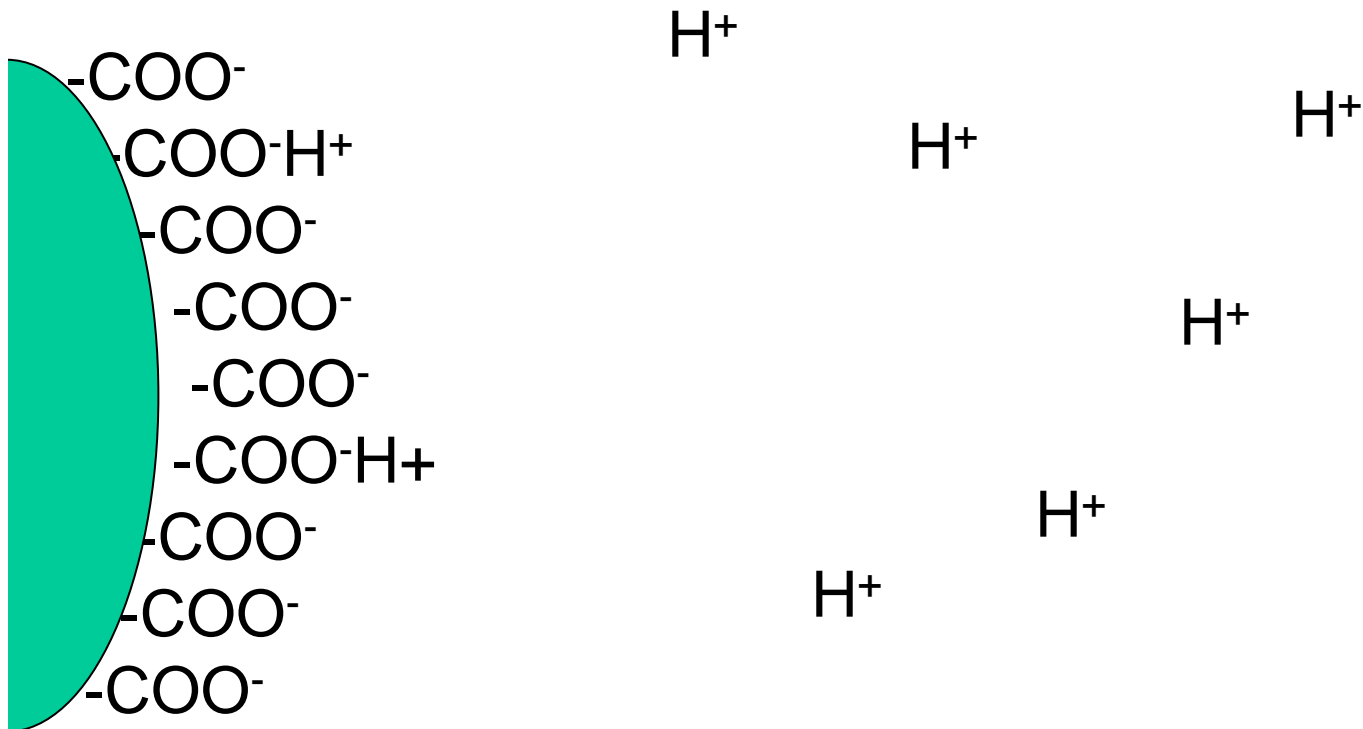
What is Zeta Potential?

- Zeta potential is the charge on a particle at the shear plane.



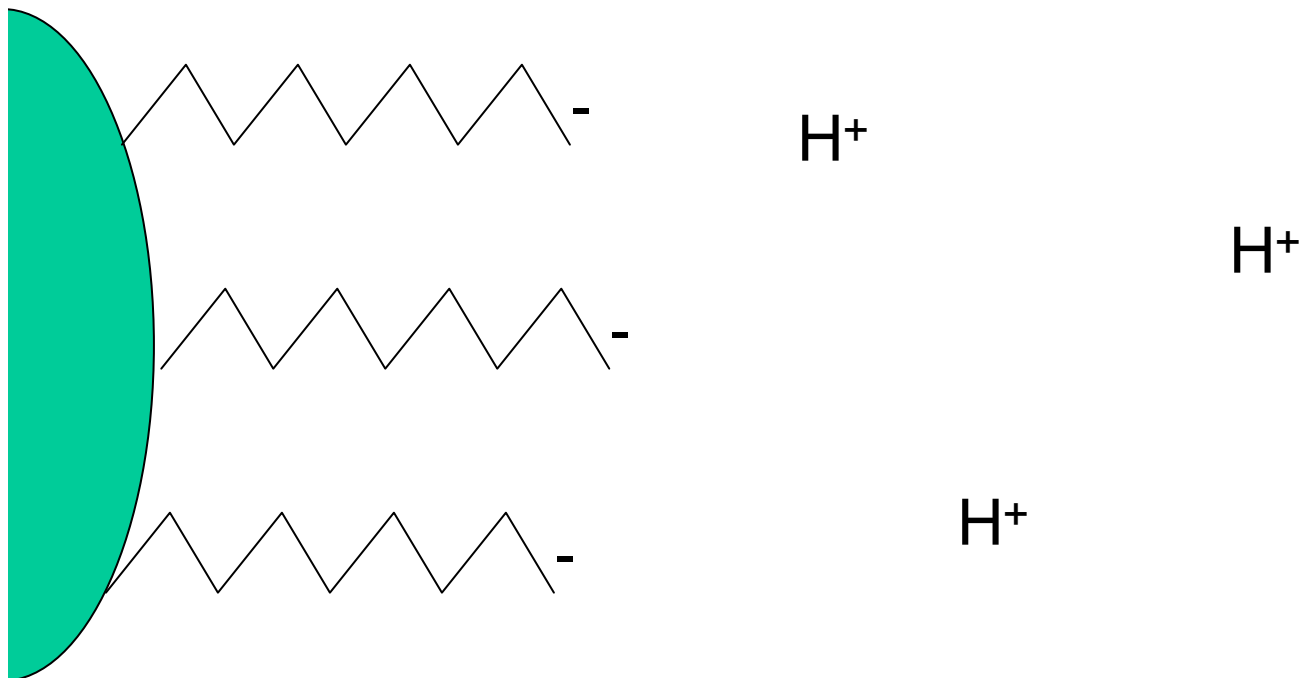
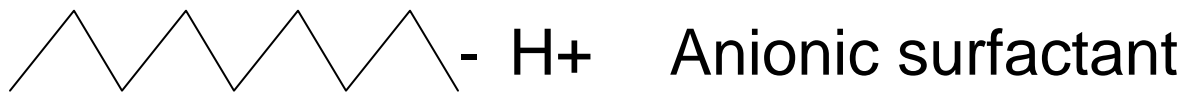
How do Surfaces Acquire Charge?

Ionization of surface groups

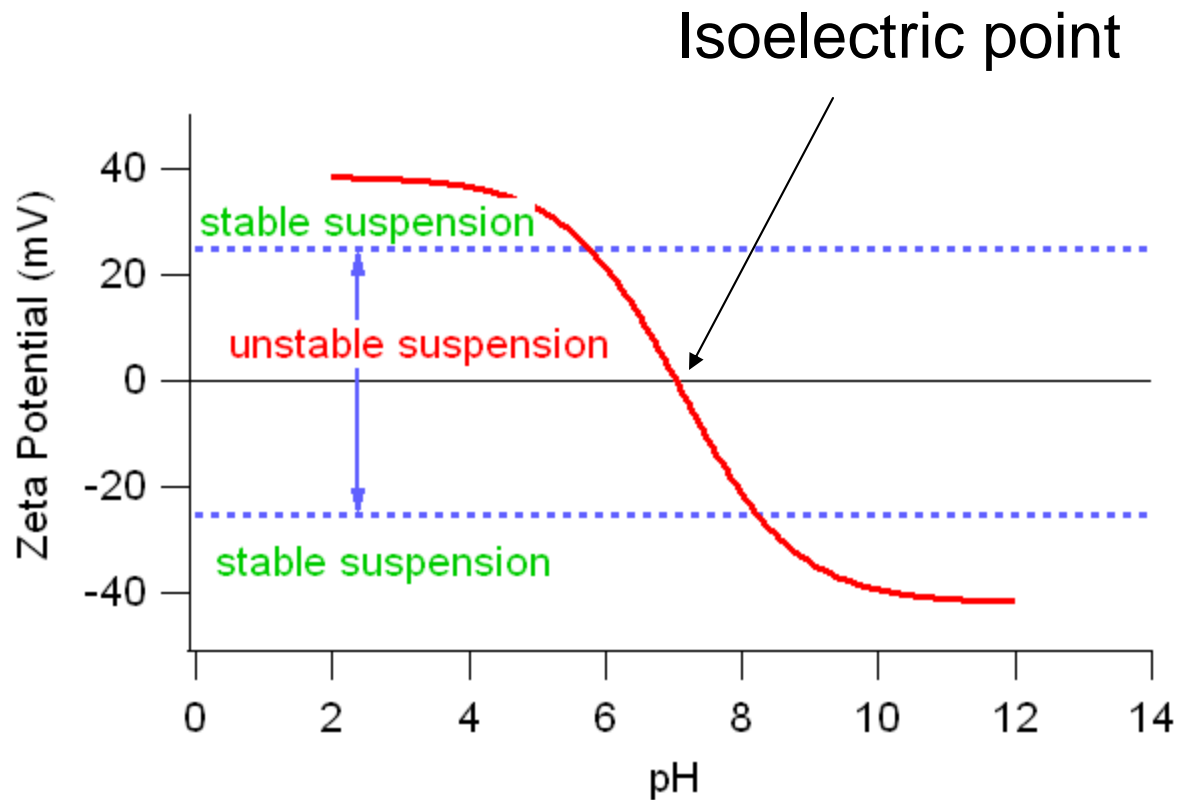


How do Surfaces Acquire Charge?

Specific adsorption of ions, e.g. ionic surfactants



Isoelectric point



X-axis can also be Ca^{++} or other ion concentration.
But, pH is most common.

Why is IEP important?

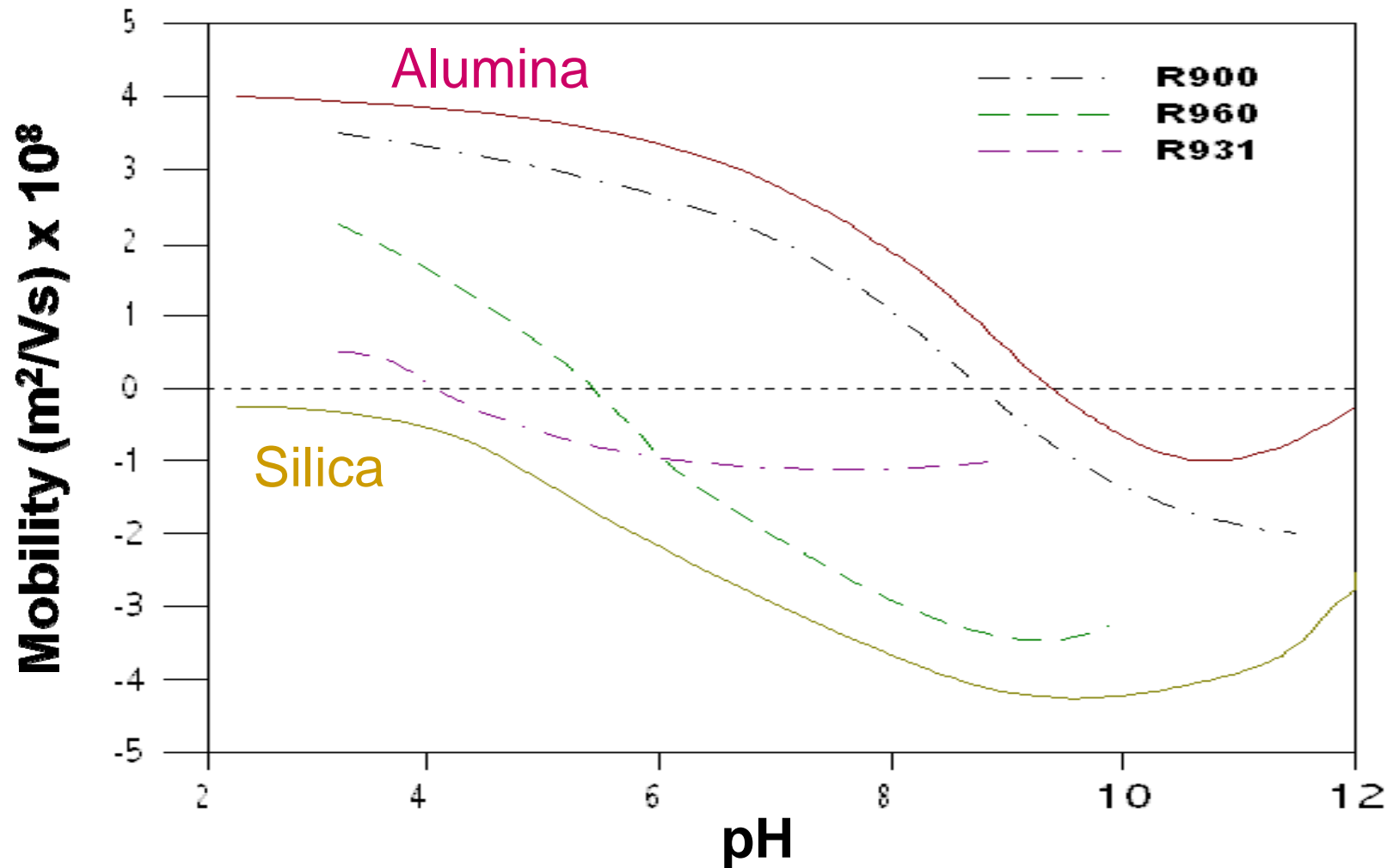
- When particle charge is important for stability (which is often), the IEP is a quick way of describing the region at which particle charge is low. And those are conditions under which flocculation will occur.
- Will depend on surface, not bulk material composition.

Why Measure IEP?

- It serves as a method of characterizing sample.
- It tells you amount of reagent to add (or regimes to avoid) when processing the sample.

TiO₂ Grades

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Care needed when dispersing!

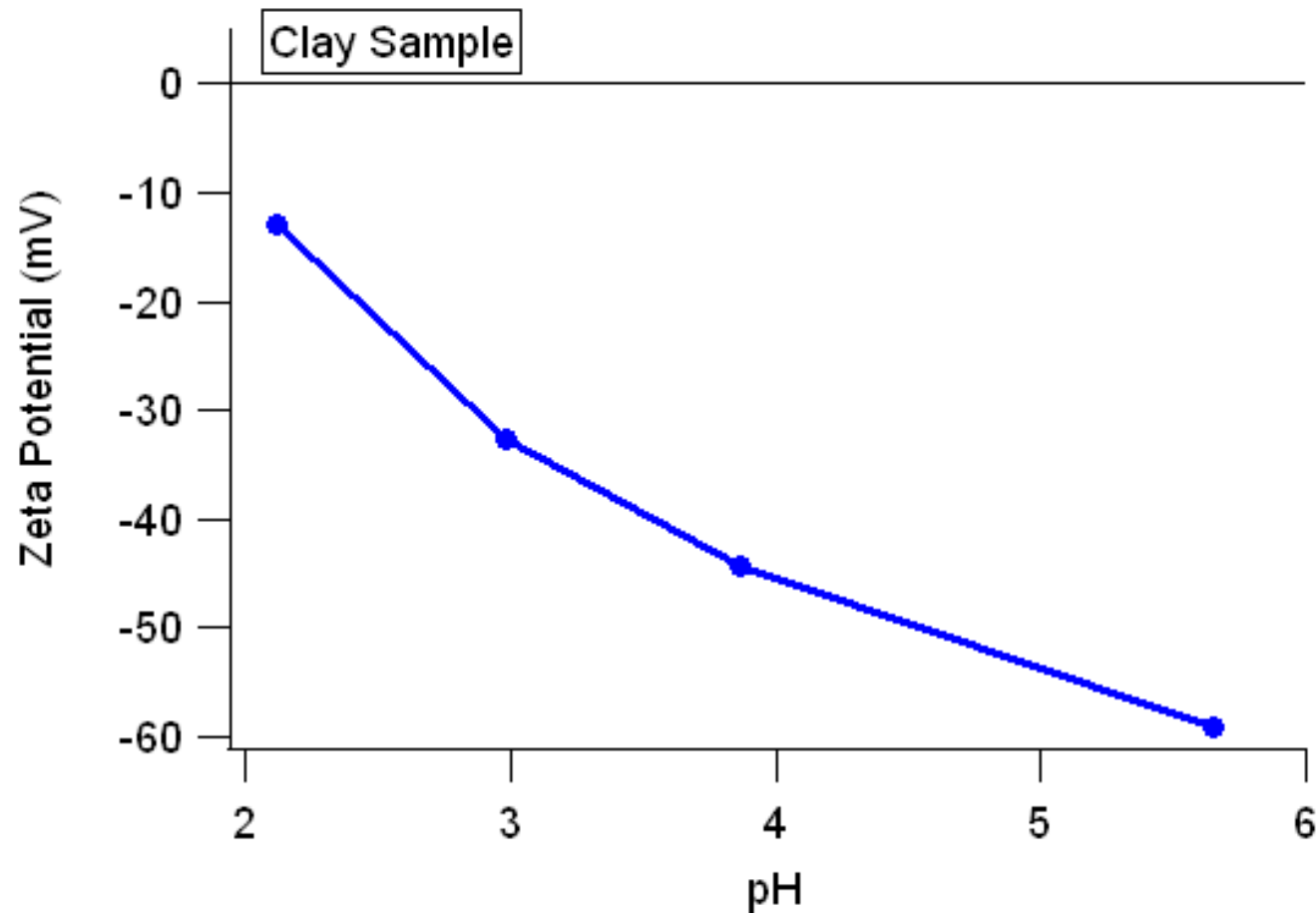
Effect of Surface Modification on the IEP of TiO₂

Bulk % coating		IEP (pH units)
SiO ₂	Al ₂ O ₃	
--	--	6.8
--	4.5	8.4 (R900)
6.5	3.5	5.8 (R960)
8.0	8.0	4.6 (R931)

Bulk percentages (elemental analysis) of each chemical coating not reliable indicator of how the surface will behave in solution

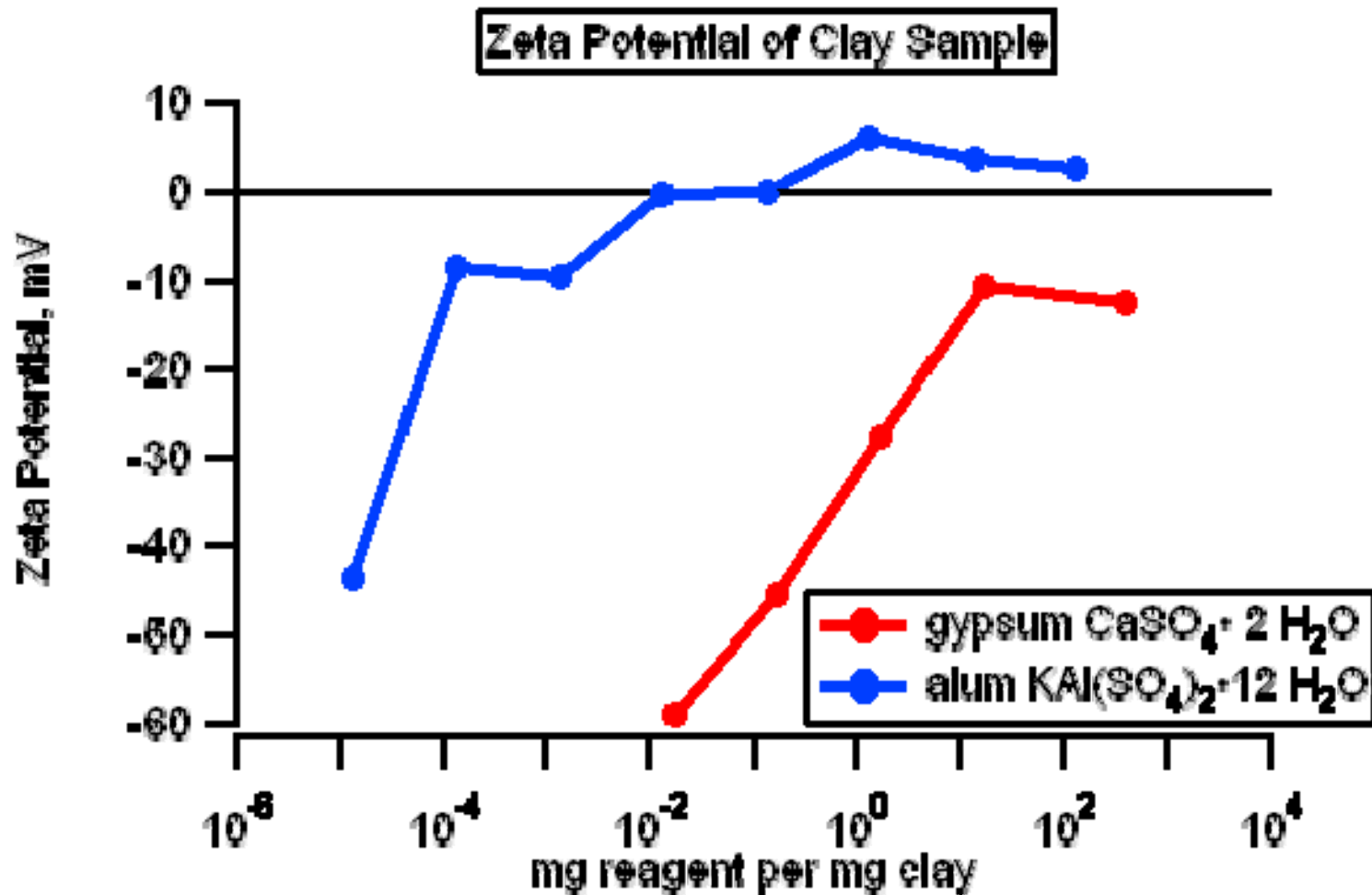
Imperative to check ZP vs pH profile for any material prior to use

Clay IEP



To flocculate clay so it settles, pH must be quite low. You will need a lot of acid.

Clay IEP with



To flocculate clay so it settles, choose alum at 0.01 g alum/g clay. Too much or too little and flocculation is not ideal.

How to Measure Zeta Potential:

- Acoustic techniques (use sound to probe particle response)
- It is much more popular to use light scattering to probe motion of particles due to an applied electric field. This technique is known as electrophoretic light scattering.
- Used for determining electrophoretic mobility, zeta potential.

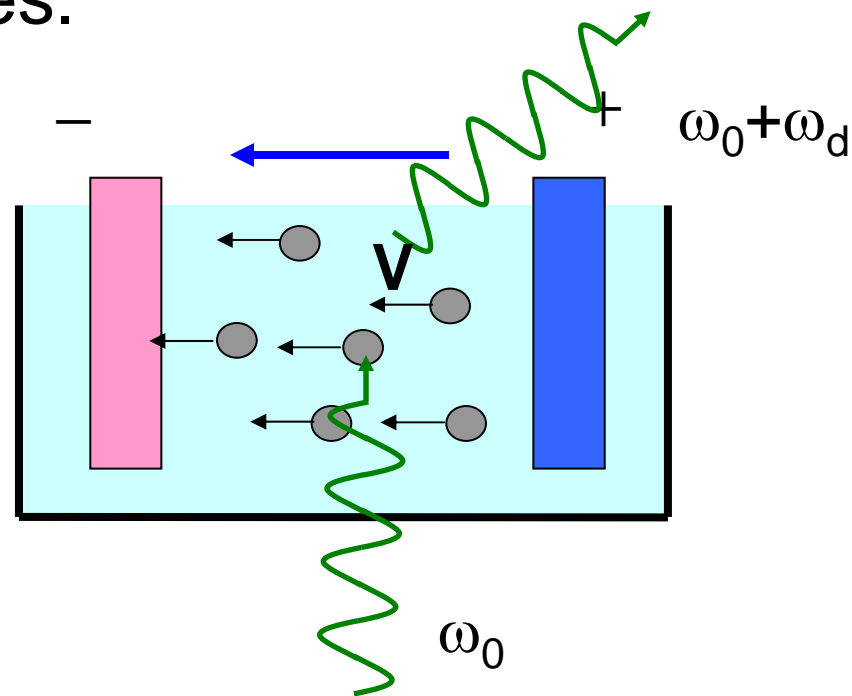
How to Measure? With the SZ-100

- Single compact unit that performs size, zeta potential, and molecular weight measurements: the SZ-100

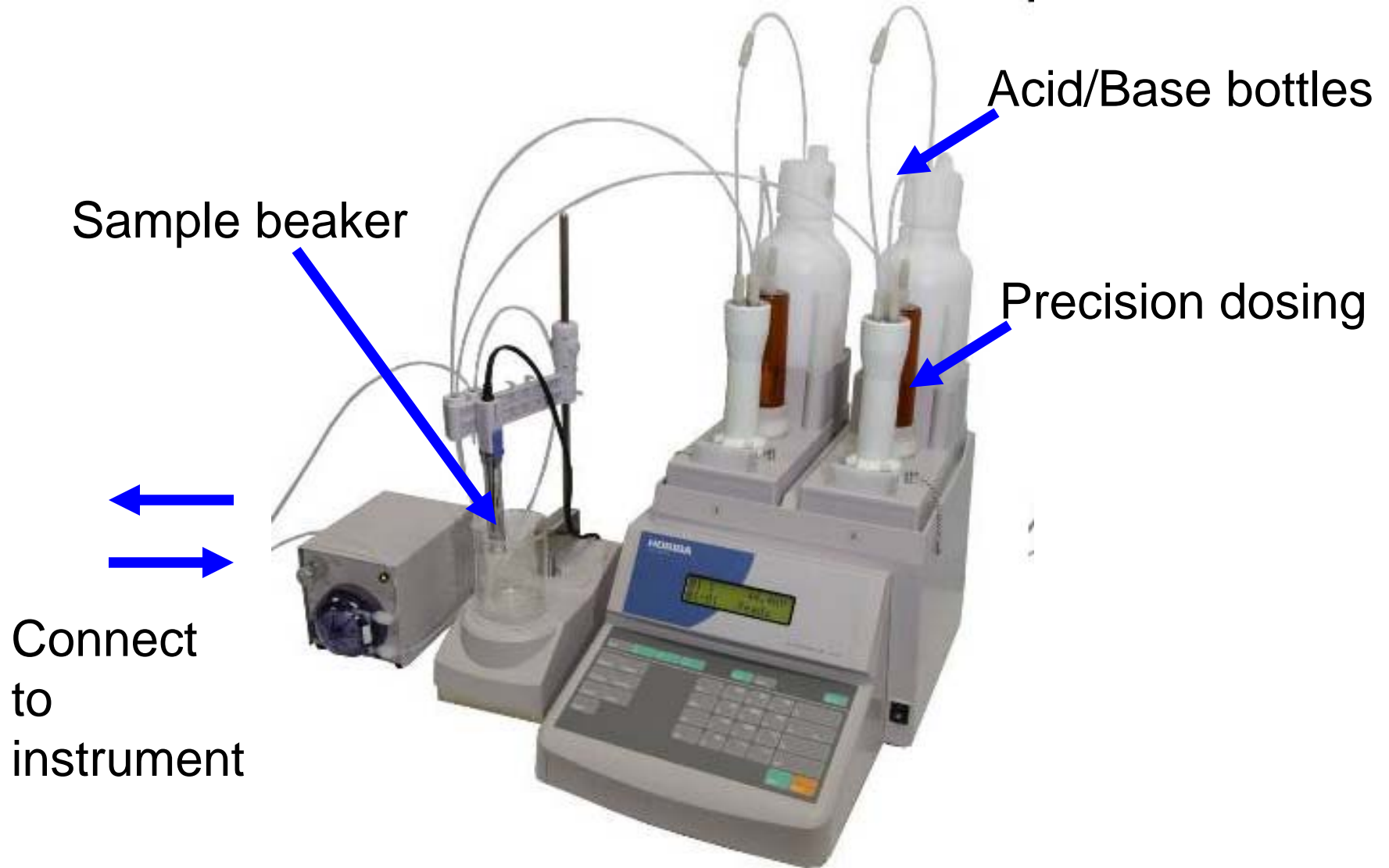


How to determine zeta potential

- Apply an electric field and probe response of particles to applied field.
- You need to see Doppler shift in scattered light due to particle motion with respect to fixed electrodes.



Autotitrator Accessory



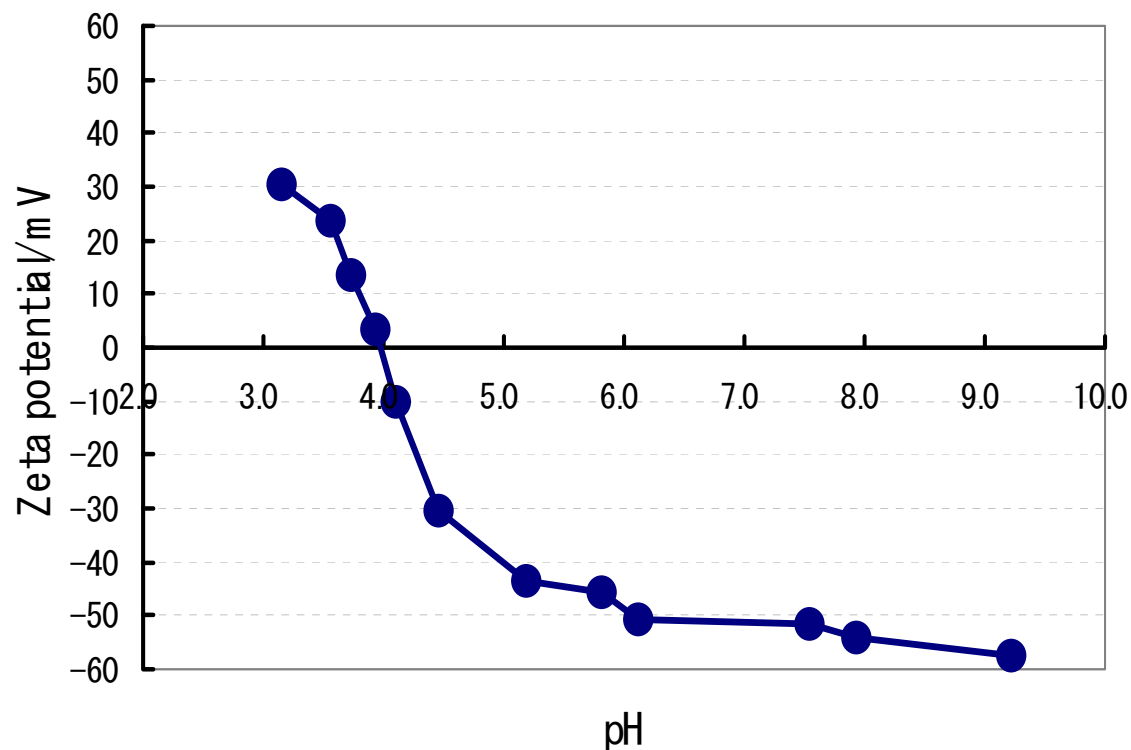
Complete unit



Application (Zeta Potential) **HORIBA**

● Iso Electric Point of Coffee Mate

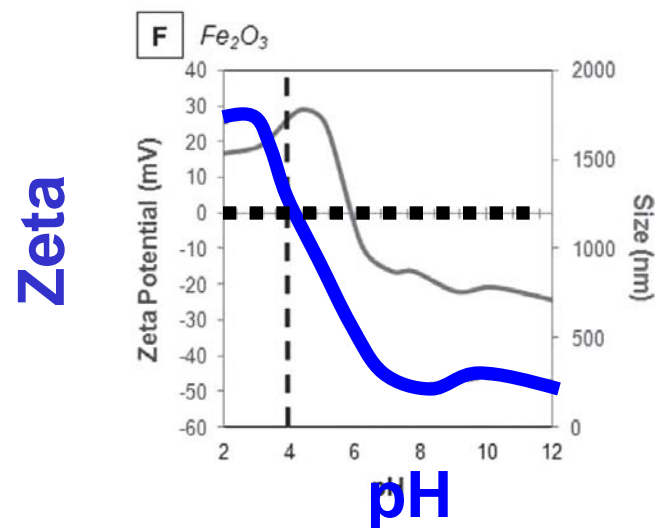
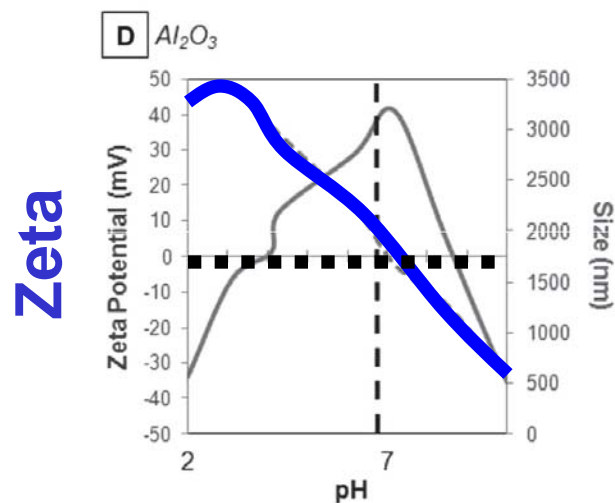
	Results
Iso-electric point	pH 4.0



If you want to bind Ludox HS (IEP ~pH 2) to Coffee Mate, what pH should you choose?

Using Zeta Potential to Predict/Control Particle Interactions

- Note size maximum at IEP due to flocculation.
- If you mix Al_2O_3 with Fe_2O_3 , what happens?
 - At pH 2, both are positive: no interaction
 - At pH 6, Al_2O_3 is positive and Fe_2O_3 is negative: particles stick together.
 - At pH 9, both are negatively charged, no interaction.



Data from Berg et al., *Nanotoxicology*, Dec. 2009; 3(4): 276-283

Can compress all of this information

- Coffee Mate IEP: pH 4
- Al₂O₃ IEP: pH 7
- Fe₂O₃ IEP: pH 4

Preparation of Béarnaise Sauce:

An exercise in Applied Colloid Chemistry

Monique's* Recipe for Béarnaise Sauce

Mix vinegar, shallots, tarragon and ground pepper. Add $\frac{1}{2}$ glass of white wine.

Boil until practically all the liquid has evaporated. Cool until nearly cold. Add egg-yolks, one-by-one while stirring vigorously. Add $\frac{1}{2}$ glass of white wine and mix well.

Heat the mixture on a "bain-marie" while stirring all the time. When the sauce becomes creamy, cool slowly again continuously stirring. When the pot temperature is such that you can touch it with your hands, add clarified butter, a small amount at a time. The temperature of the clarified butter should be about the same as the temperature of the pot mixture. Continue stirring.

When all the butter is incorporated, sieve the mixture and add one spoonful of cut chervill.

Keep the sauce tepid on the bain-marie. Never heat it up again. The consistency of the sauce should be similar to that of mayonnaise .

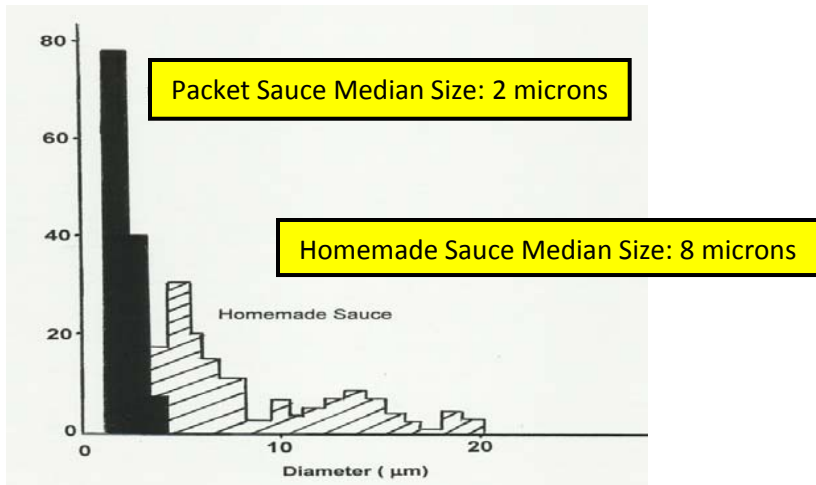
This tastes great, but sometimes it fails

Packet Sauce Instructions

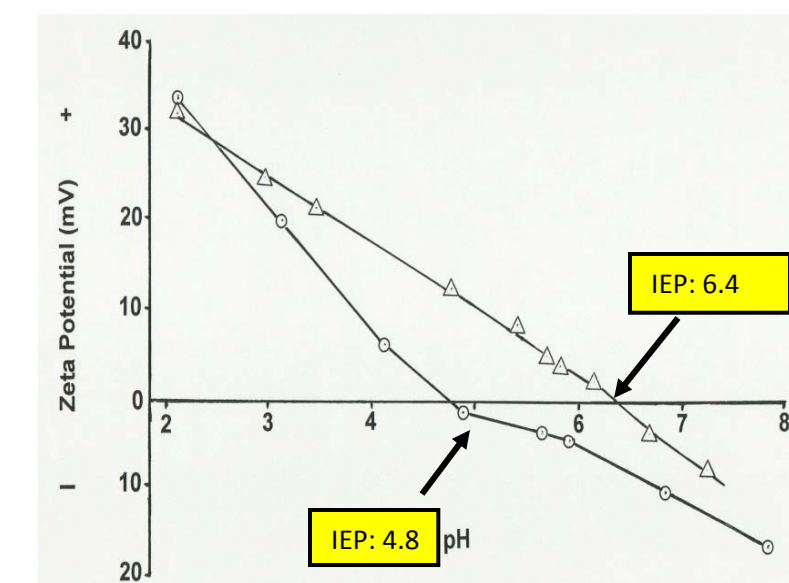
Add butter and milk to pan. Heat to boiling, add mix with stirring. Simmer and stir until sauce has creamy consistency.

Q: Why does a homemade sauce taste better?

Q: Why does a packet sauce mixture always work?

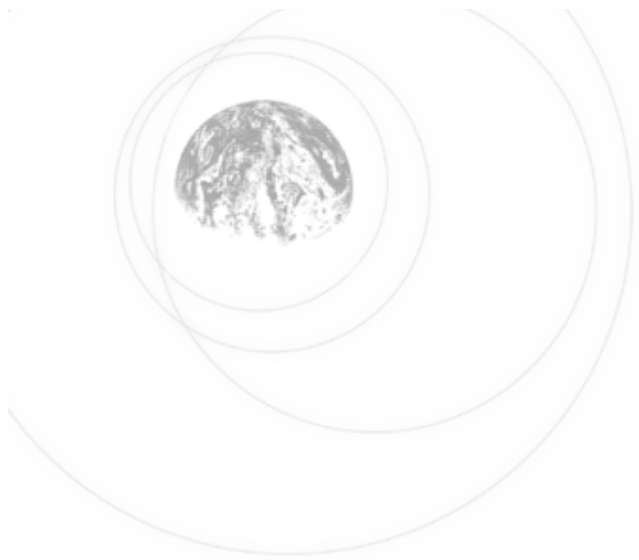


Emulsion Particle Size determines sauce mouthfeel/texture – large particles taste better.

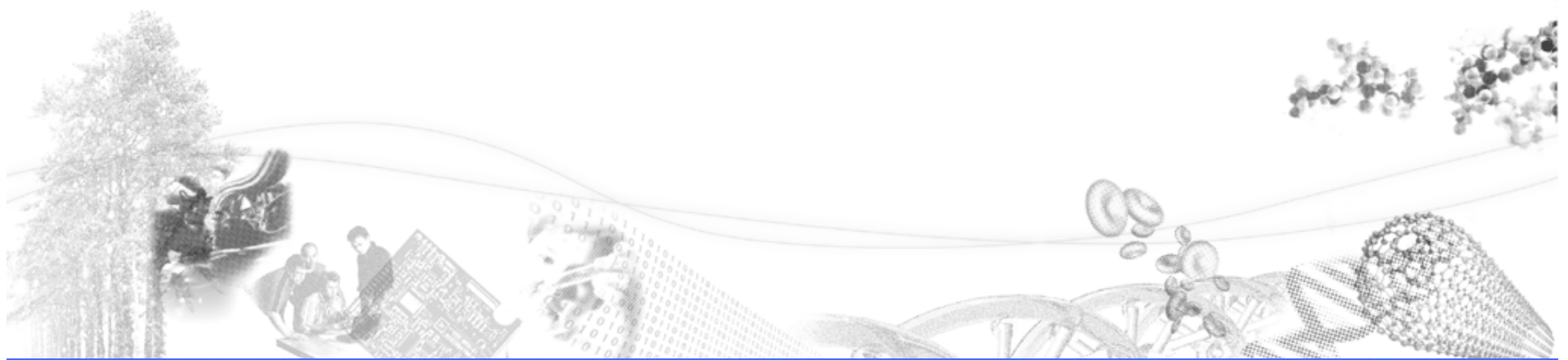


Egg Yolk Zeta Potential determines sauce stability

Vinegar will adjust pH of sauce. If you get the wrong egg, the IEP is at pH 4.8 and the emulsion droplets coalesce. You need to adjust the vinegar on a case by case basis.



Zeta Practical Tips



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Electrolyte Continued

- Titration is popular.
- Remember that acid and base will add to system ionic strength. pH 3 corresponds to 10^{-3} M electrolyte.
- Adding acid or base will increase ion concentration.
- Start with a 10 mM (10^{-2} M) salt (KNO_3) concentration to keep acid/base concentration from affecting results.

Why Zeta Potential?

- Use measured surface charge to predict colloidal stability
- Use measured surface charge to predict particle-particle interactions

Q&A

Ask a question at labinfo@horiba.com

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Thank-you