NIST Particle Characterization Laboratories

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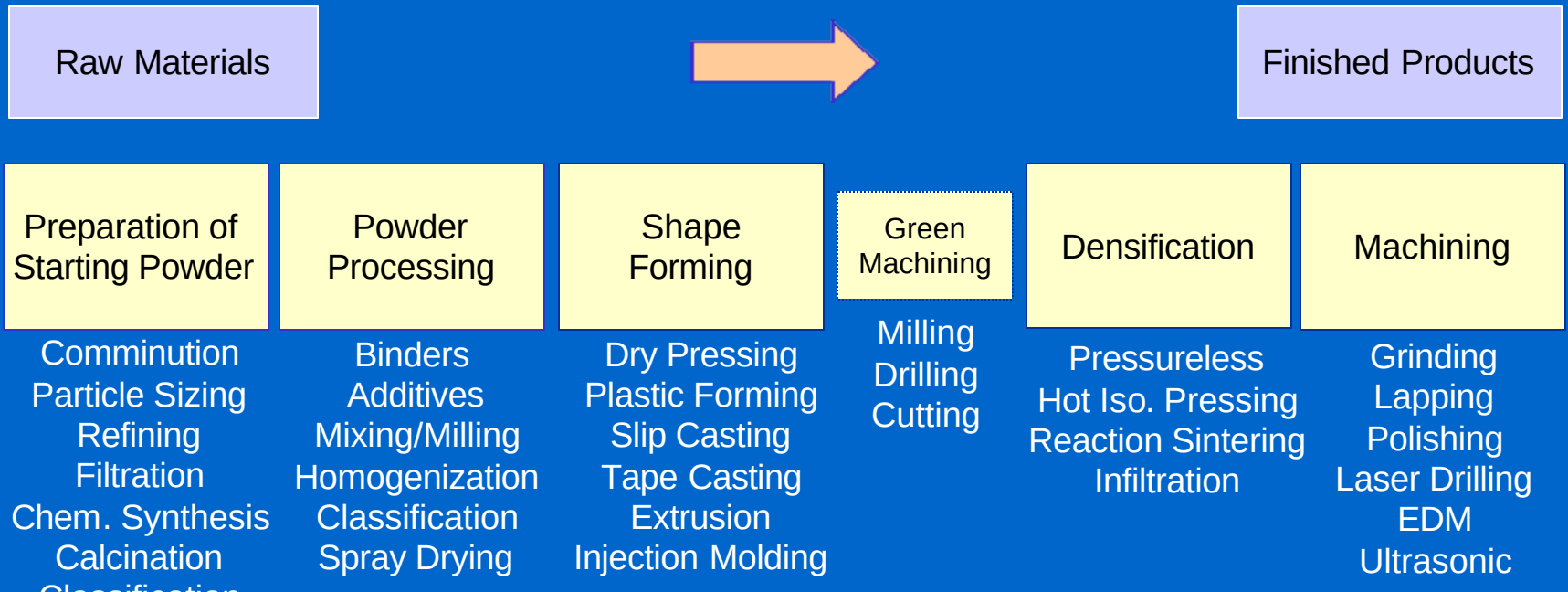
Ceramic Materials

Ceramics : non-metallic inorganic materials

Structural
Electronic
Refractory
Bioceramic
Structural Clay
White Wares
Cement

Ceramic Manufacturing

Ceramic manufacturing can involve a number of complex processes, each of which is impacted by the previous step.



Particulates in Ceramic Processing

- The vast majority of ceramics are manufactured starting from powders
- Wet processing (dispersion) is widely used in industry
- Particle characteristics have a profound impact on the properties of consolidated ceramics

Particulate Properties

Particle characterization is a key enabler for reliable cost-effective manufacture of advanced ceramics

Physical Properties

- Density
- Porosity
- Surface Area
- Shape
- Size Distribution

Dispersion Properties

- Surface Charge
- Zeta Potential
- Surface Chemistry
- Rheology
- Agglomeration

Ultrasonic Measurement Methods

The most important feature of ultrasonics is its capacity to provide useful information on concentrated suspensions

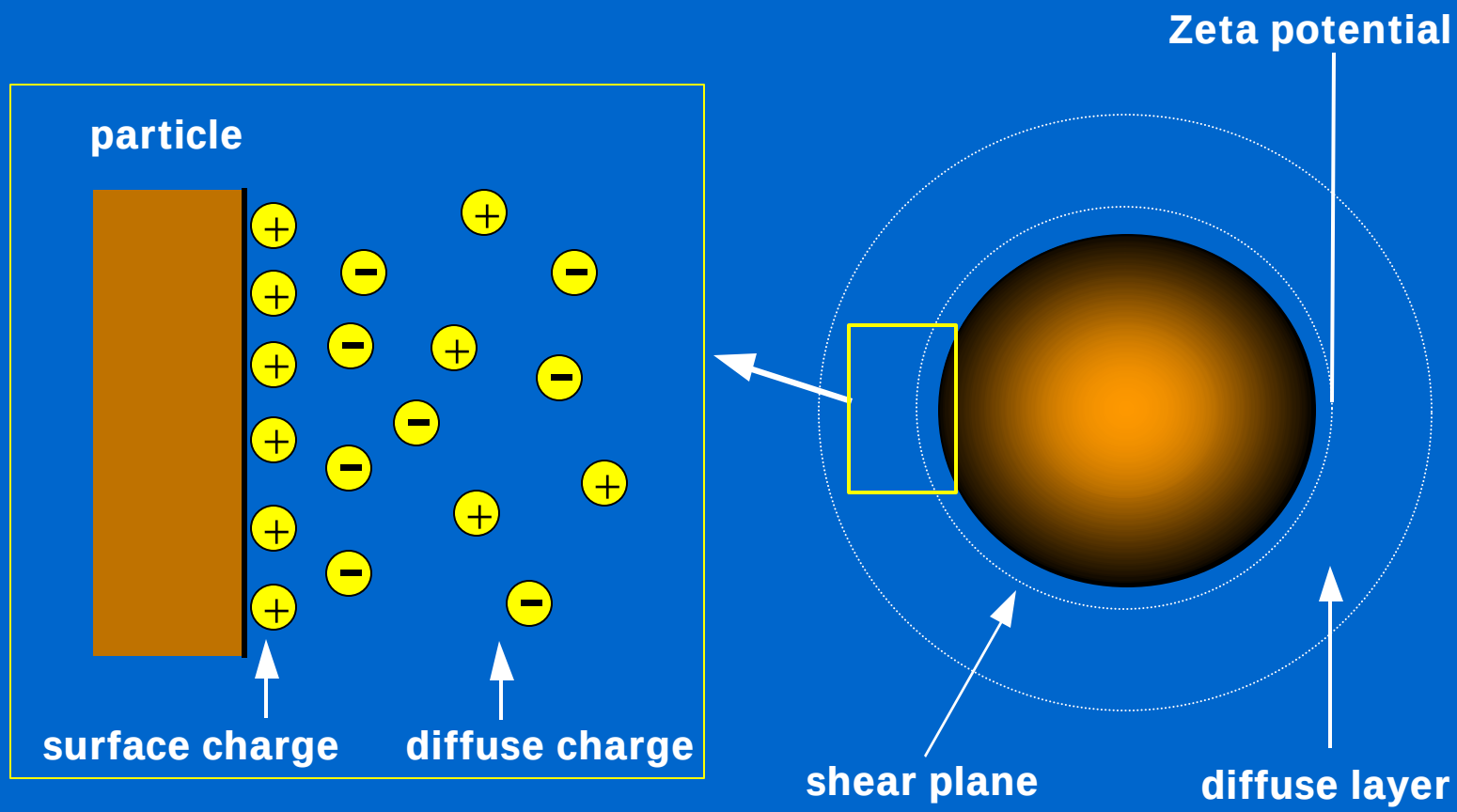
Advantages

- concentrated systems
- non-destructive
- robust sensors
- during flow
- rapid
- high precision

Properties

- particle size distribution
- zeta potential
- solids concentration

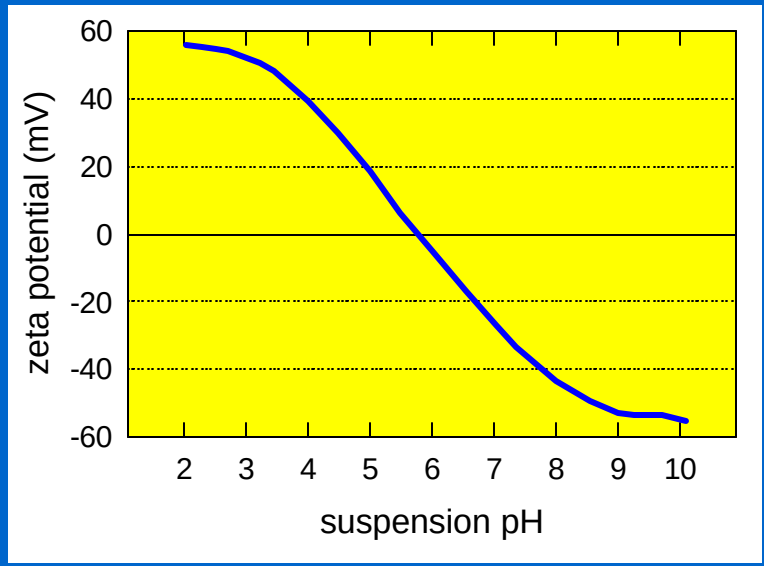
Zeta Potential



Measuring Zeta Potential

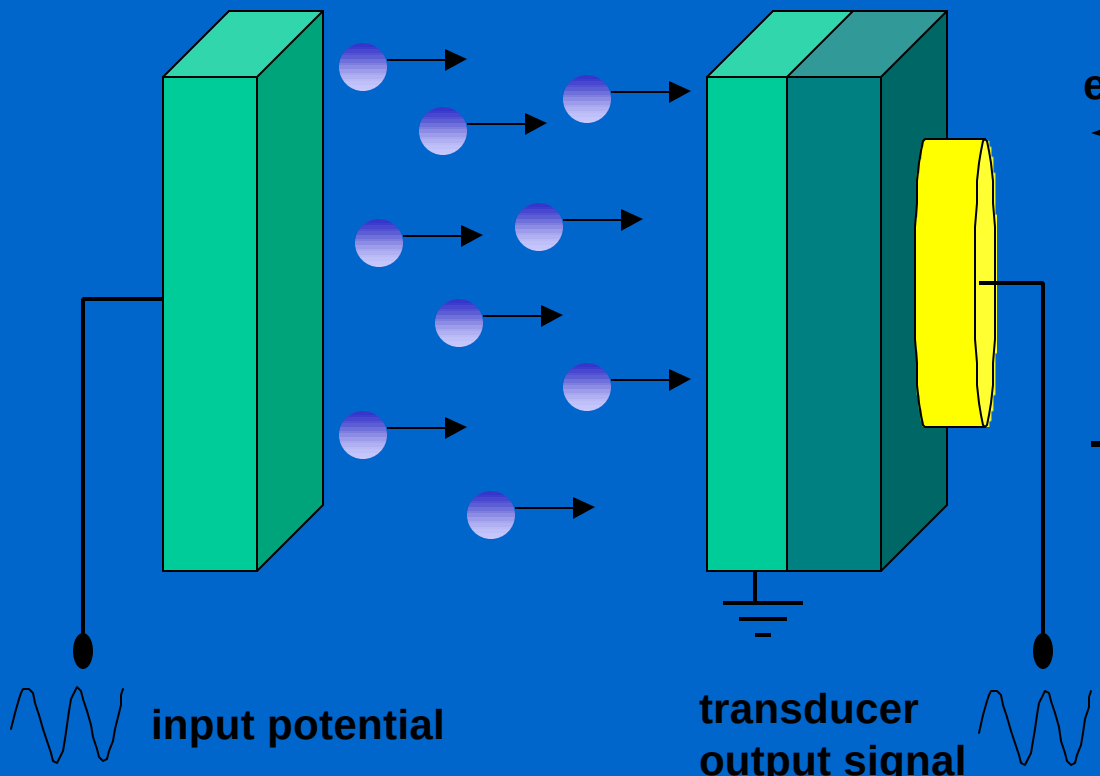
Zeta is typically measured using electrokinetic methods

In an electric field, charged particles will move with a velocity dependant on Zeta and the applied field



Electroacoustic Measurements

Based on the coupling between electric and acoustic fields in a suspension of charged particles



ESA
CVP
CVI

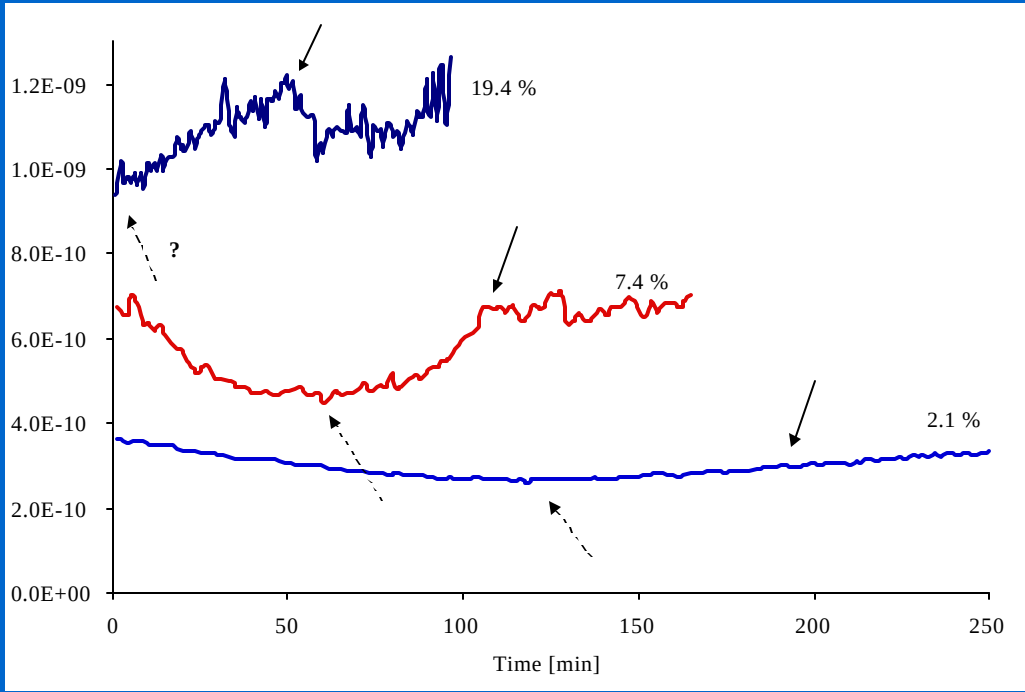
Cement Hydration

CVP Measurements Provide Information on Cement Particle Chemistry

Relative Acoustic Mobility (RAM) of Portland cement as a function of hydration time and solids loading.

Reflects physical and chemical changes that impact the cement particles.

Flatt & Ferraris (unpublished)



Conclusion

The Ceramic Manufacturing Program at NIST has:

- world class laboratories for the characterization of fine particles
- expertise in working with inorganic particulates
- unique ultrasonics facility for characterizing concentrated suspensions

Available Instrumentation

- AMRAY 1830 SEM
- Beckman J2-HC Centrifuge
- Brookfield DVII+ Viscometer
- Colloidal Dynamics Acoustosizer
- Coulter LS230 Laser Diffraction
- Coulter Multisizer II Zone Sensing
- Dispersion Technology DT1200 Acoustic Spectrometer
- Horiba LA900 Laser Diffraction
- Micromeritics Sedigraph 5100
- Micromeritics AccuPyc 1330
- Malvern Zetasizer 3000HS Doppler Laser Scattering
- Matec ESA8000 Electroacoustic Analyzer
- Perkin-Elmer 330 UV-VIS Spectrophotometer
- Quantachrome AUTOSORB-1 Multipoint Gas Adsorption
- Quantachrome AUTOSORB-60 Mercury Porosimeter
- Rheometrics RS2000 Rheometer
- Rosemount-Dohrmann DC80 TOC

Particle Shape Measurement

- Scanning Electron Microscopy/Auto-Digitization

AMRAY 1830

Rheological Measurements

- Shear Viscosity
- Storage Modulus
- Shear Modulus
- Yield Stress

Rheometrics RS-2000

Surface Charge Measurement

- Potentiometric Titration

Matec ESA-8000

Agglomeration Measurements

- Electroacoustic Spectrometry
- Acoustic Attenuation Spectrometry

Colloidal Dynamics Acoustosizer

Surface Chemistry Measurements

- Polymer Adsorption
- Isoelectric Point
- Potentiometric Titrations

Techmar-Dohrman DC-80 TOC

Zeta Potential Measurement

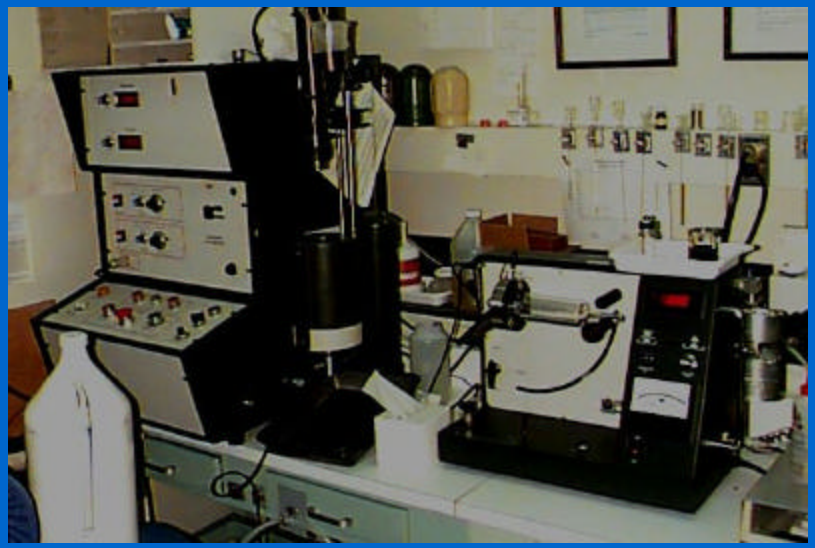
- Doppler Microelectrophoresis
- Colloid Vibration Current (CVI)
- Electrokinetic Sonic Amplitude (ESA)

Malvern Zetasizer 3000HS

Surface Area & Porosity Measurement

- N_2 Gas Adsorption
- Hg Porosimetry

Quantachrome AUTOSCAN 60



Particle Size Distribution Measurement

- Scanning Electron Microscopy (SEM)
- Doppler Laser Scattering (DLS)
- Laser Diffraction
- X-Ray Sedimentation
- Centrifugal Sedimentation
- Electrical Zone Sensing

Micromeretics Sedigraph 5100

Density Measurement

- He-Pycnometry

Micromeritics AccuPyc 1330