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ZETA POTENTIAL AS AN INDICATOR OF SOLID SURFACE CHEMICAL PROPERTIES

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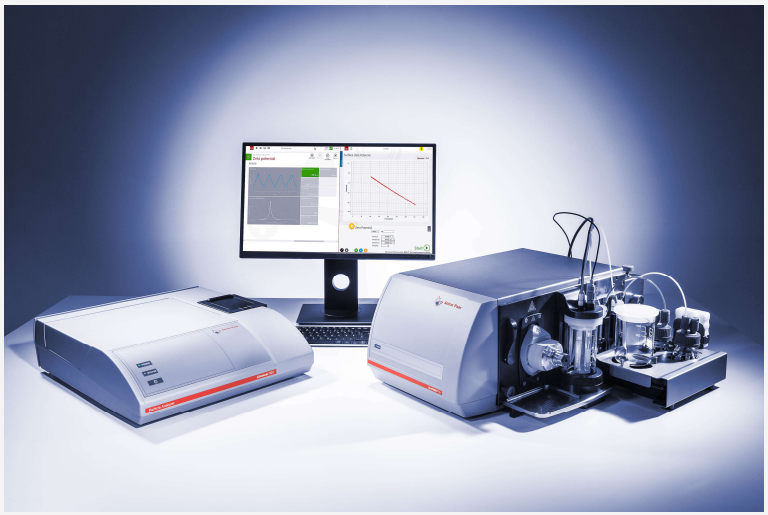
Zeta potential analysis

Instrumentation



3.8 nm — 100 µm

Litesizer 500

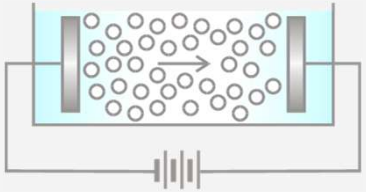
Electrophoretic Light Scattering

25 µm — unlimited

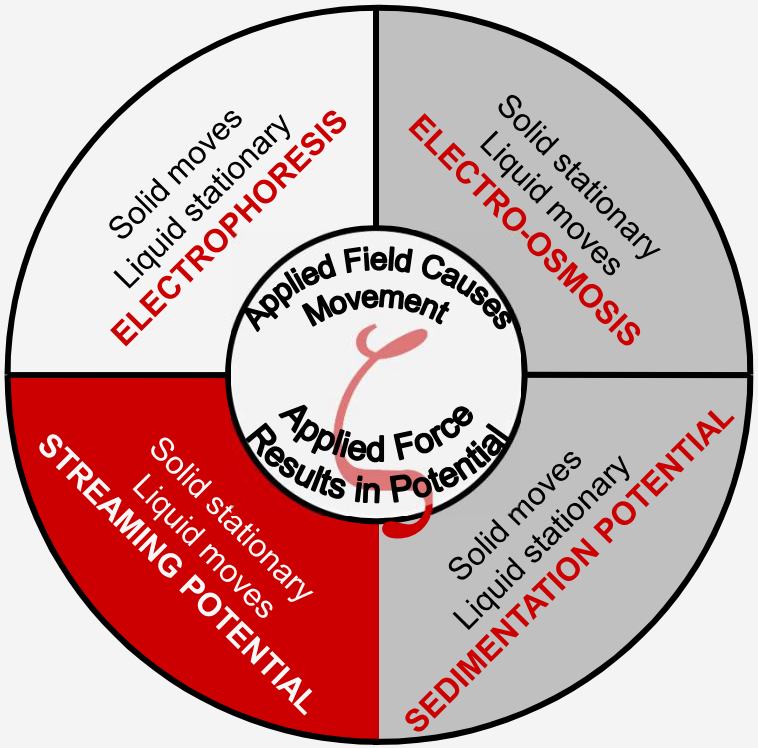
SurPASS 3

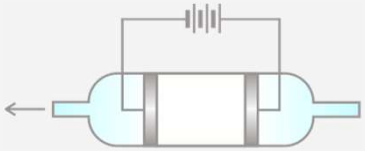
Streaming Potential

Electrokinetic effects



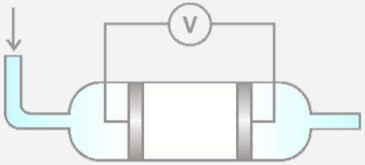
Particle dispersions
Emulsions



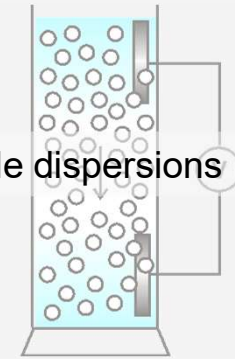


Porous plugs

Solid surface



Particle dispersions



SurPASS™ 3 Electrokinetic Analyzer for Solid Surface Analysis

determines the zeta potential on macroscopic solid surfaces

Concept of surface zeta potential

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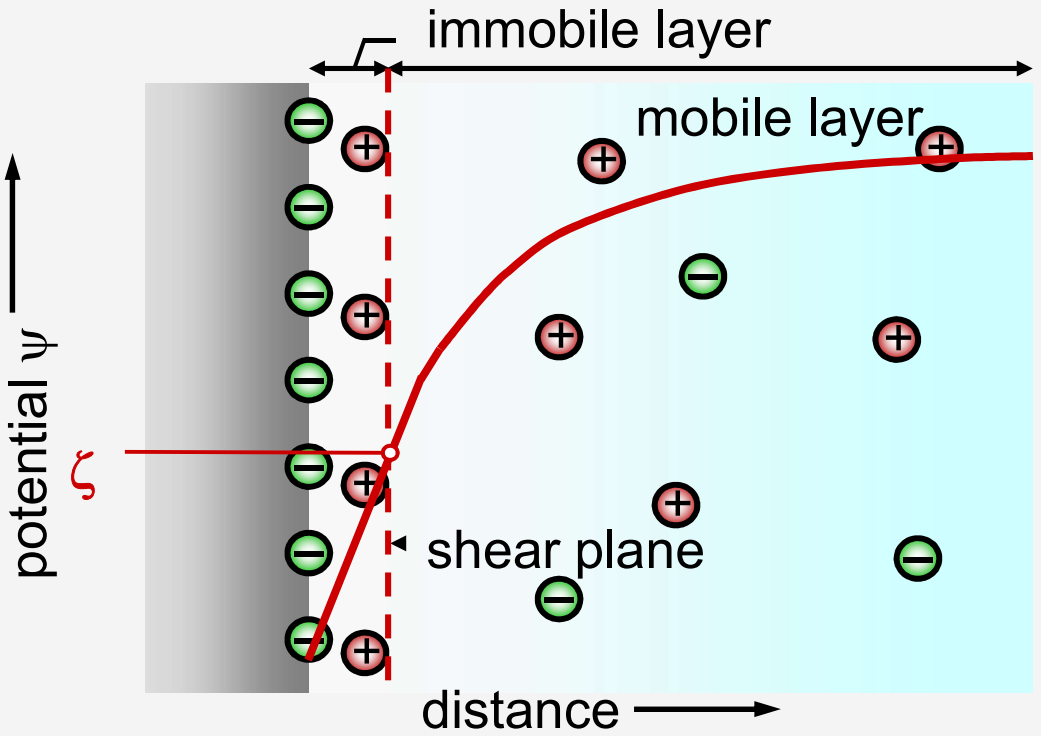
Electric double layer



Solid surface zeta potential

Surface characterization

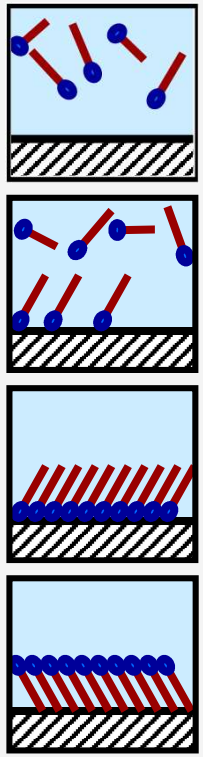
- Surface chemistry: acidic and basic functional groups
- Wettability: Hydrophilic / hydrophobic properties

Surface modification

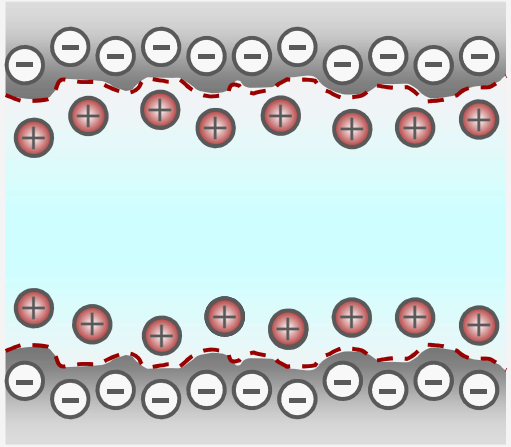
- Chemical and physical surface treatment

Adsorption studies

- Adsorption from the liquid phase on the solid surface



Streaming potential



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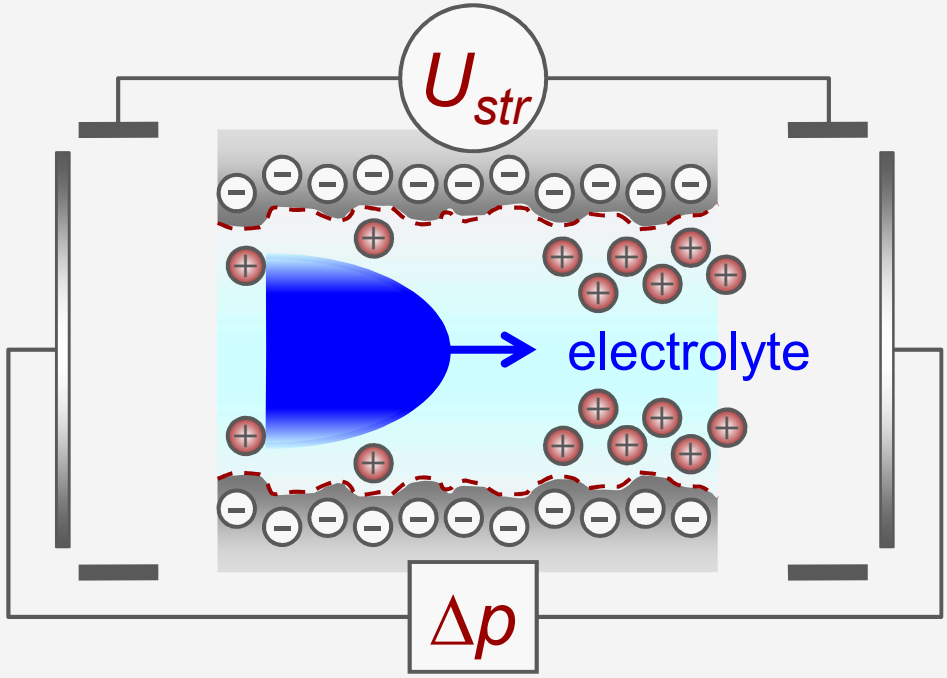
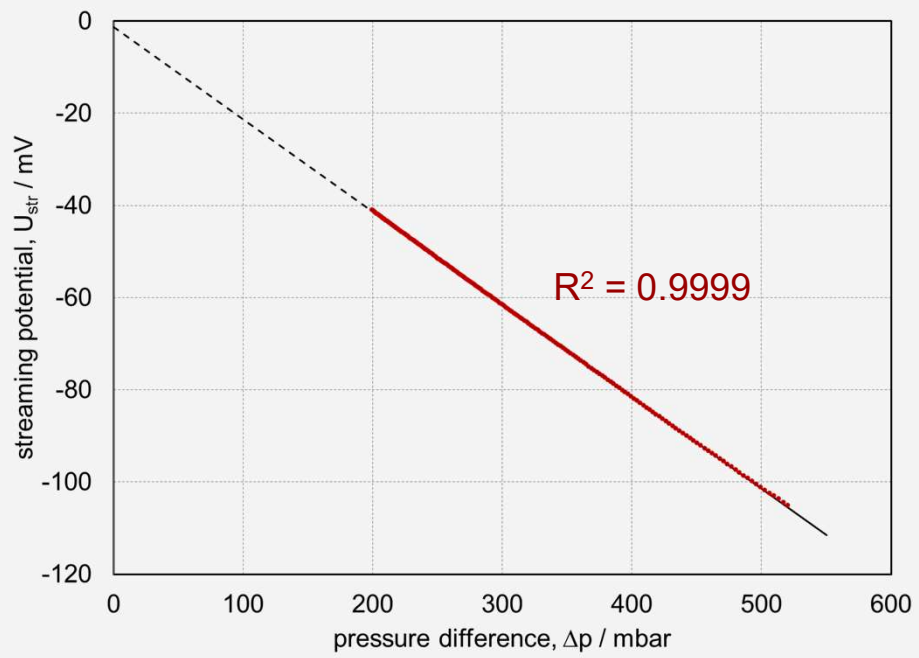
Streaming potential



Measuring principle

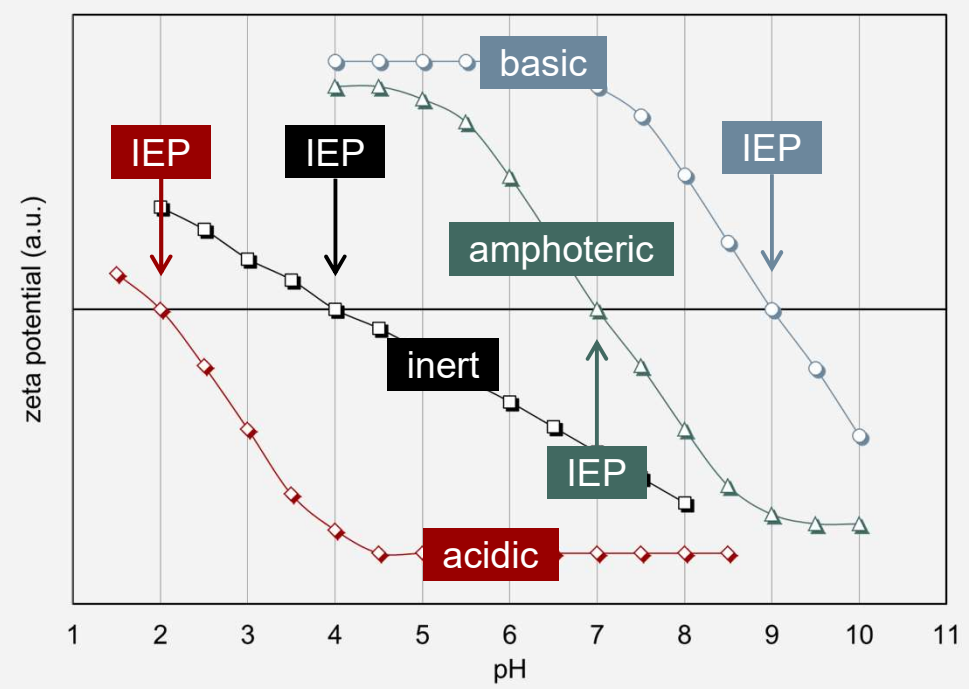


$$\zeta = \frac{dU_{str}}{d\Delta p} \times \frac{\eta}{\varepsilon_r \times \varepsilon_0} \times \kappa_B$$

$$\zeta = \frac{dI_{str}}{d\Delta p} \times \frac{\eta}{\varepsilon_r \times \varepsilon_0} \times \frac{L}{A}$$

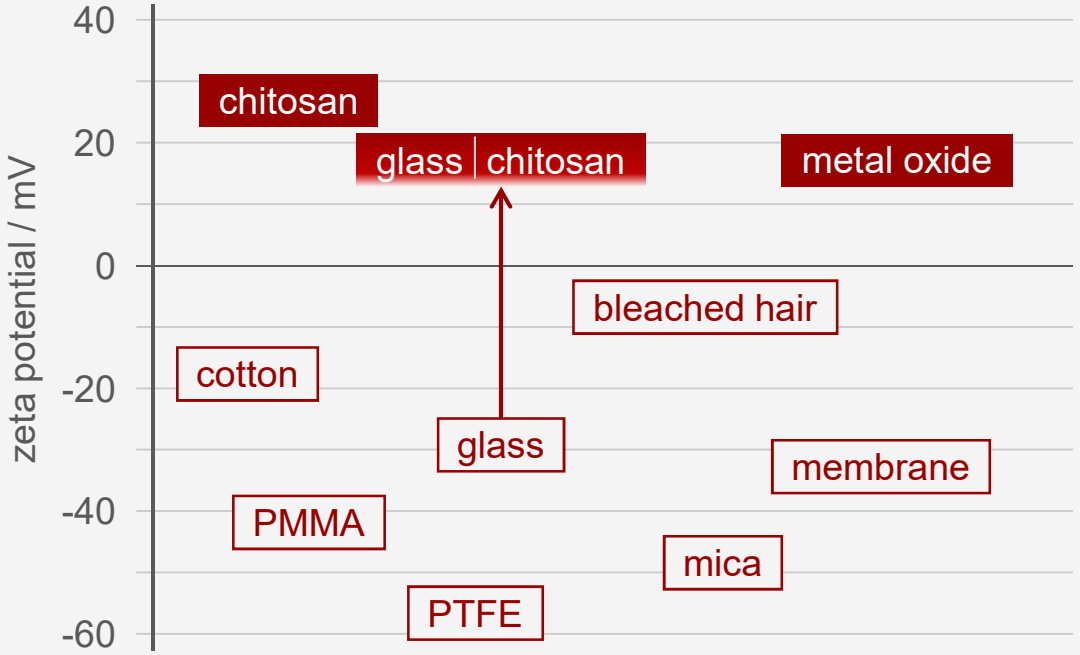
U_{str} ..... streaming potential
I_{str} ..... streaming current
Δp ..... pressure difference
η ..... viscosity
$\varepsilon_r \times \varepsilon_0$ ..... dielectric permittivity
κ_B ..... electrolyte conductivity
L/A ..... cell constant

pH dependence



0.001 mol/l KCl

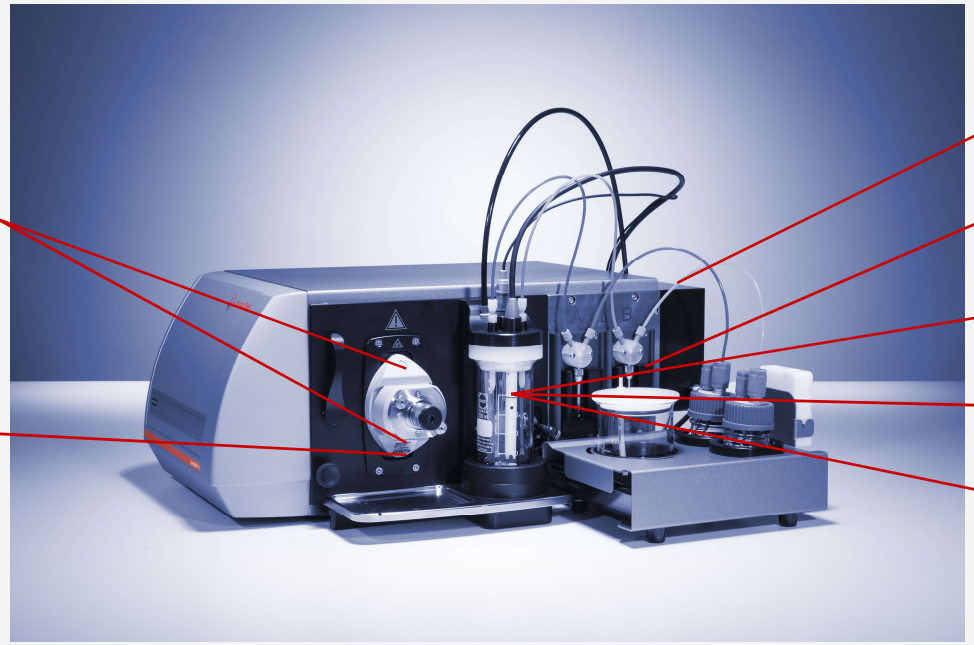
Single zeta potential



pH 7
0.001 mol/l KCl

SurPASS™ 3

The high-end electrokinetic analyzer for fully automated analysis



Ag | AgCl electrodes:
streaming potential
streaming current
cell resistance

measuring cell

external pressure control

titration unit

pH electrode

conductivity probe

temperature sensor

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SurPASS 3 measuring cells

Adjustable Gap Cell

Adjustable Gap Cell for Disks

Clamping Cell

Cylindrical Cell

MC for Ceramic Membranes

MC for Flexible Tubing

MC for Soft Contact Lenses

MC for Hollow Fiber Membranes

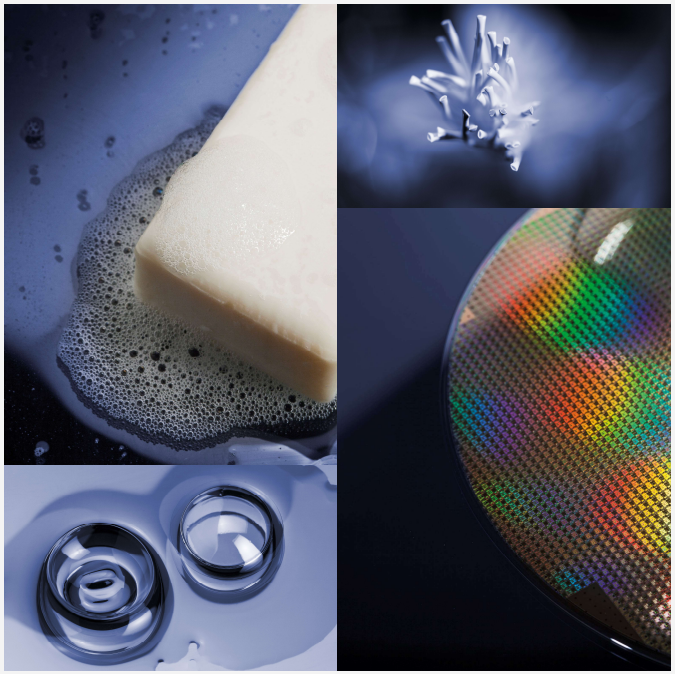
MC for 1 ml Pre-Filled Syringes

MC for Core Samples

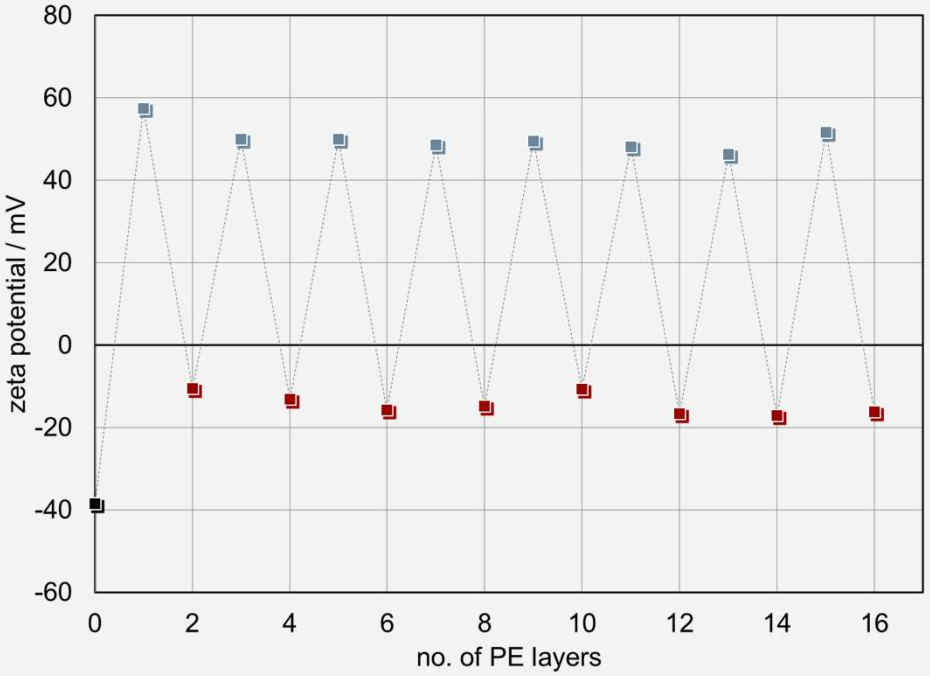
SurPASS™ 3 applications

- Membranes and filters
- Biomaterials
- Semiconductors
- Fibers and fabrics
- Cosmetics and detergents
- Minerals
- Polymers

- and many more



Polyelectrolyte multilayer

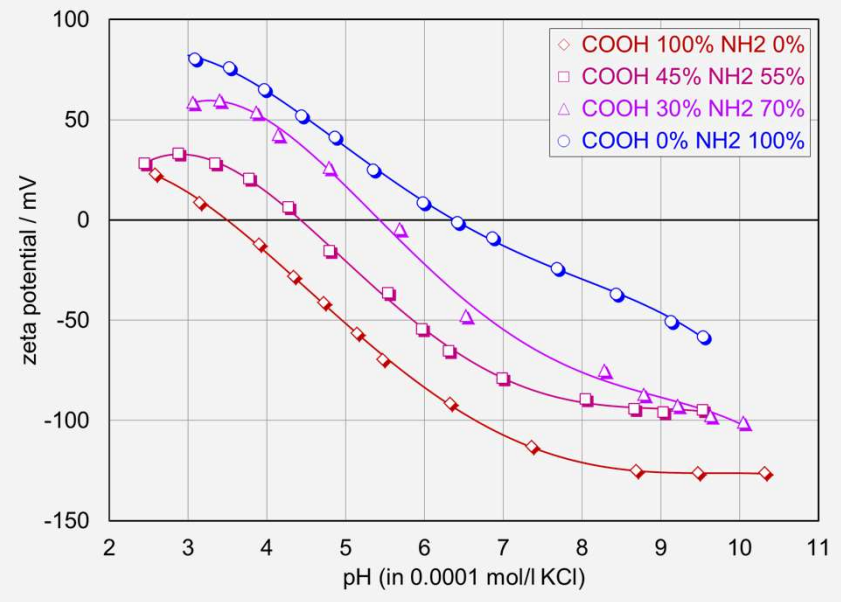


- PLL | CS multilayer on glass
  PLL ..... poly(L-lysine)
  CS ..... chondroitin sulfate
- Polyelectrolyte deposition in 0.025 M HEPES, 0137 M NaCl, pH 7.4
- ζ-analysis in 0.001 mol/l NaCl, pH 5.5

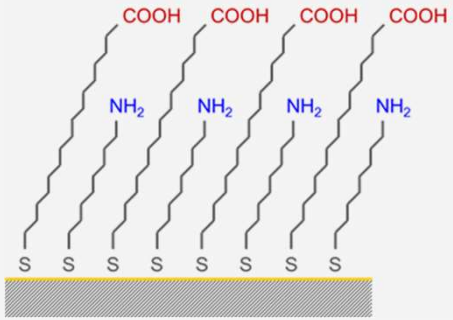
S. Grohmann et al., Biomacromolecules 12 (2011) 1987

SurPASS 3 for semiconductor applications

Self-assembled monolayers: Sensitivity of zeta potential

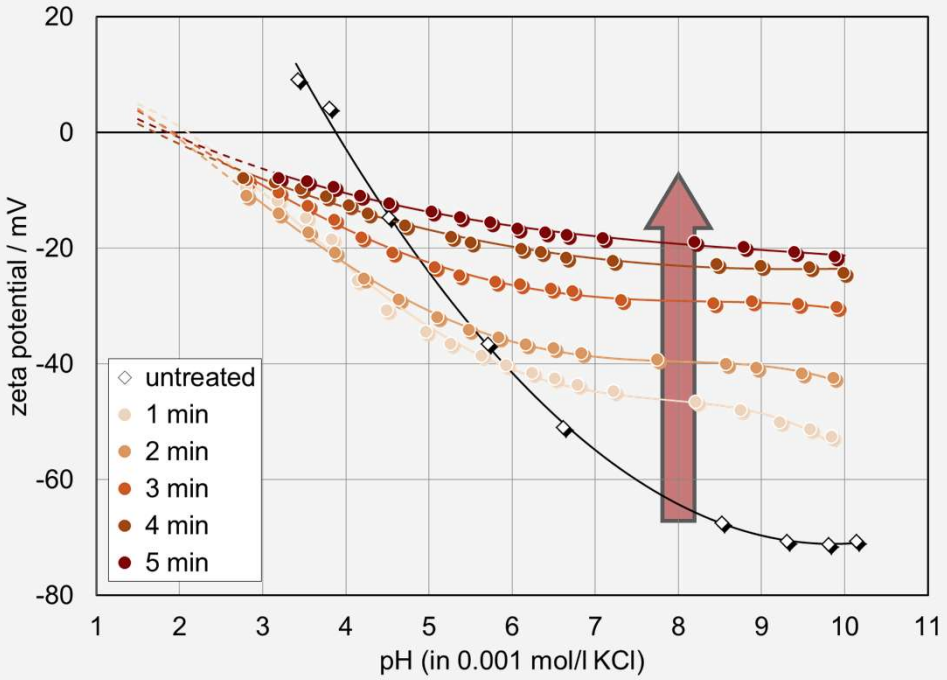


- SAM of thiols with carboxylic acid and amine terminal groups on gold surface
- HS – $(CH_2)_{15}$ – COOH
- HS – $(CH_2)_8$ – NH_2

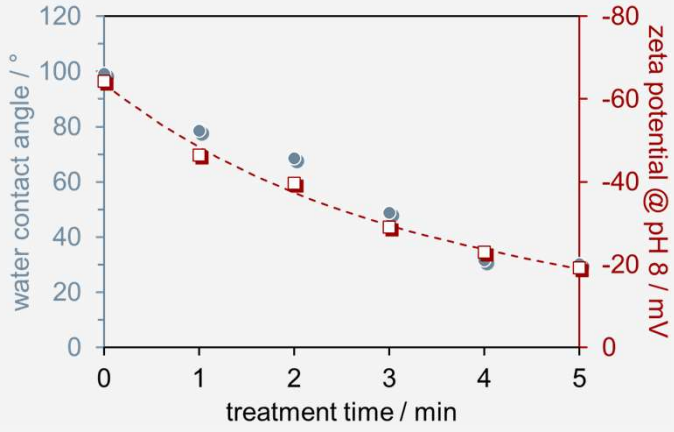


Lin et al., Phys. Chem. Chem. Phys. 11 (2009) 6199

Polymer surface activation



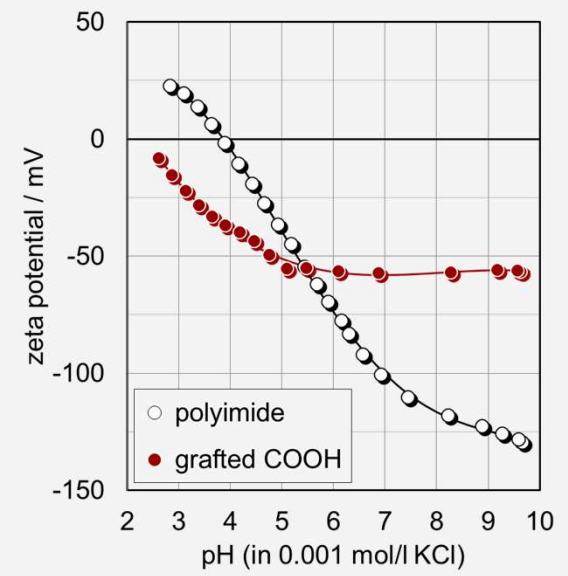
- Modification of polyethylene foil thereby retaining bulk properties
- Introducing acidic groups by photochemical process



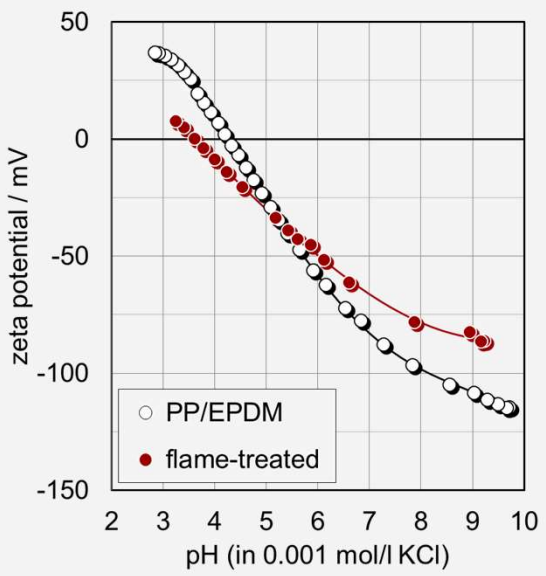
S. Temmel et al., Prog. Colloid Polym. Sci. 132 (2005) 54

Polymer surface activation

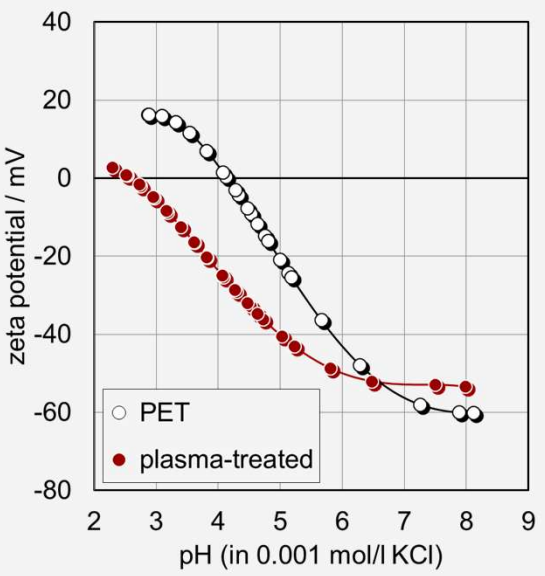
chemical grafting



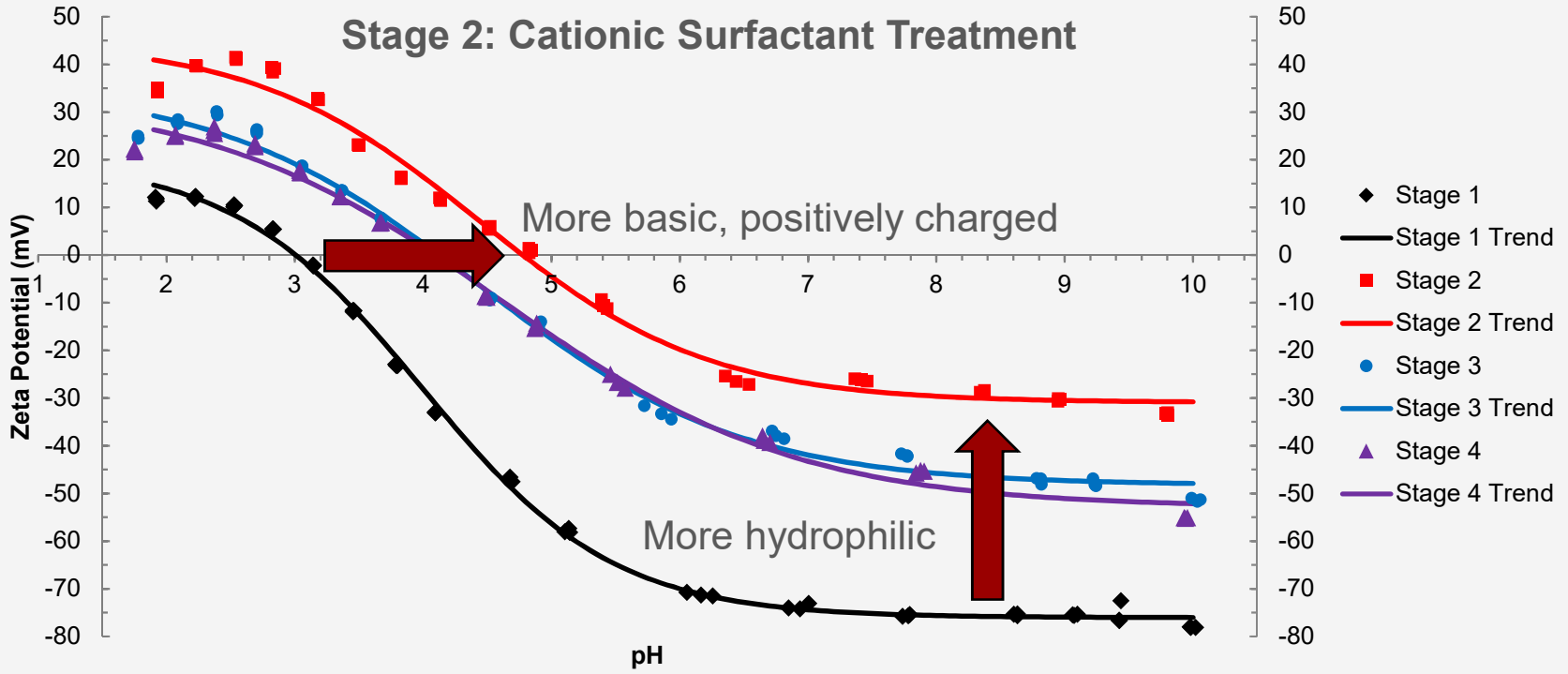
flame treatment



plasma treatment



Step-by-Step Process Treatment of Plastic for Semiconductor Applications



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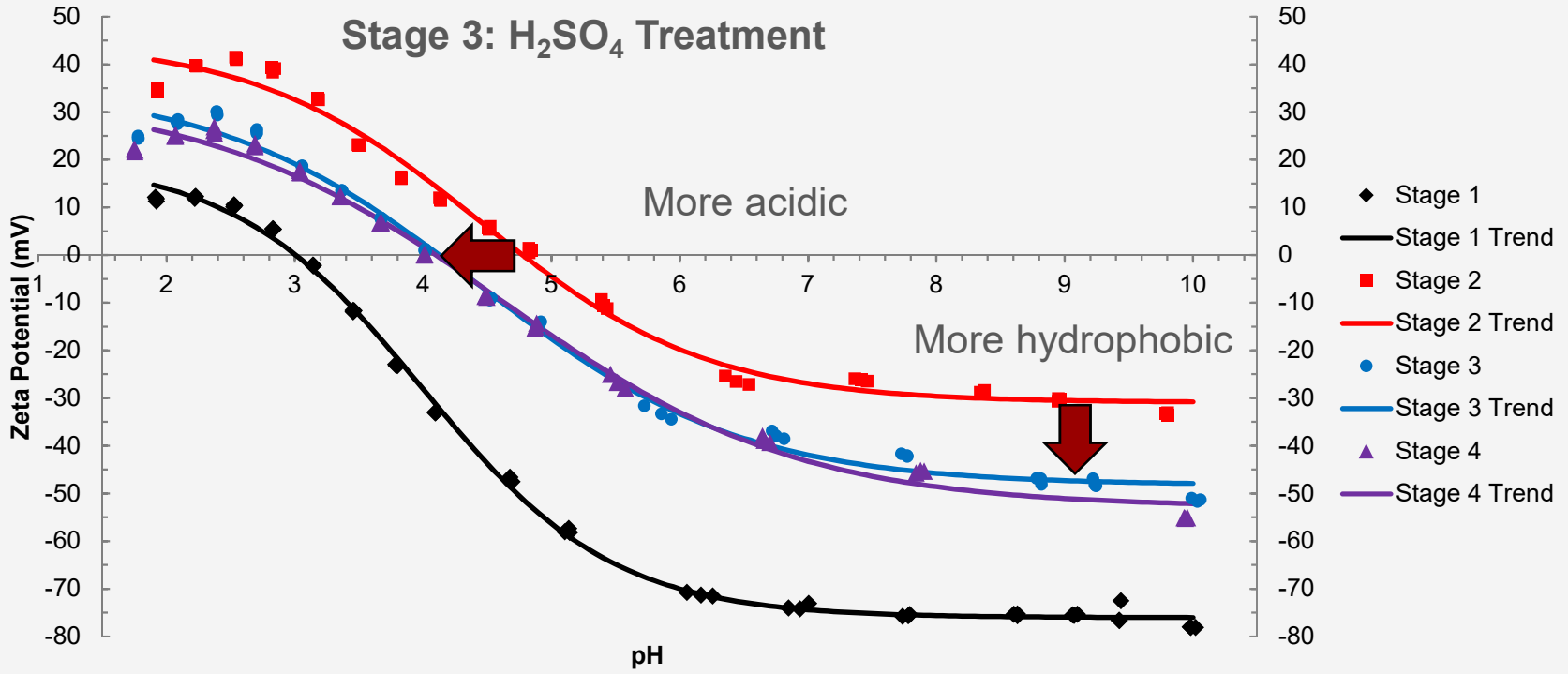

Step-by-Step Process Treatment of Plastic for Semiconductor Applications

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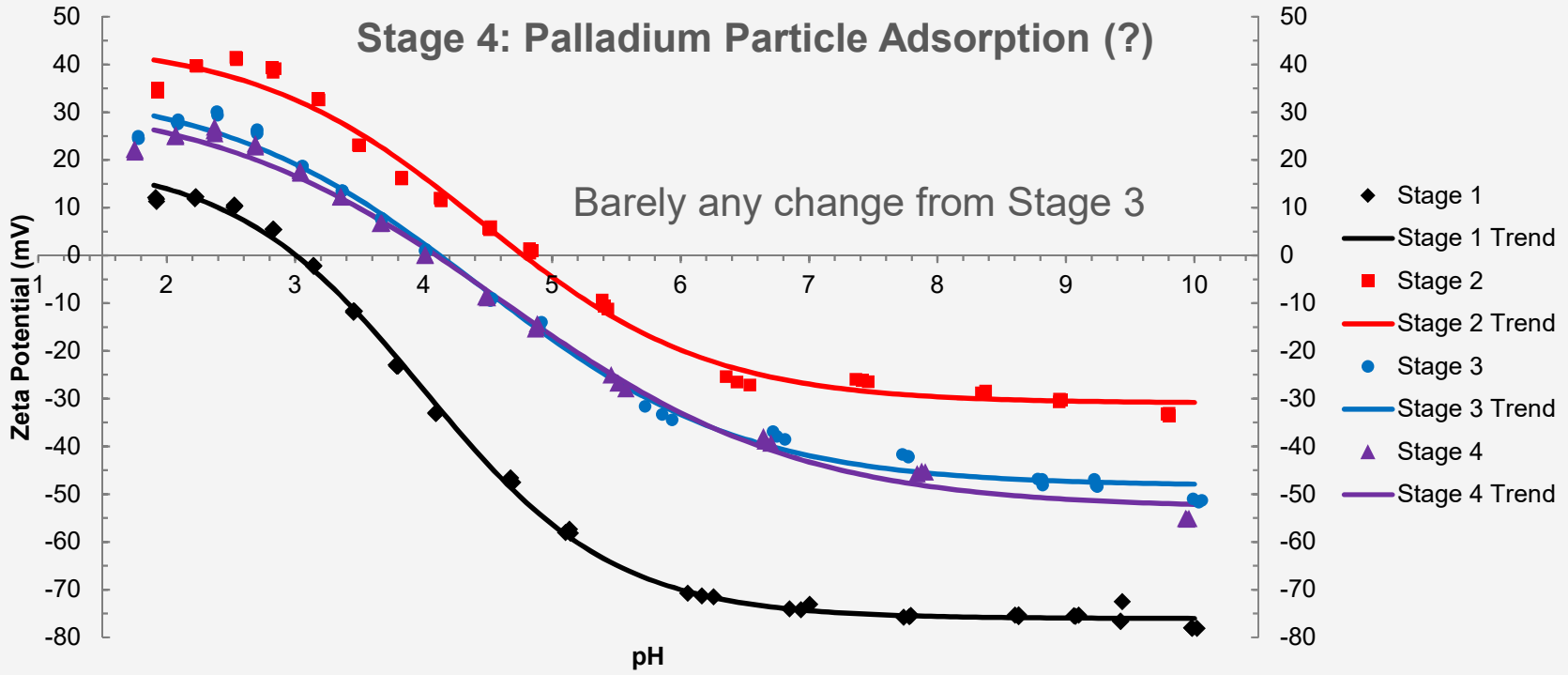

Particle Adsorption on Silicon Wafer

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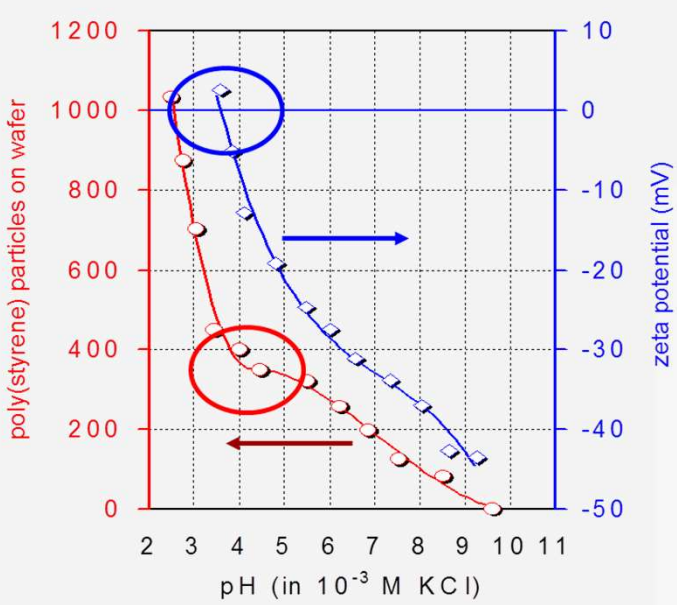
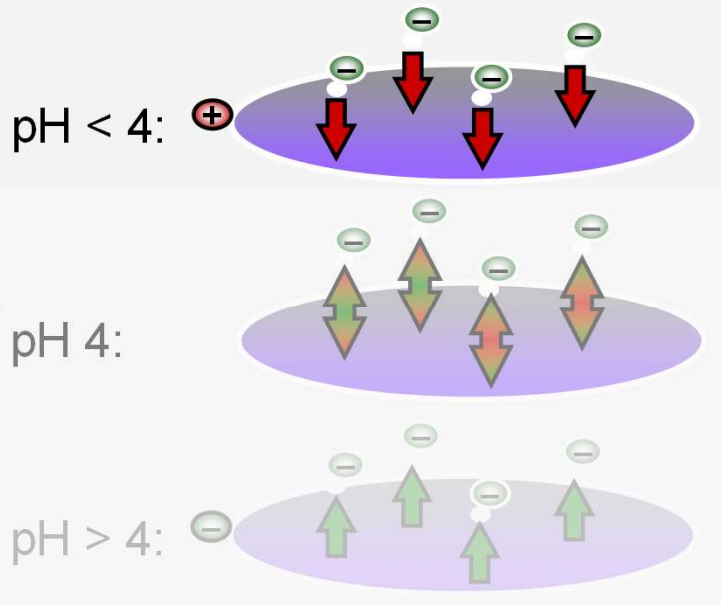
Adsorption of negatively charged poly(styrene) particles on wafer surface





Source: D.Jan, S.Raghavan, Proc. 3rd Int. Symp. on Cleaning Technology in Semiconductor Device Manufacturing (1993)

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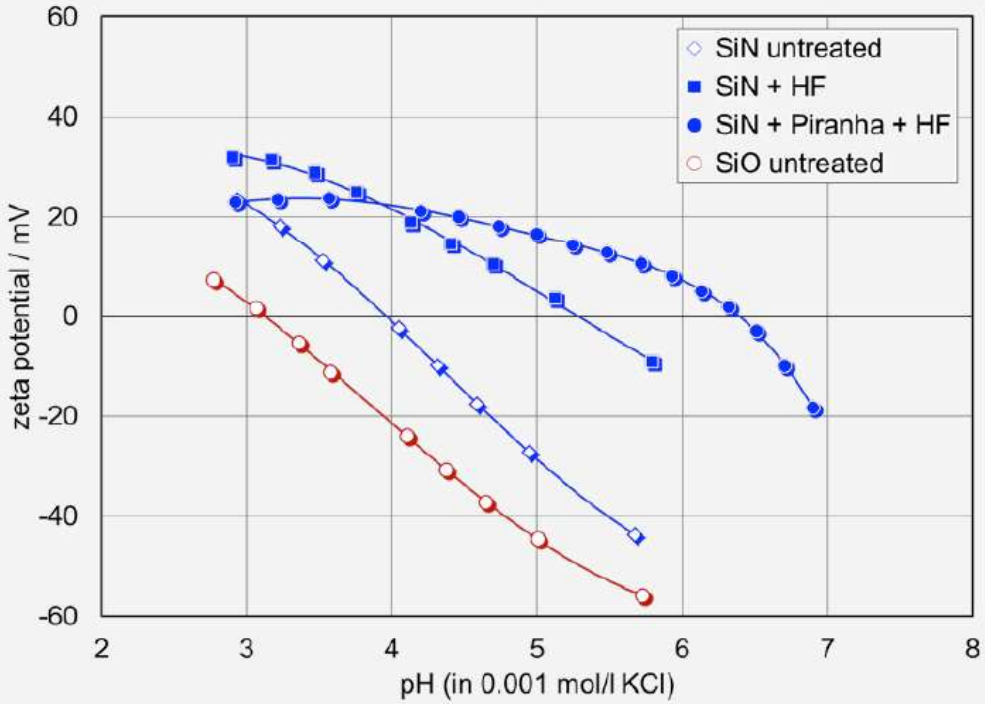
Wafer cleaning efficiency



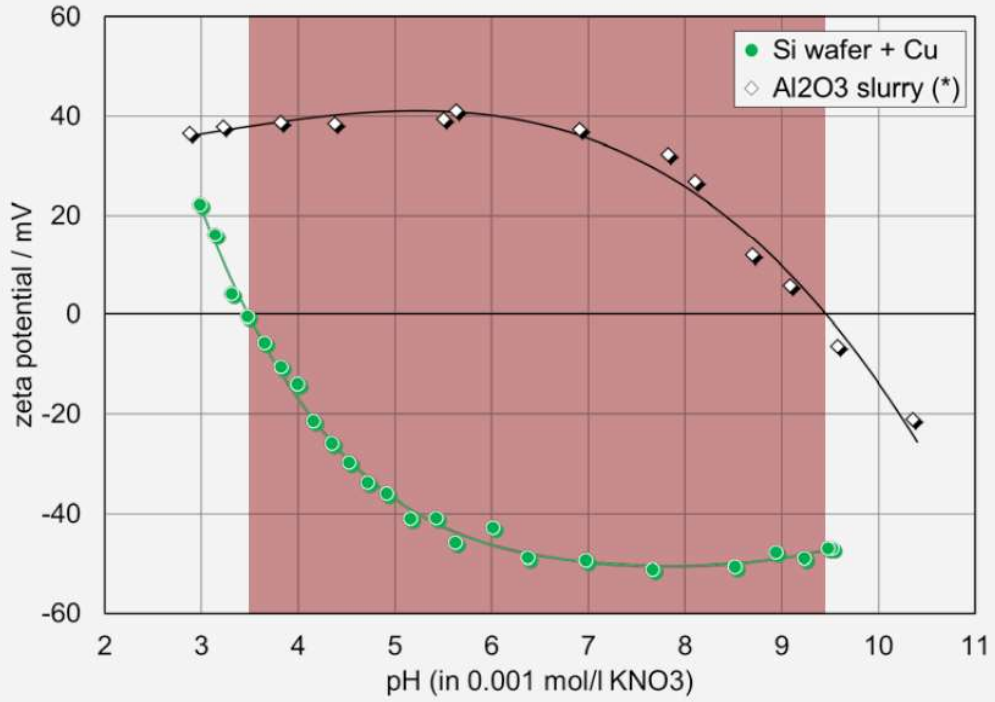
SiN ..... silicon nitride wafer

SiO ..... silicon oxide wafer

Piranha: H_2SO_4:H_2O_2 = 3:1, oxidative removal of organic contaminant

HF: removal of silicon oxide

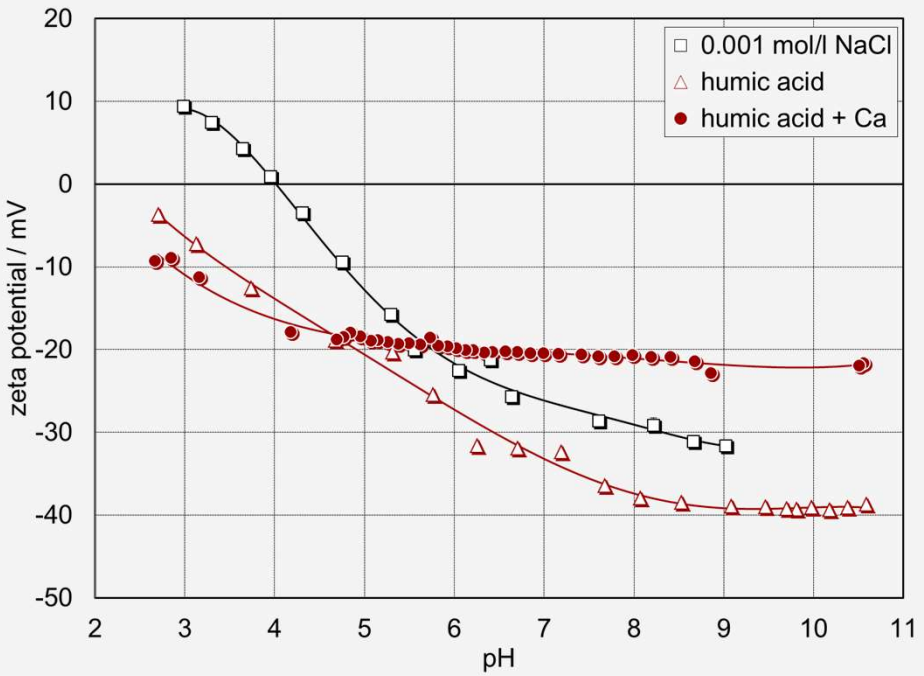
Chemical Mechanical Polishing



- CMP process uses abrasive particles (e.g., Al_2O_3 or SiO_2 slurries)
- After CMP, particles must not adhere to the wafer surface
- Electrostatic repulsion requires equally charged wafer and particle surfaces

(* measured by ELS)

Membrane fouling



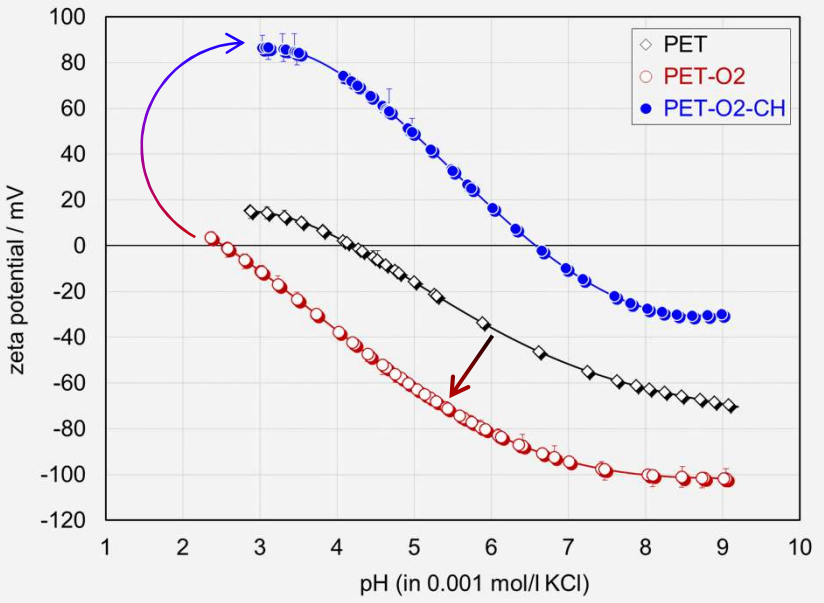
- Thin-film composite polyamide membrane for reverse osmosis
- Virgin membrane ζ determined in 0.001 mol/l NaCl
- Adsorption of 100 mg/l humic acid
- Adsorption of 10 mg/l Ca^{2+}

I. Owusu-Agyeman et al., J. Membr. Sci. 528 (2017) 82

SurPASS 3 for polymer applications

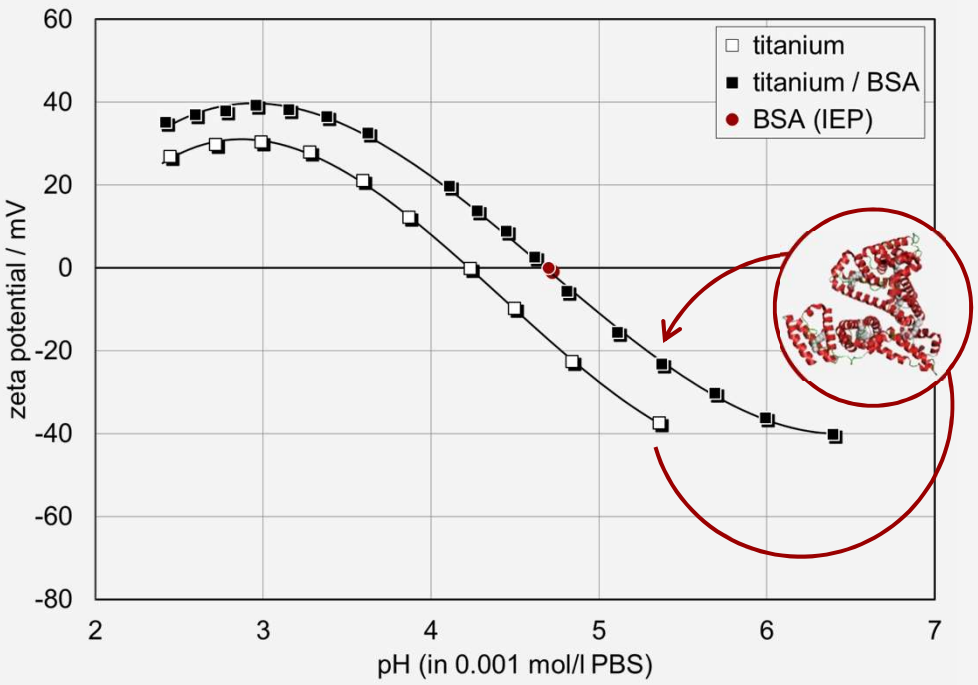
Antimicrobial coatings

- PET
  poly(ethylene terephthalate) foil
- PET-O_2
  PET foil treated with oxygen plasma
- PET-O_2-CH
  PET foil treated with oxygen plasma and coated with chitosan



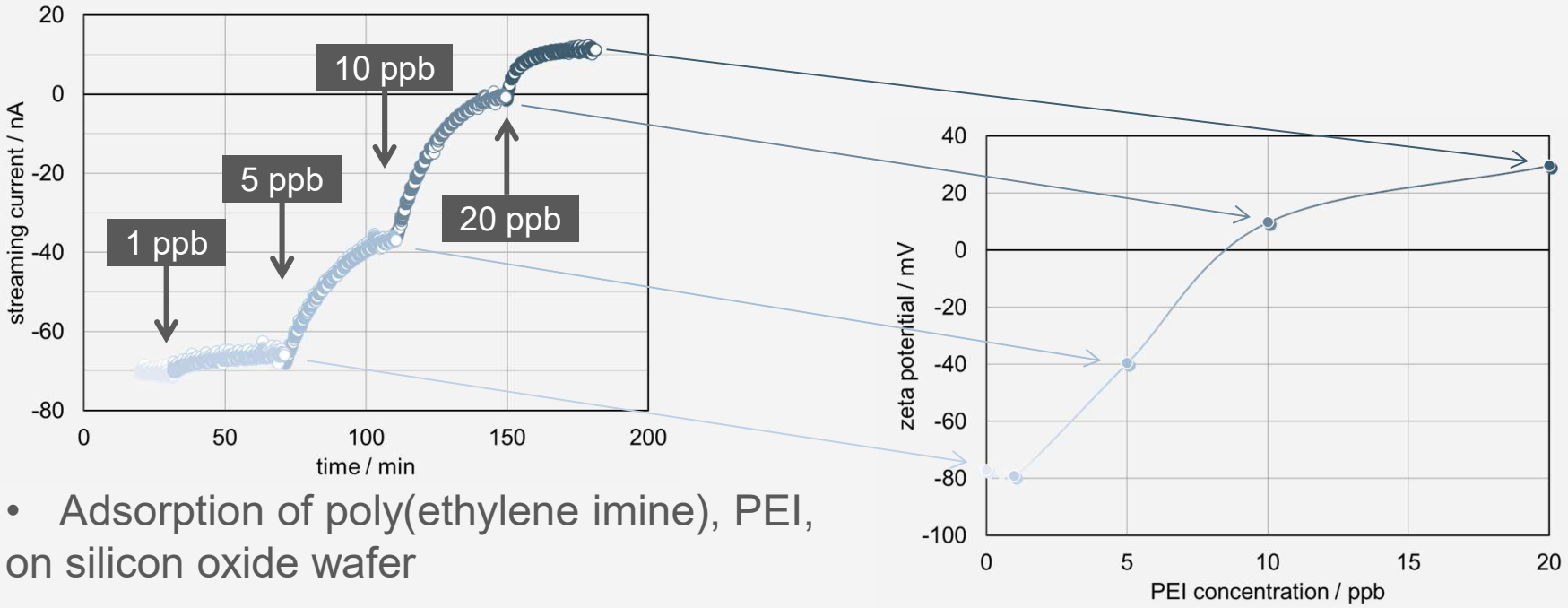
T. Tkavc et al., J. Adhes. Adhes. 48 (2014) 168

Protein adsorption



- Adsorption of BSA (bovine serum albumin) on titanium
- Isoelectric point (IEP) of titanium | BSA matches IEP of BSA in solution

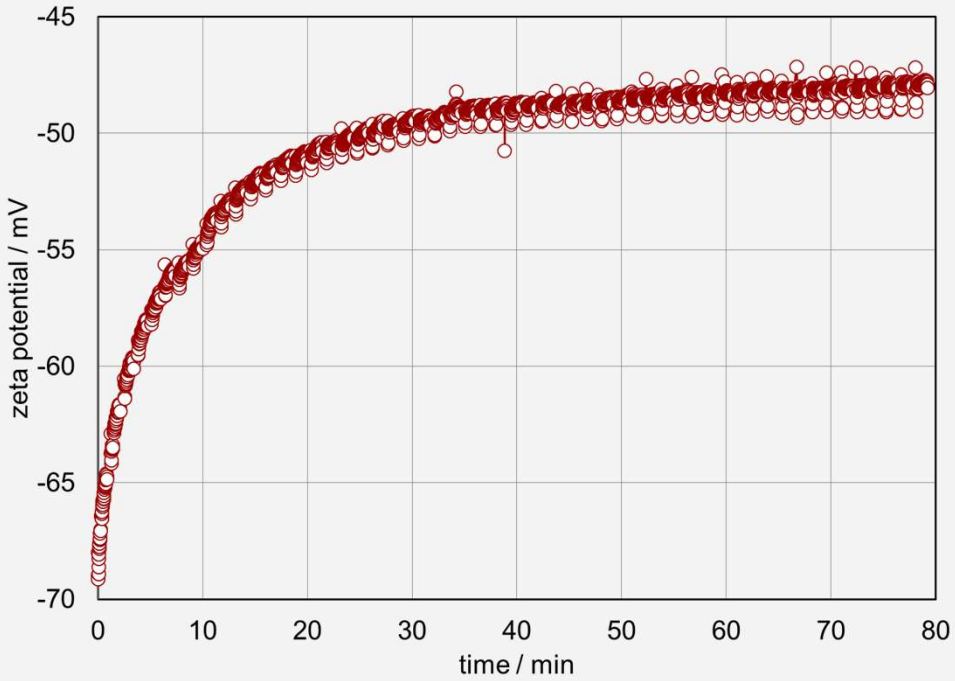
Monitoring of Adsorption Processes



- Adsorption of poly(ethylene imine), PEI, on silicon oxide wafer

SurPASS 3 for biomaterial applications

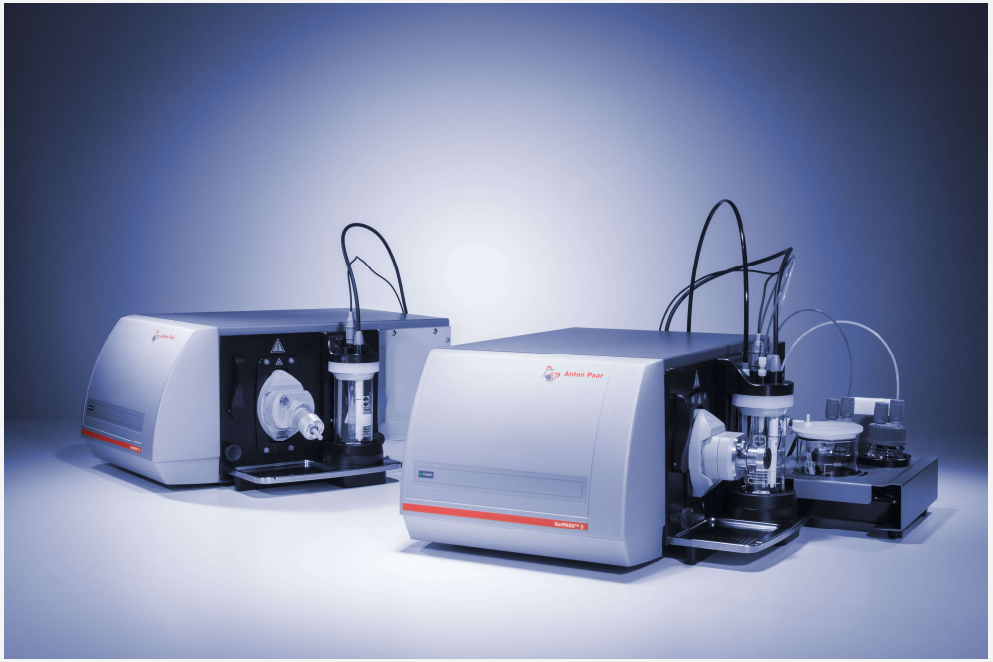
Protein adsorption



- Adsorption kinetics of bovine serum albumin (BSA) on glass
- 0.2 mg/ml BSA
- 0.001 mol/l PBS, pH 6.5

Thank you !

Please send your Questions in the Chat Box



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