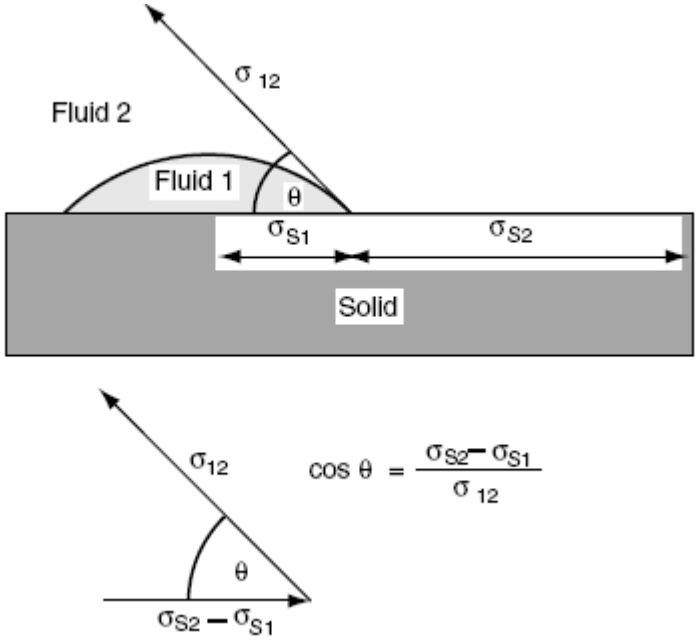
EXPERIMENT #2 **April 1, 2013**

MEASUREMENT OF CONTACT ANGLE AT SOLID/LIQUID INTERFACES

If one considers the three-phase system depicted in which the liquid drop is designated fluid 1, the surrounding medium fluid 2, and the Solid surface S,



then at equilibrium the contact angle will be given by Young's equation as

$$\sigma_{12} \cos \theta^{\circ} = \sigma_{S2} - \sigma_{S1}$$

Where **σ**12, **σ**S1, and **σ**S2 are the interfacial tensions at the respective interfaces. Although this equation was originally proposed on the basis of a mechanical analysis of the resultant forces at the three-phase contact line, it has since been derived rigorously on the basis of fundamental thermodynamic principles.

While Young's equation provides a thermodynamic definition of the contact angle, its experimental verification is prevented by the fact that the values of **σ**S1 and **σ**S2 cannot be directly determined experimentally. In this sense, the contact angle of a liquid on a solid differs from that of a liquid on a second liquid since in the latter case all three interfacial tensions can be determined independently and the relationship can therefore be verified directly. When the liquid of interest (1) is found to spread completely over the solid surface and Equation reduces to

$$\sigma_{12} = \sigma_{S2} - \sigma_{S1}$$

If it is assumed that the second fluid (2) is air and the only component adsorbed at the **σ**S2 interface is the vapor of liquid 1, Equation can be written

$$\sigma_{12} = \sigma_{S} - \pi_{S2,1} - \sigma_{S1}$$

Where **σ**is the surface tension (energy) of the solid surface with no adsorbed molecules and πs2,1 is the surface pressure of adsorbed liquid 1 at the S2 interface so that

$$\sigma_{S} - \pi_{S2,1} = \sigma_{S2}$$

If spreading occurs, the spreading pressure $\pi S2,1$ will increase, reducing $\boldsymbol{\sigma}S2$ until this Equation is exactly satisfied.

Method

Goniometer is the traditional method to measure contact angles at solid/liquid or solid/air interfaces.

Analysis of the shape of a drop of test liquid placed on a solid is the basis for goniometry. The basic elements of a goniometer include a light source, sample stage, lens and image capture. Contact angle can be assessed directly by measuring the angle formed between the solid and the tangent to the drop surface.

The production of drops with advanced and receded edges involves one of two strategies. Drops can be made to have advanced edges by addition of liquid. Receded edges may be produced by allowing sufficient evaporation or by withdrawing liquid from the drop.

Also with the same equipment contact angle of a bubble to a solid can be measured by submersing solid particle in a quartz cell filled with liquid and attaching an air bubble produced by a syringe.

Equipment, accessories and materials:

Dataphysics Contact angle measuring
Glass plate and other polymeric plates
0.001 Mole/L SDS solutions
Distilled water
Syringe

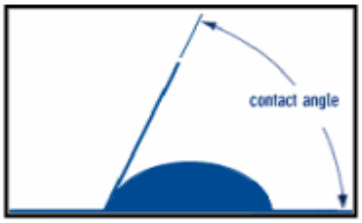
Experimental Procedure:

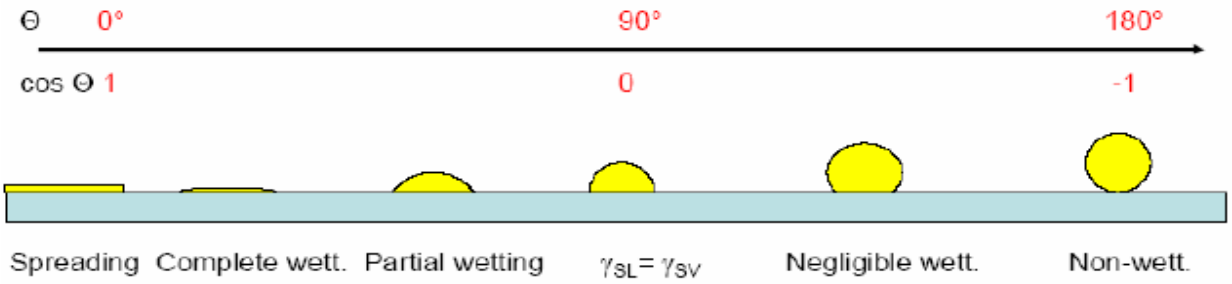
1. Clean the glass plate carefully
2. Allow a drop of distilled water and measure the contact angle. Change the substrate from glass to Nylon 6 and polypropylene and apply the same procedure.
3. Thoroughly clean the system and allow a drop of solution of 10^{-3} mole/l Sodium dodecyl sulfate (SDS) on the glass plate. Change the substrate from glass to Nylon 6 and polypropylene and apply the same procedure.

Report:

Describe the experiment you did and comment on your results for each case?
What is the difference between the contact angles for different solid substrates? What is the reproducibility of the tests?

Contact angle (Θ)





Θ depends on chemical constitution of both S and L

1) hard solids - covalent, ionic, metallic =>
high energy surfaces γ_{sv} ~ 500 to 5000 mN/m

2) weak molecular crystals - VdW, H bonds =>
low energy surfaces γ_{sv} ~ 50 mN/m