Capability for surface ζ-potential of materials and analysis of film surfaces

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Background and motivation for surface ζ-potential analysis

The aim of this project was to develop a reliable method for the measurement of surface ζ-potential of thin films.

ζ-potential is the charge acquired by a material when it is immersed in a conductive medium. Surface ζ-potential is the charge at the surface of the material.

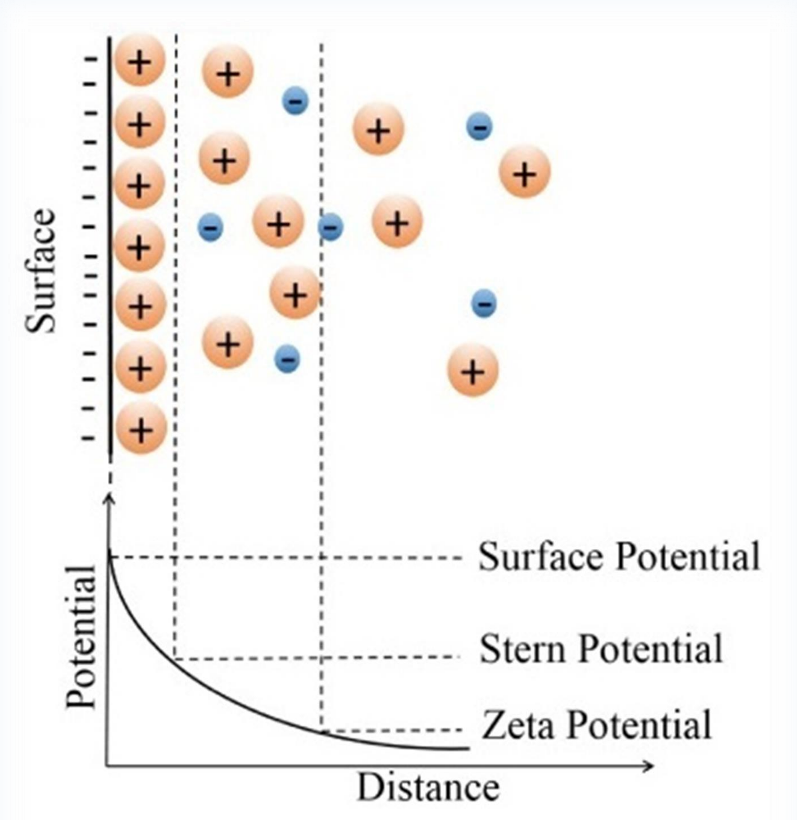

Fig. 1: A charged flat surface obtains a ζ-potential from the ions in a fluid [3].

Electro-osmosis and electrophoresis have different contributions on particles' mobility near a charged surface depending on their displacement from the plate. Hence particle mobility at increasing displacements can be measured to determine the surface ζ-potential.

A regression line on a plot of ζ-potential against displacement can be extrapolated to zero displacement to obtain the surface ζ-potential.

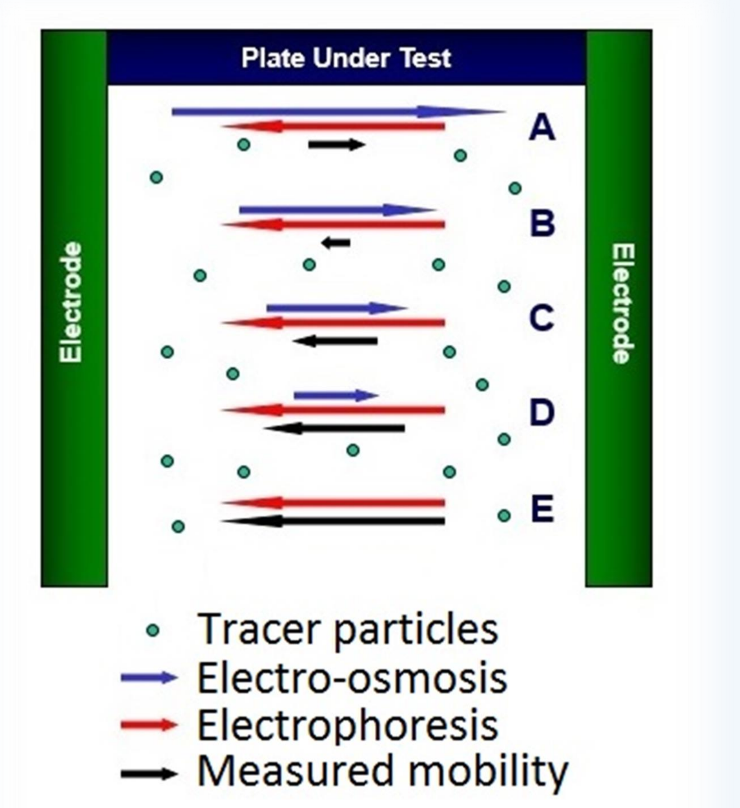

Fig. 2: Mobility of tracer particles at locations A-E allows surface ζ-potential to be measured. Electrokinetic effects on the tracers are present [4].

Sample preparation

Precise sample preparation was key to obtaining accurate results.

Using uncleaned surfaces and the presence of bubbles could result in anomalous data.

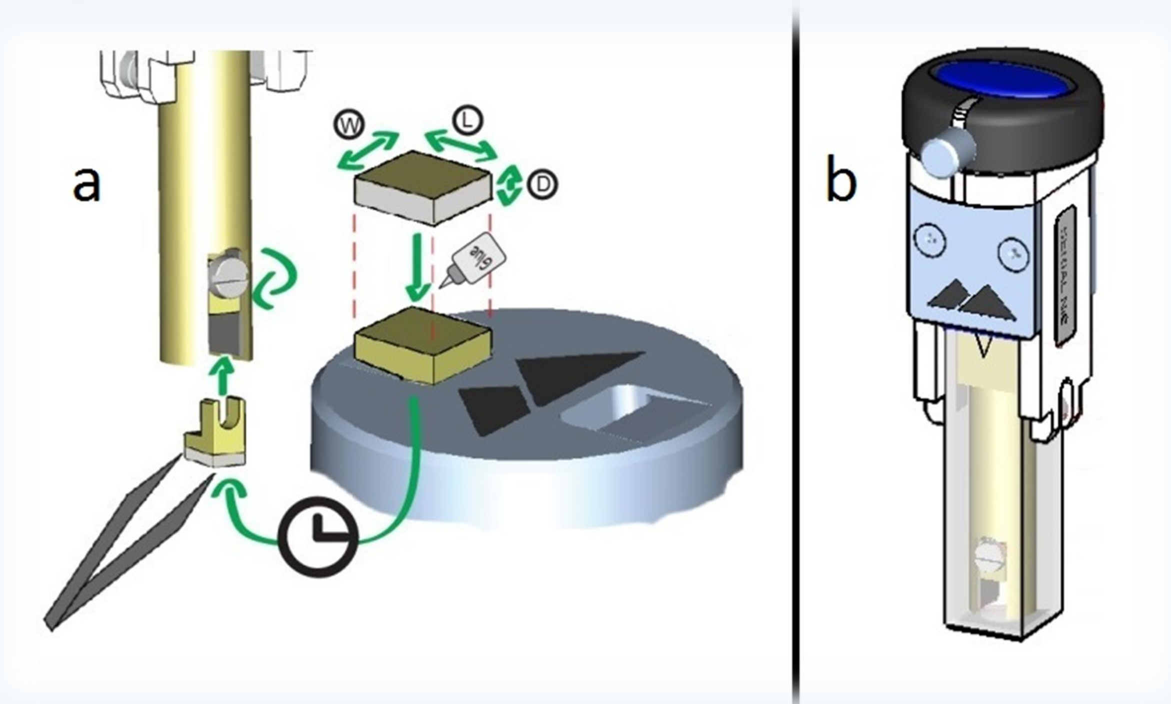

Fig. 3: a) Illustration of sample preparation; stick surface to sample holder and screw onto the cell. b) Illustration of cell and cuvette, containing sample surface and conductive fluid [5].

- Cut material no larger than (4x7x1.5) mm
- Clean with IPA in sonic bath
- Stick material onto sample holder with tape
- Fix plate to cell and zero the height
- Insert cell into particle dispersion, ensuring no bubbles form
- Final height alignment

Fig. 4: Flow diagram of the sample preparation steps

Characterisation of tracer particles

Table 1: Various tracer particles used. Surface ζ-potential is of a silica wafer.

Material	Conductivity (mS/cm)	Surface ζ-potential (mV)	pH
Polystyrene	0.02 ± 0.01	-75 ± 4	7.70 ± 0.10
Malvern Panalytical polystyrene	0.32 ± 0.01	-82 ± 5	8.50 ± 0.10
Gold	0.05 ± 0.01	-65 ± 10	7.60 ± 0.10
Gold 1:10 dilution in 1 mM NaCl	0.33 ± 0.01	-60 ± 5	6.73 ± 0.01

Identifying suitable tracer particles was also a key step in the measurement procedure. Tracers must not interact with the plate, the particle dispersion must have a good conductivity and must have a low concentration to prevent any interactions with the surface.

The tracer particles which produced the most reproducible results were the gold nanoparticles in a 1:10 dilution of 1 mM NaCl. As shown in Table 1, it had the highest conductivity. These tracers were found to be the most suitable and thus used in all later experiments.

Measurements of surface ζ-potential

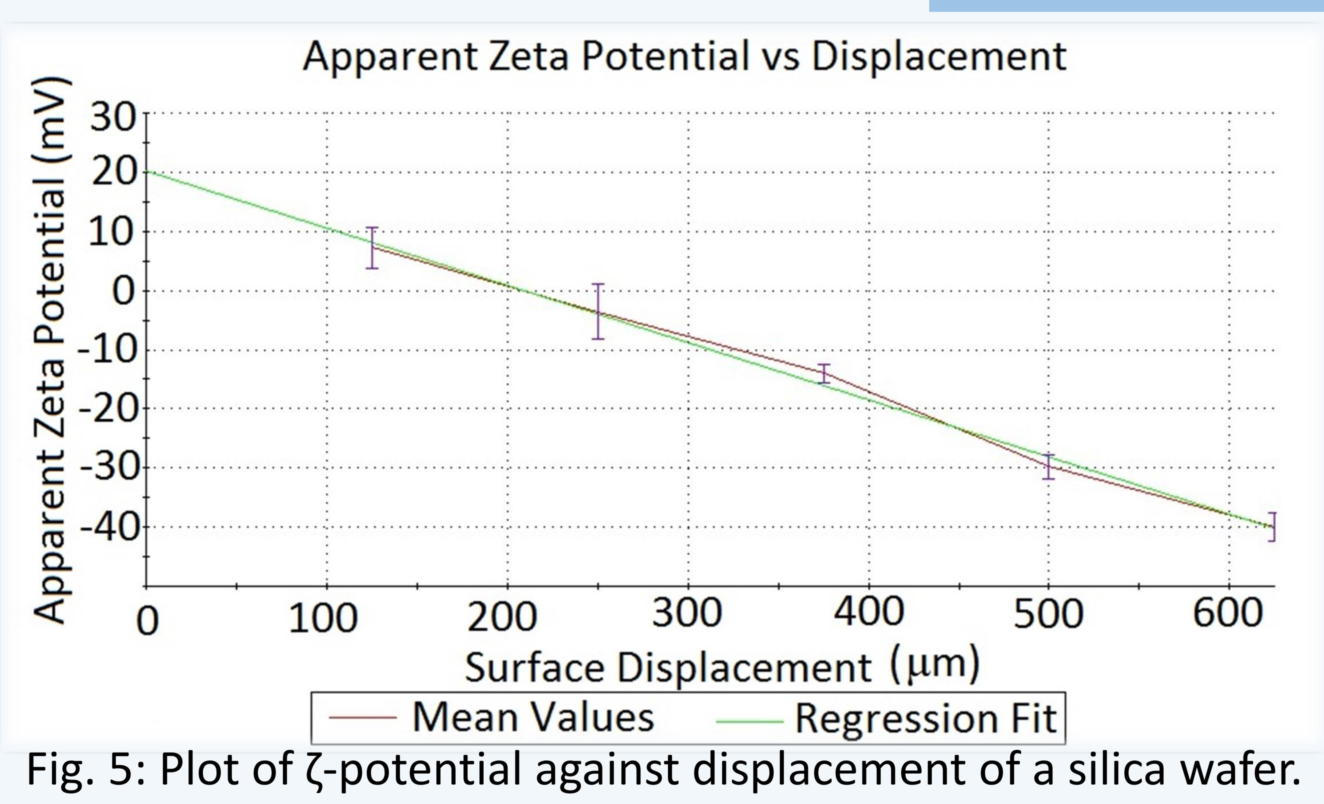

Fig. 5: Plot of ζ-potential against displacement of a silica wafer. ζ = (-60 ± 5) mV with pH (6.73 ± 0.01)

After establishing a reproducible measurement method, the surface ζ-potential of various surface materials were measured.

It was concluded that a reproducible measurement protocol relies on the use of suitable tracer particles. The most appropriate particle dispersion could change depending on the surface material being investigated.

Table 2: Surface ζ-potential measurements of various materials.

Material	Surface ζ-potential (mV)	pH	R^2
Silica	-60 ± 5	6.73 ± 0.01	1.00
Polystyrene	-58 ± 7	6.73 ± 0.01	0.98
Gold	-47 ± 4	6.73 ± 0.01	0.97
PTFE	-50 ± 5	6.73 ± 0.01	0.99

References:
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