CHEMICAL ENGINEERING
UC SANTA BARBARA

Determination of Energy of Hydrophobic Interfaces through Contact Angle Measurements

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Interactions of Molecules

Courtesy of hergoodybag.com

Product Efficacy

Courtesy of pgbeauty.com

Transportation and withstanding environments

Courtesy of bloomburg.com

Courtesy of bloomburg.com

Hydrophobic Interactions between Molecules

Hydrophobic –
To repel, not combine with or incapable of dissolving in water.

Waxed Surface

Water Droplet

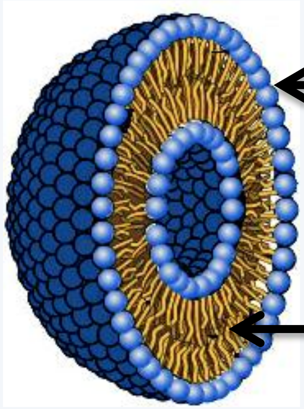
Courtesy of carcare-mvs.co.uk

Cooking Oil

Water

Courtesy of eHow.com

Liposomes



Hydrophilic Head Group (water-loving)

Hydrophobic Tail Group (water-hating)

Courtesy of SupplementClinic.com

Action Plan for our Research

Measure Contact Angle for droplets of various solutions

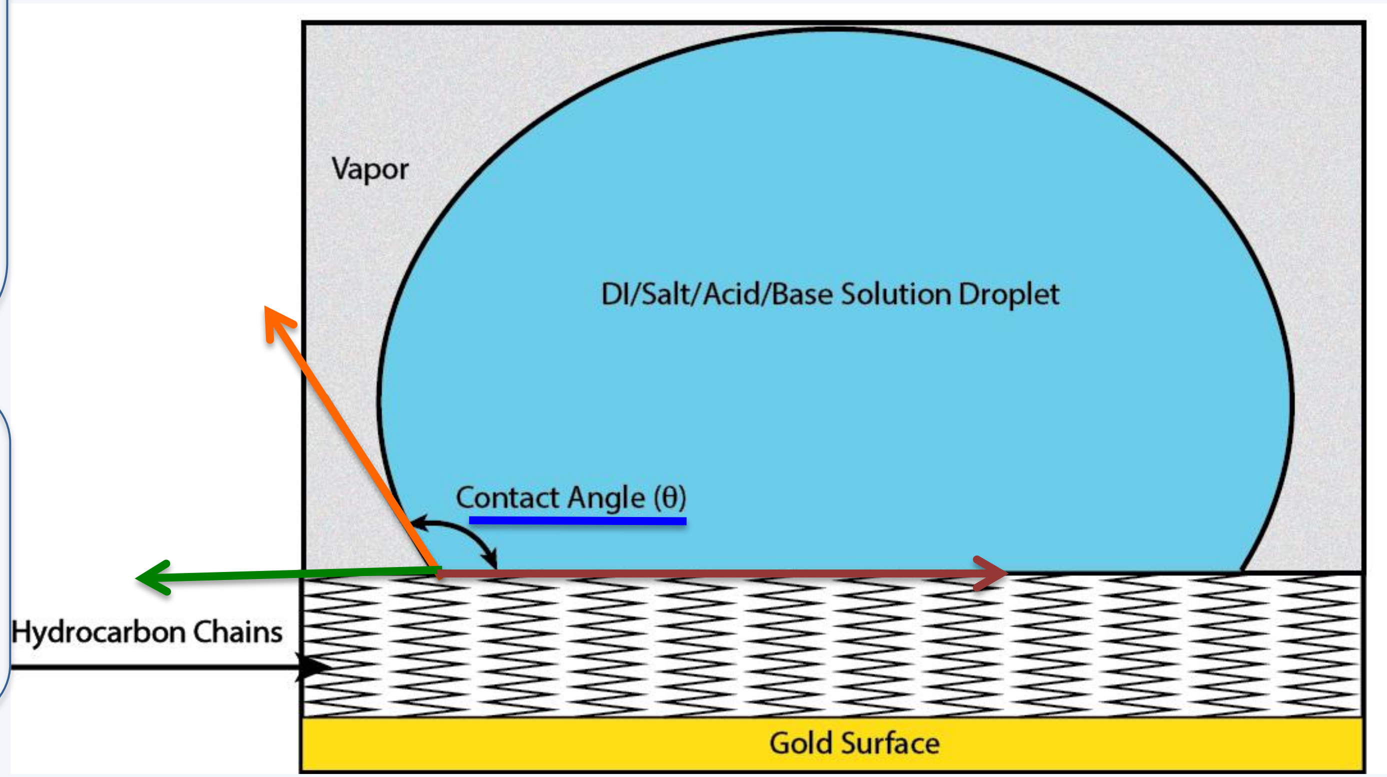
Analyze values to help aware us of influences the solution has on the hydrocarbon chains. (e.g. equilibrium contact angle)

Calculate values of surface energy between hydrocarbon (HC) and liquid phase (γ_{sl})

Young's Equation

γ = Interfacial Energy, units: mJ/m^2

$$\gamma_{\text{HC to liquid}} = \gamma_{\text{HC to vapor}} - \gamma_{\text{liquid to vapor}} * \cos(\theta)$$

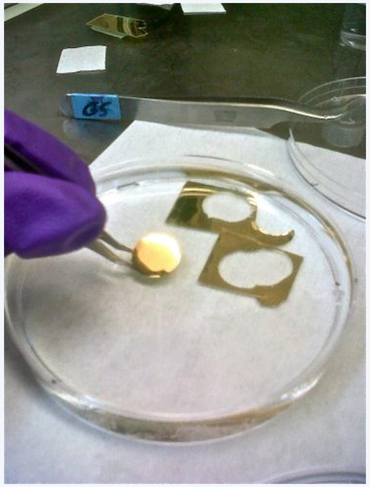


Glimpse of Procedure to Determine Contact Angles

Extract Data

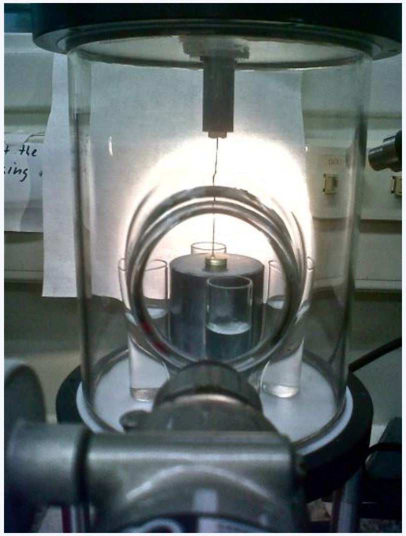
Clean Glass Surfaces

Plate Gold On Surfaces

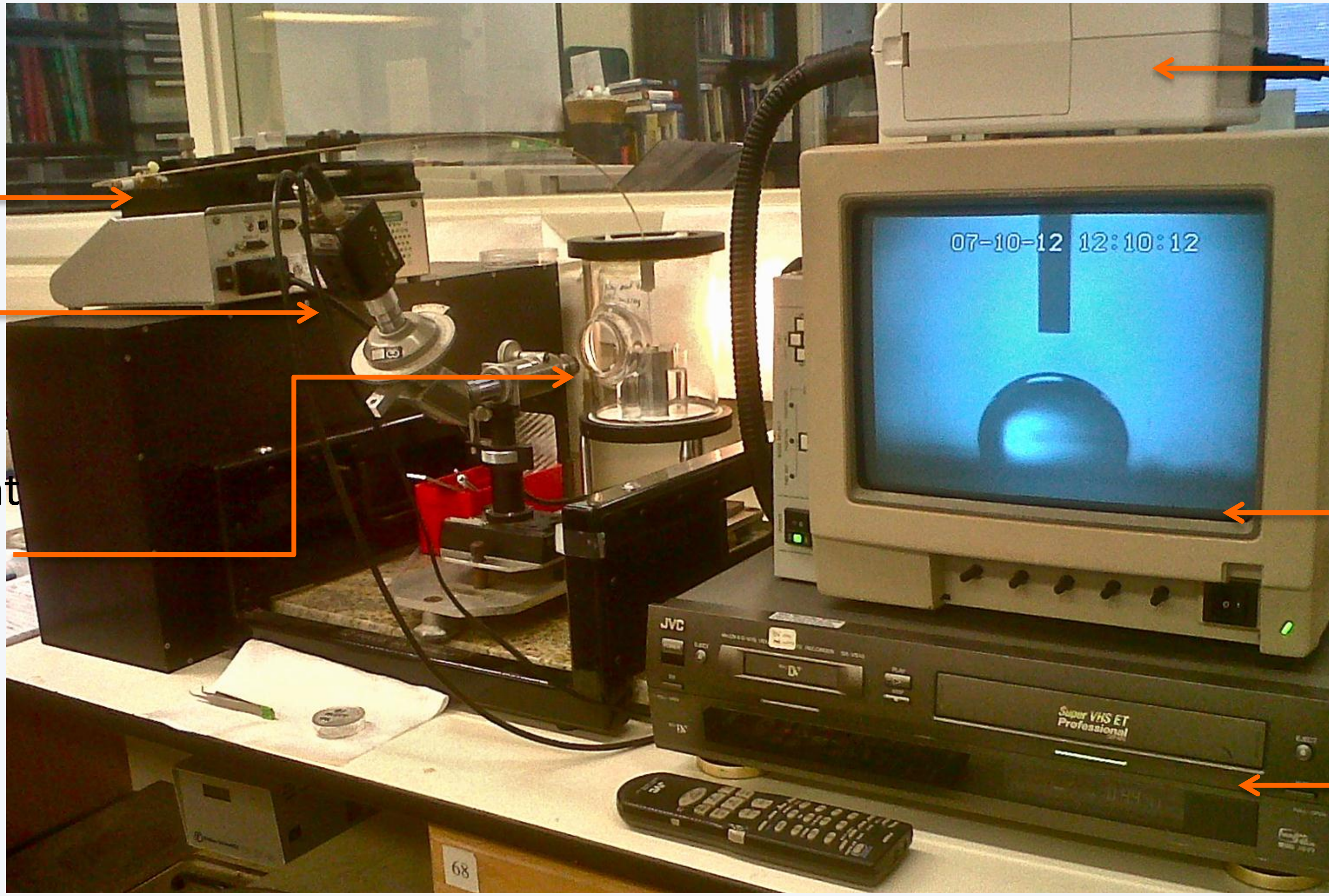


Soak in Thiol Solution

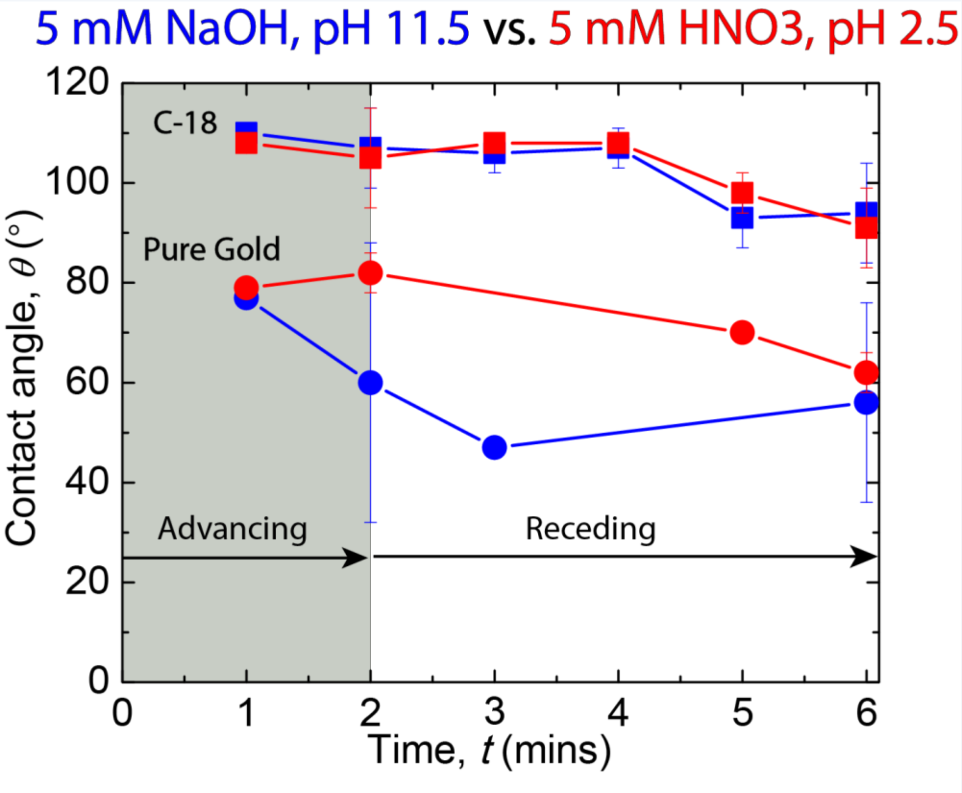
Test & Observe Surfaces



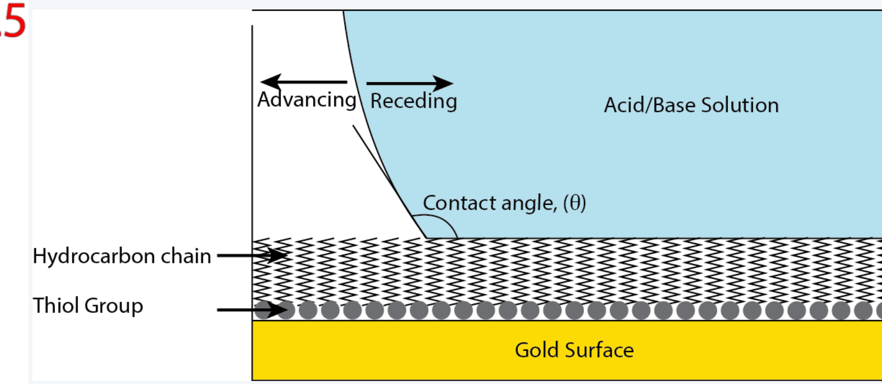
Experimental Method for Measurements



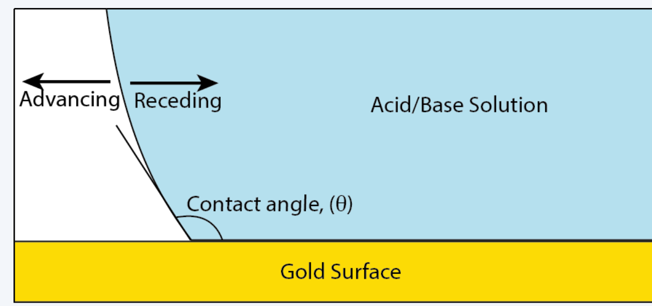
Advance-Recede-Stop Trial



(a)



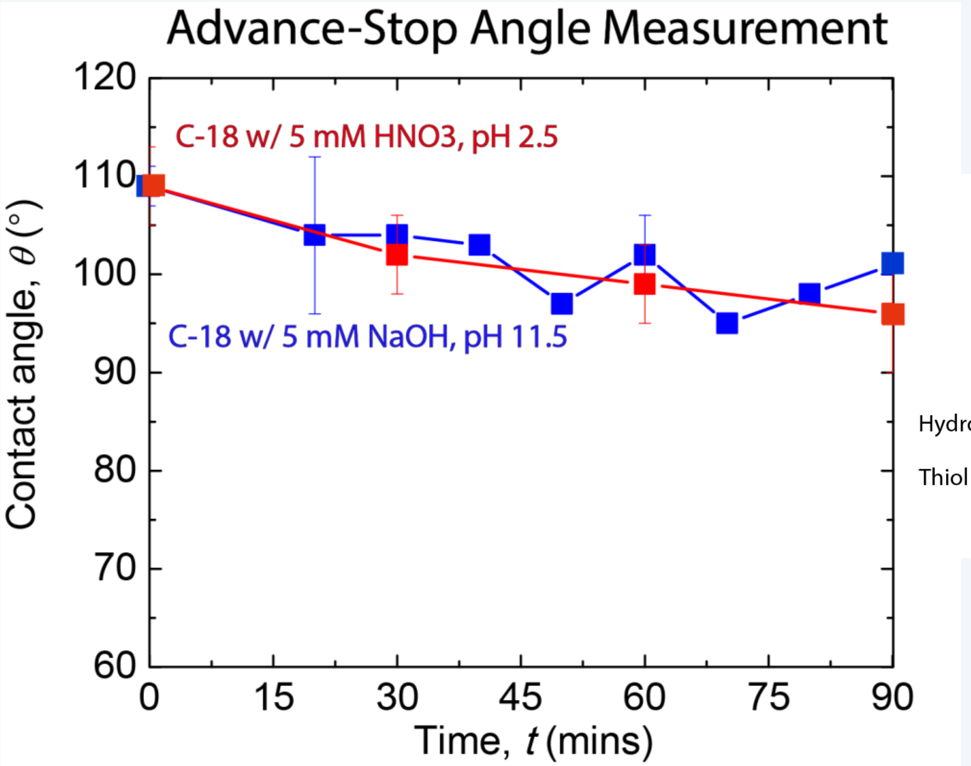
(b)



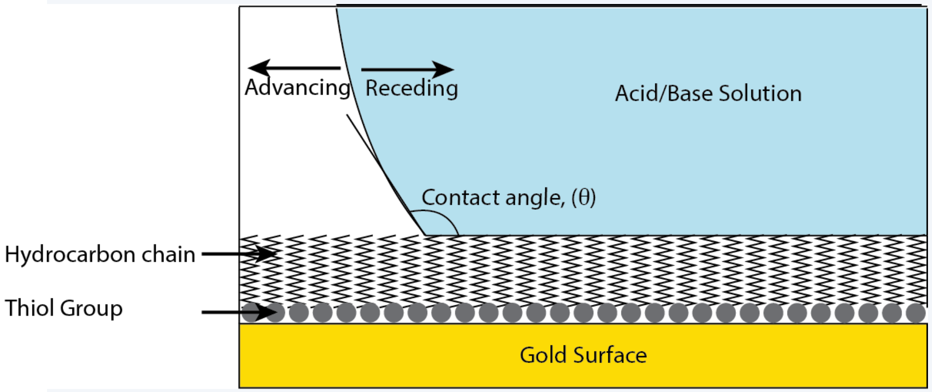
(c)

Figure 1. (a) Comparison of contact angle values of basic and acidic solution on C-18 hydrocarbon chain and pure gold surface. Closed squares represent C18 surface and the filled circles denote the pure gold surface. (b) Droplet pumped over hydrocarbons. (c) Droplet pumped directly on gold surface.

Experimental Outcomes



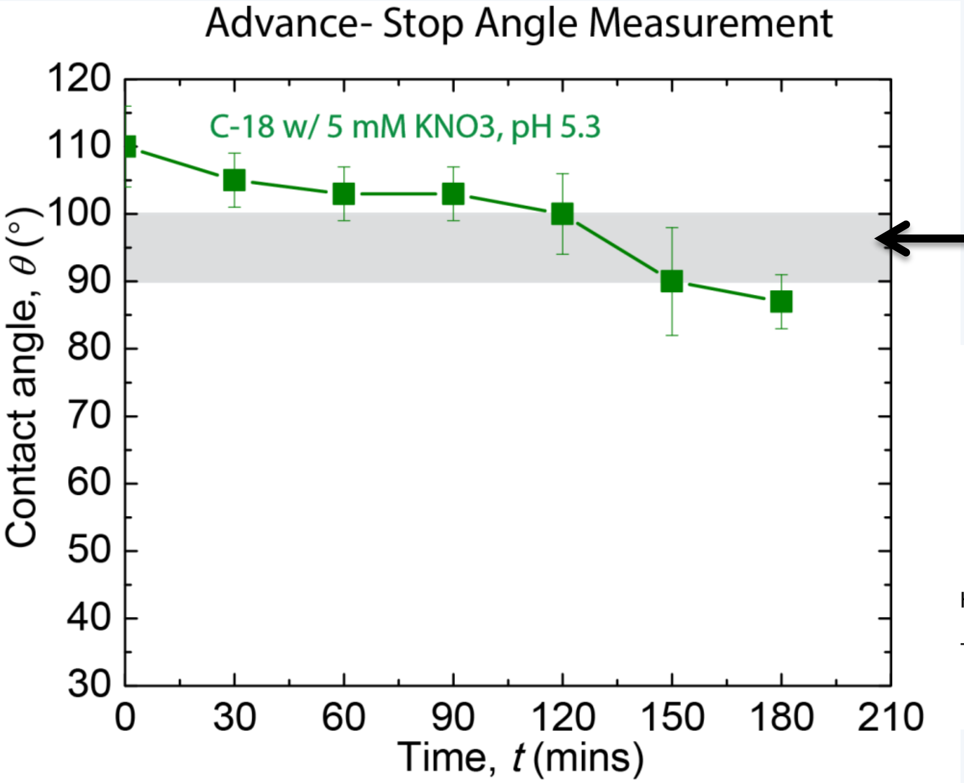
(a)



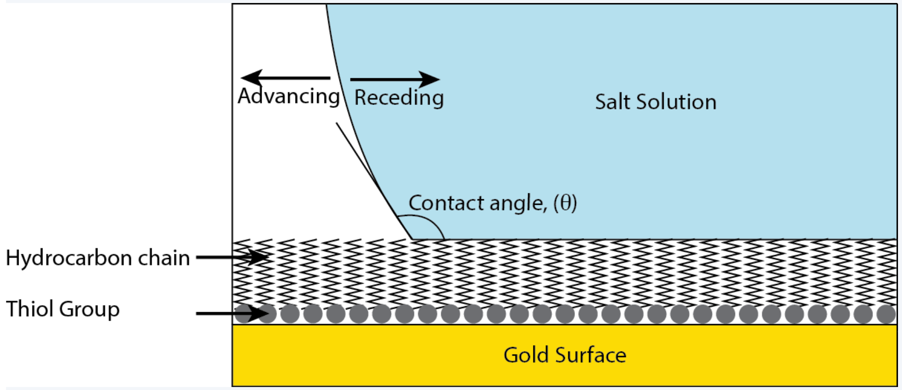
(b)

Figure 2. (a) Comparison of contact angle values of basic and acidic solution on a C-18 hydrocarbon chain. Closed squares represent C18 surface and the filled circles denotes the pure gold surface. (b) Droplet pumped directly over hydrocarbons.

Experimental Outcomes



Equilibrium Angle (θ_E) ≈ 95° ± 5



(b)

(a)

Figure 3. (a) Contact angle values of salt solution on a C-18 hydrocarbon chain. Shaded area represents the possible existence of an equilibrium contact angle. (b) Salt droplet pumped directly over hydrocarbons.

Energy on Hydrocarbon (HC)-Liquid Interface (γ_{SL})

Young's Equation

$$\gamma_{\text{HC to liquid}} = \gamma_{\text{HC to vapor}} - \gamma_{\text{liquid to vapor}} * \cos(\theta)$$

γ = Interfacial Energy, units: mJ/m^2

$$\gamma_{\text{HC to liquid}} = 25\ mJ/m^2 - 72\ mJ/m^2 * \cos(\theta)$$

If contact angle = 95° (equilibrium contact angle from 5mM KNO_3, pH 5.3 on C-18 surface) then….

$$\gamma_{sl} = 31\ mJ/m^2$$

Summary of Contact Angle Analysis

Measured and analyzed contact angle results for HNO_3, KNO_3, NaOH solutions and DI water conditions on C18 hydrocarbon chain

Concluded that when the system is allowed to relax over time after any change, an equilibrium contact angle exists, regardless of the way we disturb the drop on surface

Equilibrium contact angle for each solution will give us an effective interfacial energy from Young's equation

Future Work

Discussion and experiment with a greater variety of solutions on C18 surface to confirm that an equilibrium contact angle exists at 95°± 5 for all solutions

Experiment with different hydrocarbon chains (C-11) and Compare contact angles to confirm contact angle is independent of hydrocarbon chain used

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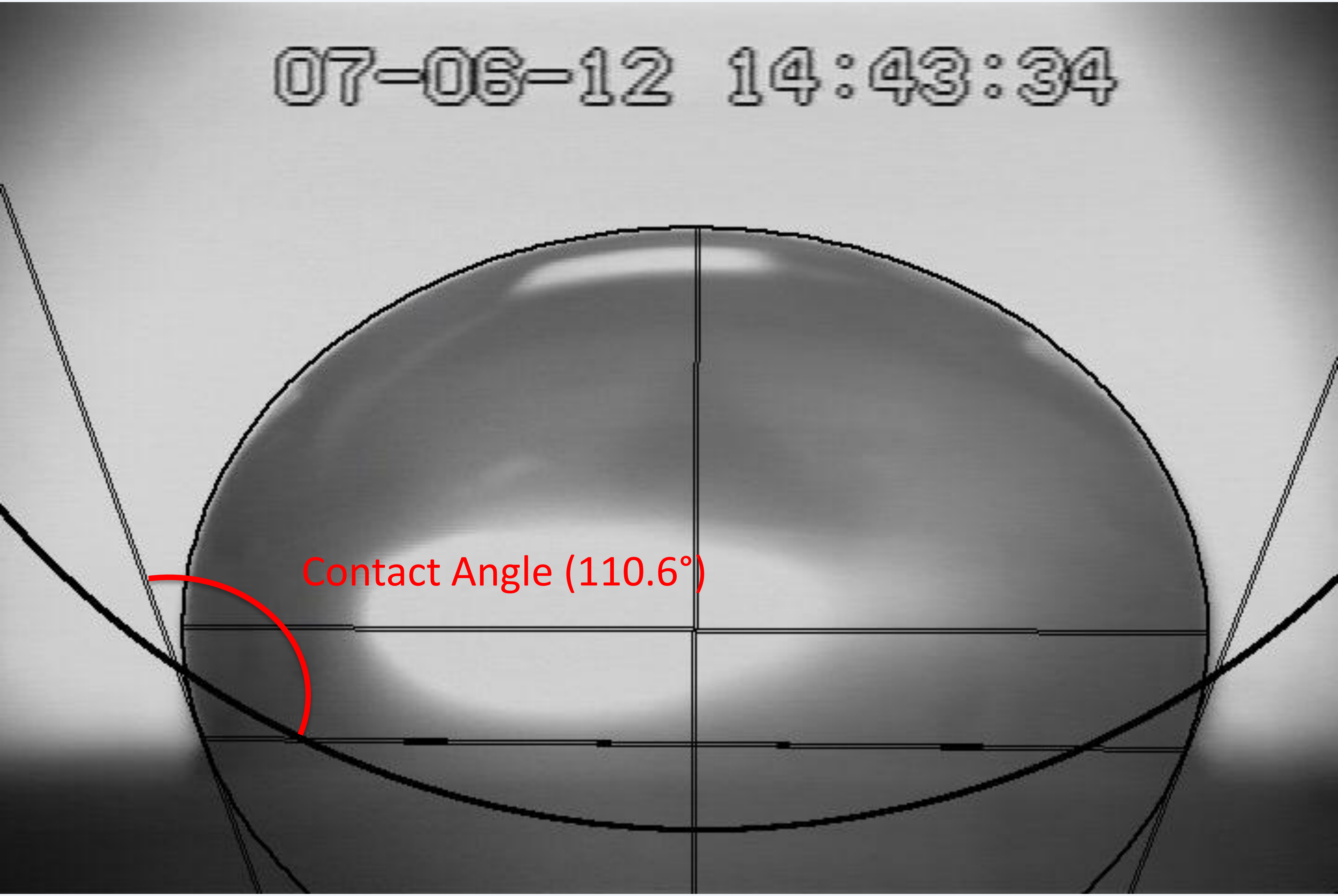
P&G
NSF
INSET
Internships in Nanosystems Science, Engineering and Technology


07-06-12 14:43:34
Contact Angle (110.6°)