

Contact Angle Measurements

Purpose

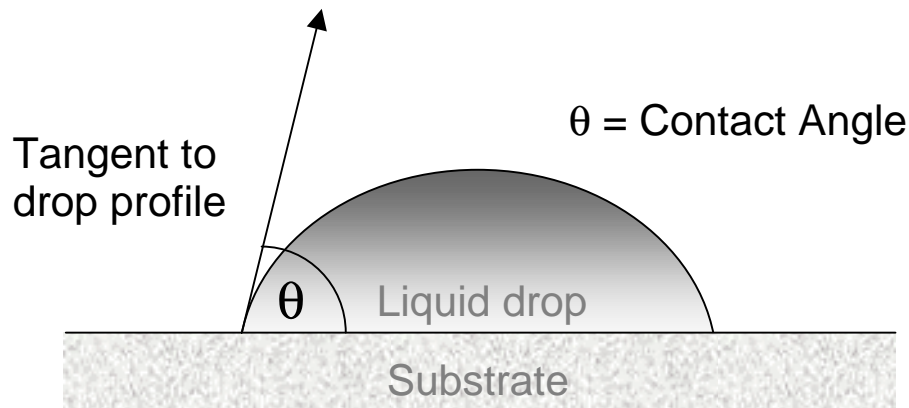
- To demonstrate the relationship between the properties and chemistry of a surface:

Wettability (ability of a fluid to cover a surface) varies with both the completeness of the monolayer and its degree of order.

Wettability also varies with the polarity of the monolayer surface functional groups.

- To determine the surface free energy of the monolayers by measuring contact angles as a function of surface tension of a series of liquids.

Theory



Young's Equation:

$$\gamma_{sg} = \gamma_{sl} + \gamma_{lg} \cos \theta$$

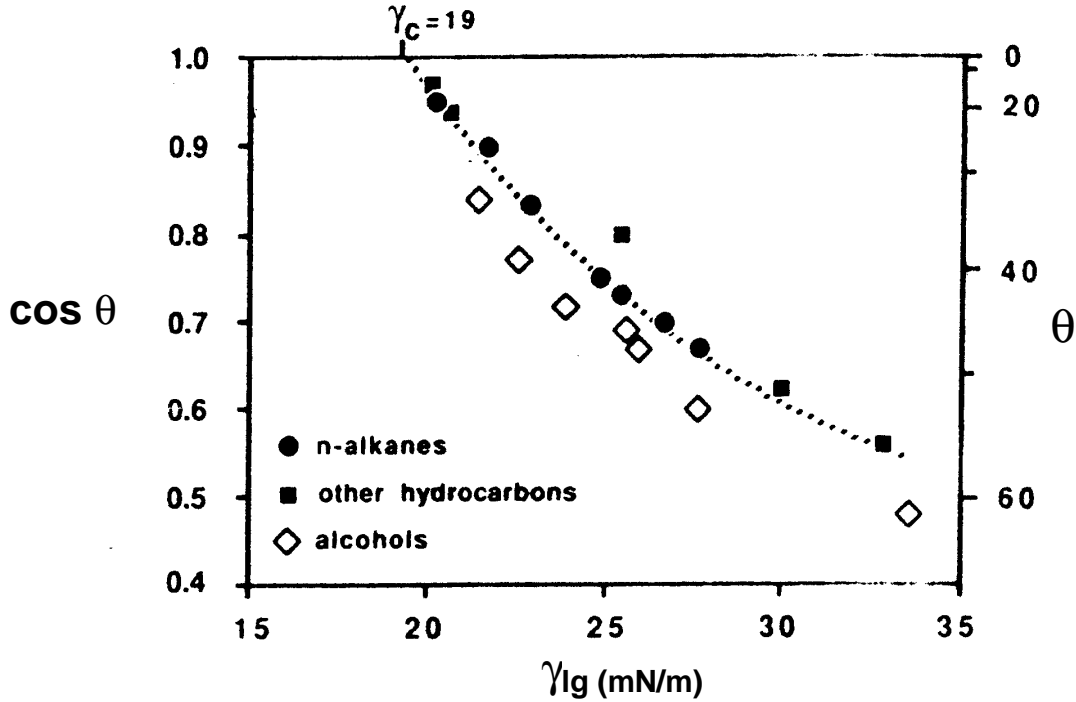
γ = surface tension which can be thought of as the energy required to create a unit area of an interface

Energy minimization:

If the energy required to create the solid-liquid (sl) interface is greater than that required for creation of a solid-gas (sg) interface, then the critical angle will be greater than 90°. In other words, the liquid will bead up on the surface to minimize the solid-liquid interfacial area.

Contact Angle Measurements (continued)

Determination of surface free energy



Zisman plot for monolayer of $\text{CH}_3(\text{CH}_2)_{21}\text{SH}$ on gold¹

Critical surface tension γ_c

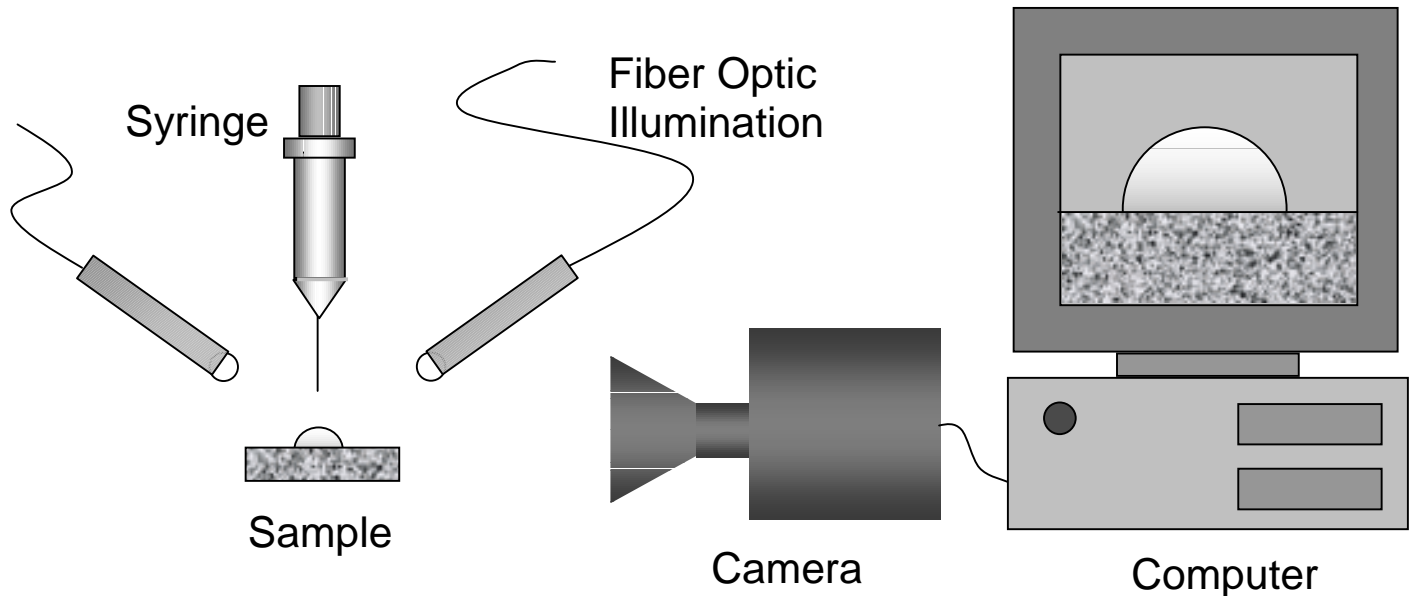
- For a particular surface, liquids with a surface tension \leq this value will wet the surface. A fluid with $\theta \leq 10^\circ$ “wets” the surface.
- Surface free energy $\propto \gamma_c$ so the lower γ_c , the lower free energy of the surface.

Critical Surface Tensions γ_c ¹

Surface	γ_c , mN/m
$\text{CF}_3(\text{CF}_2)_{10}\text{CO}_2\text{H}/\text{Pt}$	6
Teflon	18
$\text{CH}_3(\text{CH}_2)_{21}\text{SH}/\text{Au}$	19
$\text{CH}_3(\text{CH}_2)_{17}\text{SiCl}_3/\text{Si}$	20
Hexatriacontane	22
$\text{CH}_3(\text{CH}_2)_{17}\text{NH}_2/\text{Pt}$	24
polyethylene	31

Contact Angle Measurements (continued)

Experimental Setup:



Experiments

- (1) Contact angles on cleaned and uncleaned gold surfaces will be measured. *This will show the effect of surface contamination on the wettability.*
- (2) Contact angles on an octadecanethiol monolayer will be measured as a function of the annealing time. *This will allow correlation between the degree of organization of the alkyl chain and the wettability.*
- (3) The surface free energy of gold, octadecanethiol monolayers, and MUD monolayers will be determined by measuring the contact angles of different fluids on these surfaces and constructing Zisman plots.