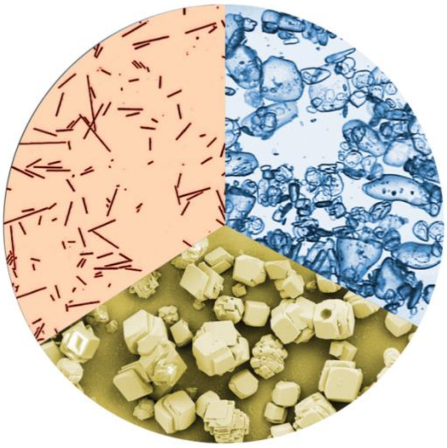
CENTRAL LABORATORY

Research & Training Center

METU, Ankara

Particle Size and Zeta Potential Measurement Laboratory



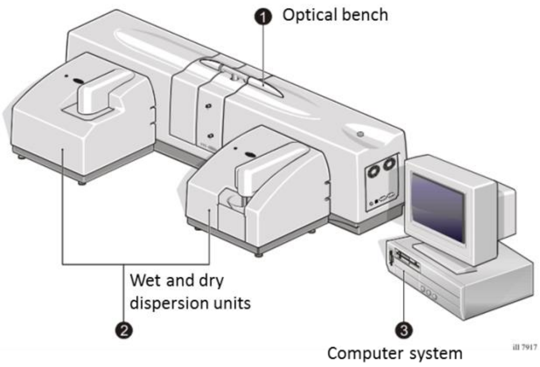
Many of the materials that we use are formed by combining the small grains together and subjecting to a treatment. For example; construction materials like concrete, plaster, paint; ceramic kitchen and bathroom products; pharmaceutical ingredients, food products etc. are fine grained structures. Material properties like strength, chemical reactivity, opacity, material strength and fluidity depend on particle size characteristics of the materials.

Instruments

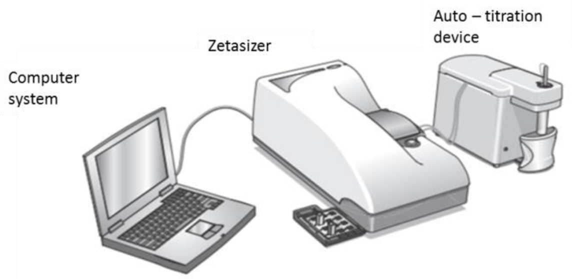
Malvern Mastersizer 2000: Has two sample dispersion units that allow it to measure wet and dry samples. Particle size measurement range is from 20 nm to 2 µm.

Malvern Nano ZS90 (zetasizer): Provides size (2nm - 3µm), zeta potential (3nm - 10µm) and isoelectric point measurement. It uses dynamic light scattering and electrophoretic light scattering for size and zeta potential measurement, respectively. The measurement of zeta potential has important applications in a wide range of industries including; ceramics, pharmaceuticals, medicine, mineral processing, electronics and water treatment.

Property	Mastersizer 2000	Nano ZS90
Measurement range	20 nm – 2 mm	2 nm -2 µm
Technique	Red and blue laser diffraction	90° red laser diffraction
Minimum amount of sample for measurement	Wet analysis: 200 mg Dry analysis: 10 g	Sample less than 2% suspended in 2 cm^3 liquid
Tests	Particle size	Particle size, zeta potential, isoelectric point



a)Malvern Mastersizer 2000



b) Malvern Nano ZS90

Figure 1. Measuring instruments

BASIC PRINCIPLES

Particle size distribution measurement: Laser diffraction is a widely used particle sizing technique for materials ranging from 0.02 to 2000 µm. The sample is dispersed in either air or a suitable liquid media. The laser passes through the dispersion media and is diffracted by the particles. The sample is dispersed well and it is ensured that the particles pass the laser beam in a homogeneous stream. The blue laser is used for measuring the small particles, while the red detects the larger particles. The diffraction pattern is measured by detectors, and the signal is then transformed to a particle size distribution based on an optical model.

There are 2 scattering model: Mie theory and Fraunhofer approximation. Mie is superior to the Fraunhofer approximation as it predicts all of the scattering from a particle based on its optical properties. Particularly important for particles less than 50 µm.

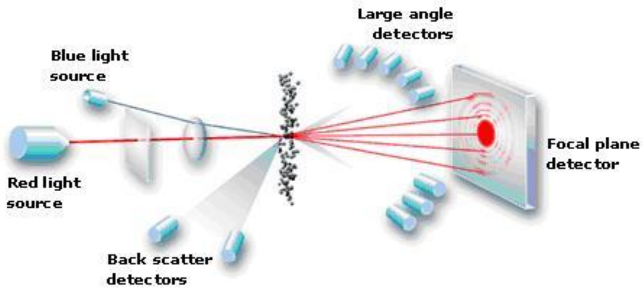


Figure 2: Laser diffraction theory for determination of particle size distribution

Zeta potential: Zeta potential is a measure of the magnitude of the electrostatic or charge repulsion/attraction between particles, and is one of the fundamental parameters known to affect stability. It depends on the chemistry of the particle surface and the dispersant. Its magnitude indicates the potential stability of the colloidal system. High zeta potential value indicates high interparticle repulsion and stable suspension. Low or zero value indicates flocculation, aggregation, agglomeration, thus unstable suspension. Its measurement brings detailed insight into the causes of dispersion, aggregation or flocculation, and can be applied to improve the formulation of dispersions, emulsions and suspensions.

Changes in pH affects zeta potential. The iso-electric point is the pH value at which the zeta potential is approximately zero.

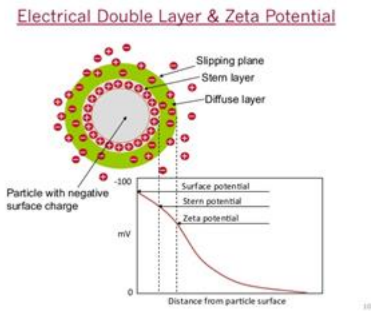


Figure 3: Electrical potential at the slipping plane (charge a particle acquires in a particular medium)

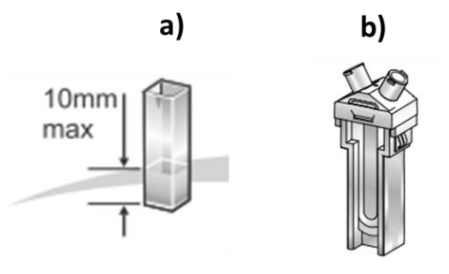
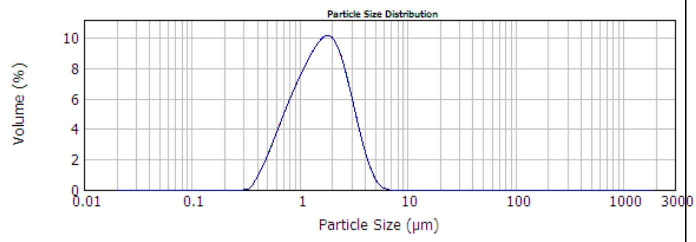


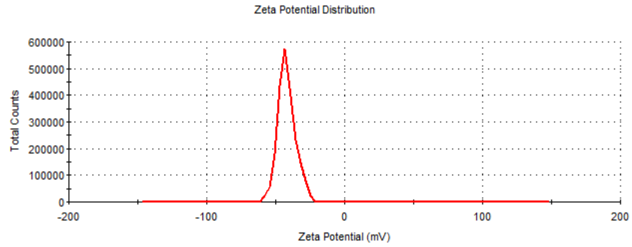
Figure 4. Cuvettes used in zetasizer for measurement of a) Particle size, b) Zeta potential

EXAMPLES OF STUDIES

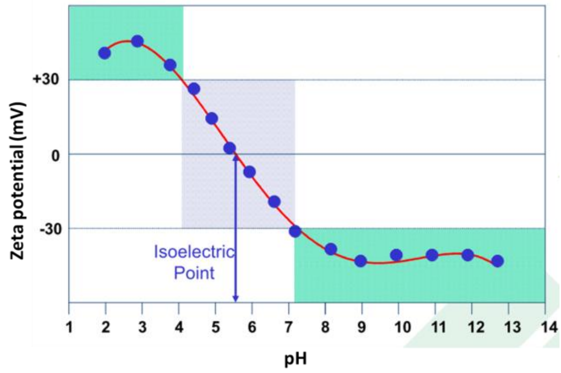
As an example, particle size distribution of an oxide material is given in Figure 5-a, and zeta potential measurement is given in Figure 5-b (single point) and Figure 5-c (against pH).



a) Particle size distribution



b) Zeta potential graph



c) Graph of zeta potential versus pH

Figure 5. Examples of particle size distribution and zeta potential measurement

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