Hydrophobic Interactions: Determination of Interfacial Energy through Contact Angle Measurements

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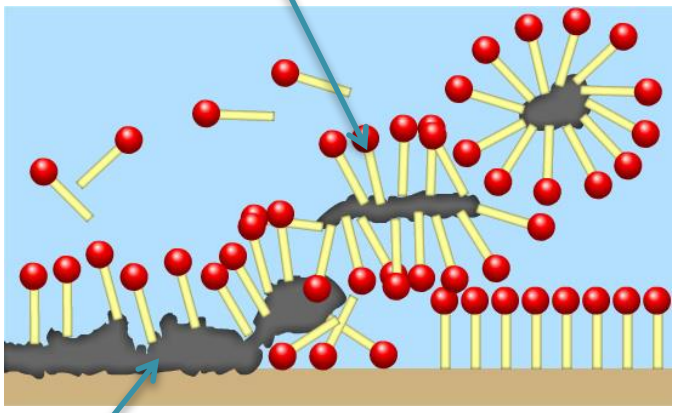
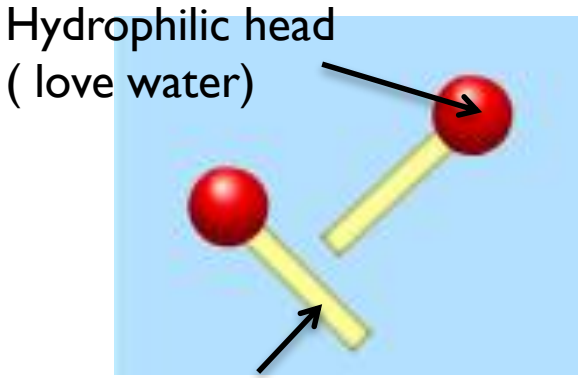
Molecule Interactions

Laundry Detergent

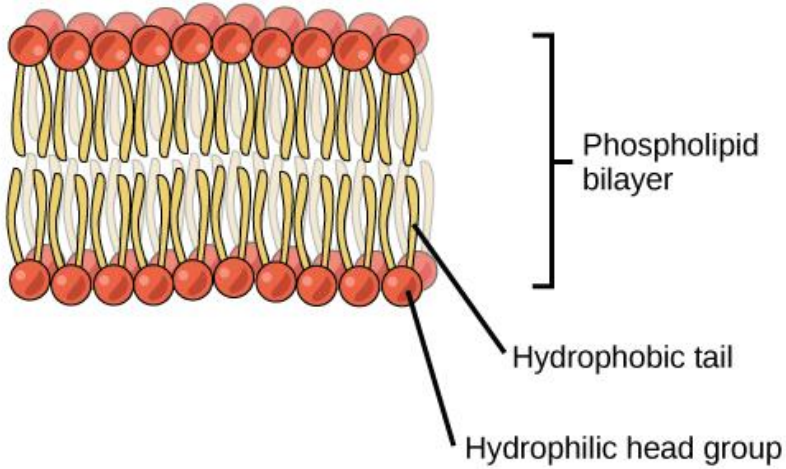


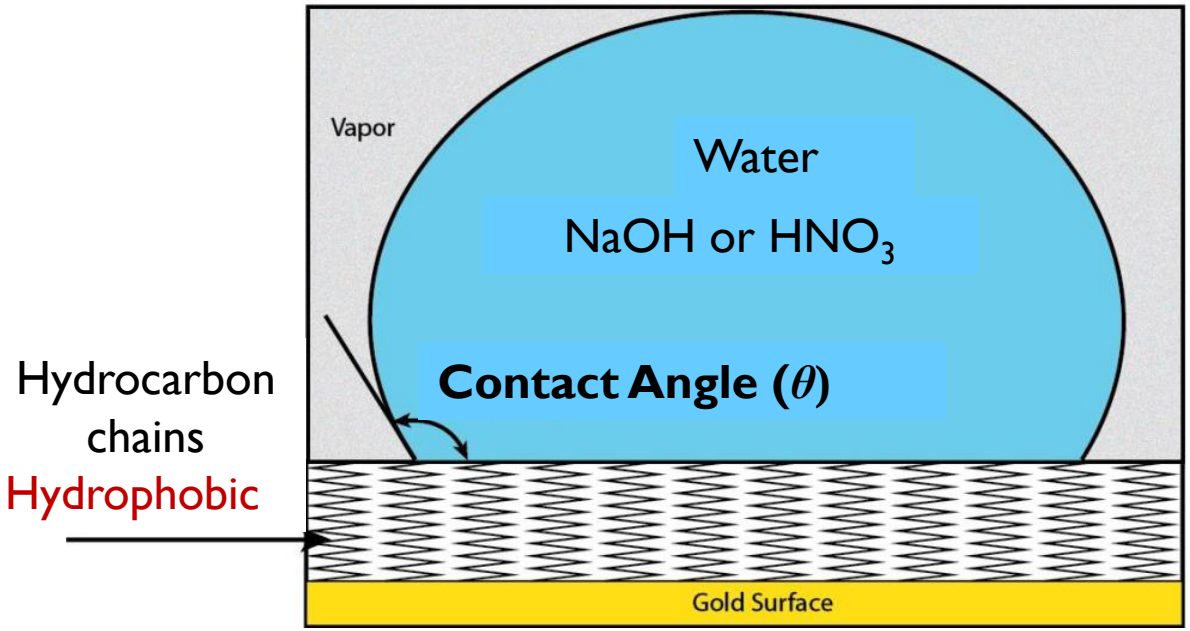
- Interactions between molecules and surfaces in liquid and vapor.
- How to determine forces?
  - Surface Force Apparatus
- Interfacial energy from Contact Angle Goniometer



Hydrophobic Interactions

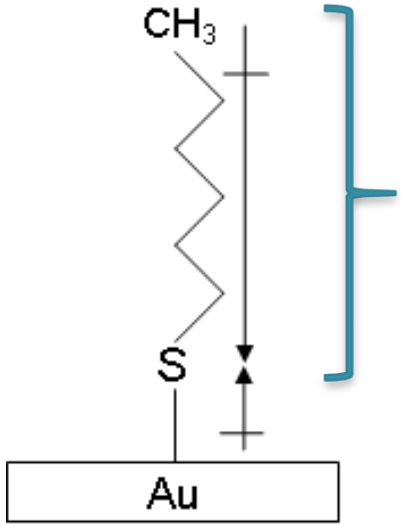
- **Hydrophobic Interaction**: strong attraction between hydrophobic molecules and surfaces in water.





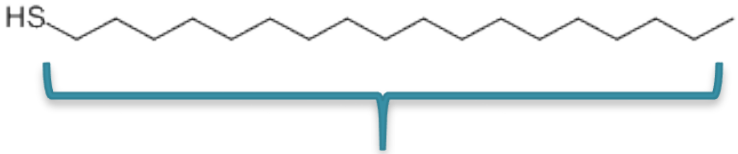
- Determine energies at the hydrophobic interface
- Effect of pH on hydrophobicity

Preparing Hydrophobic Surface

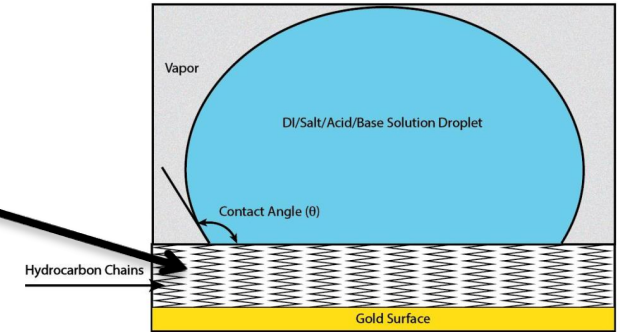


C-18 Hydrocarbon Chain

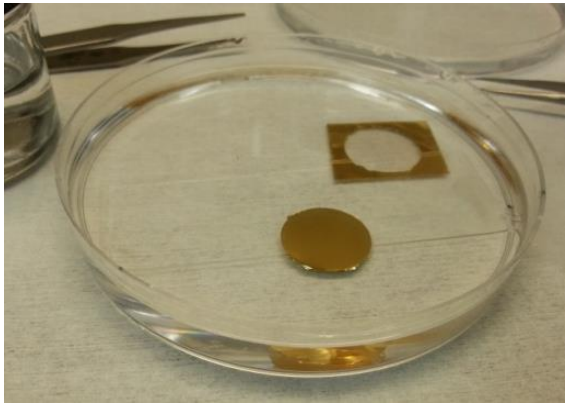
Octadecanthiol



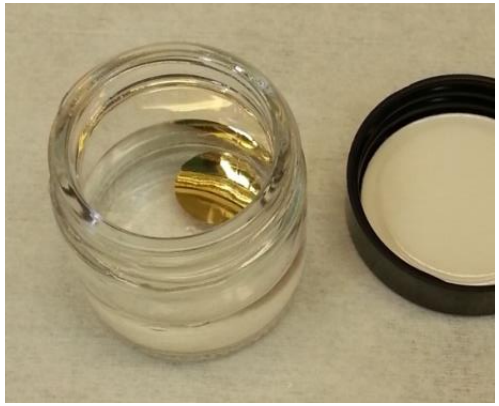
C-18 Hydrocarbon Chain



Prepare mica surfaces

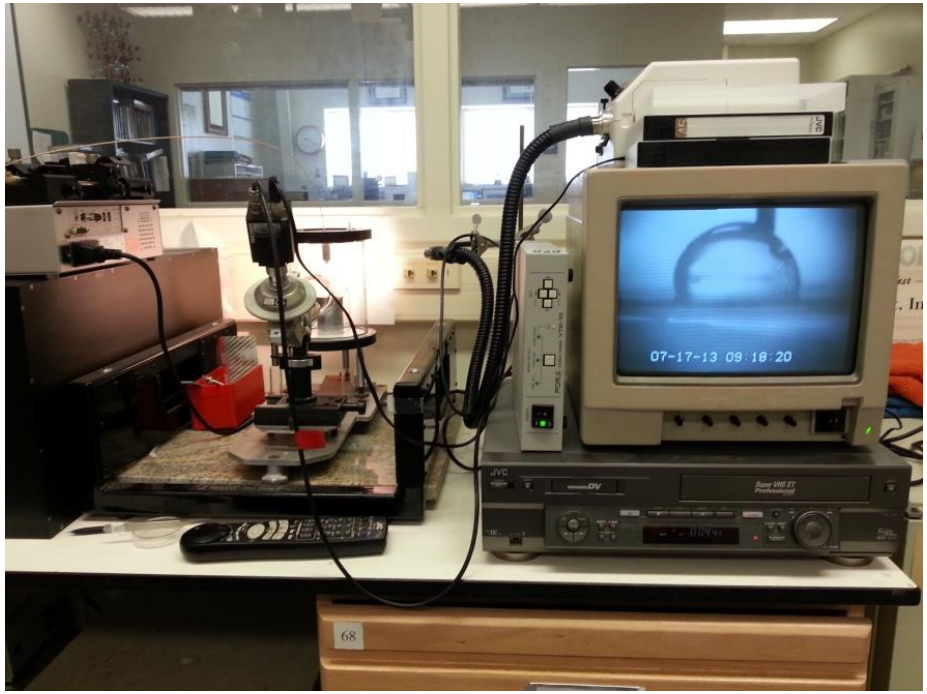


Coat gold on mica surfaces



Immerse in thiol solution

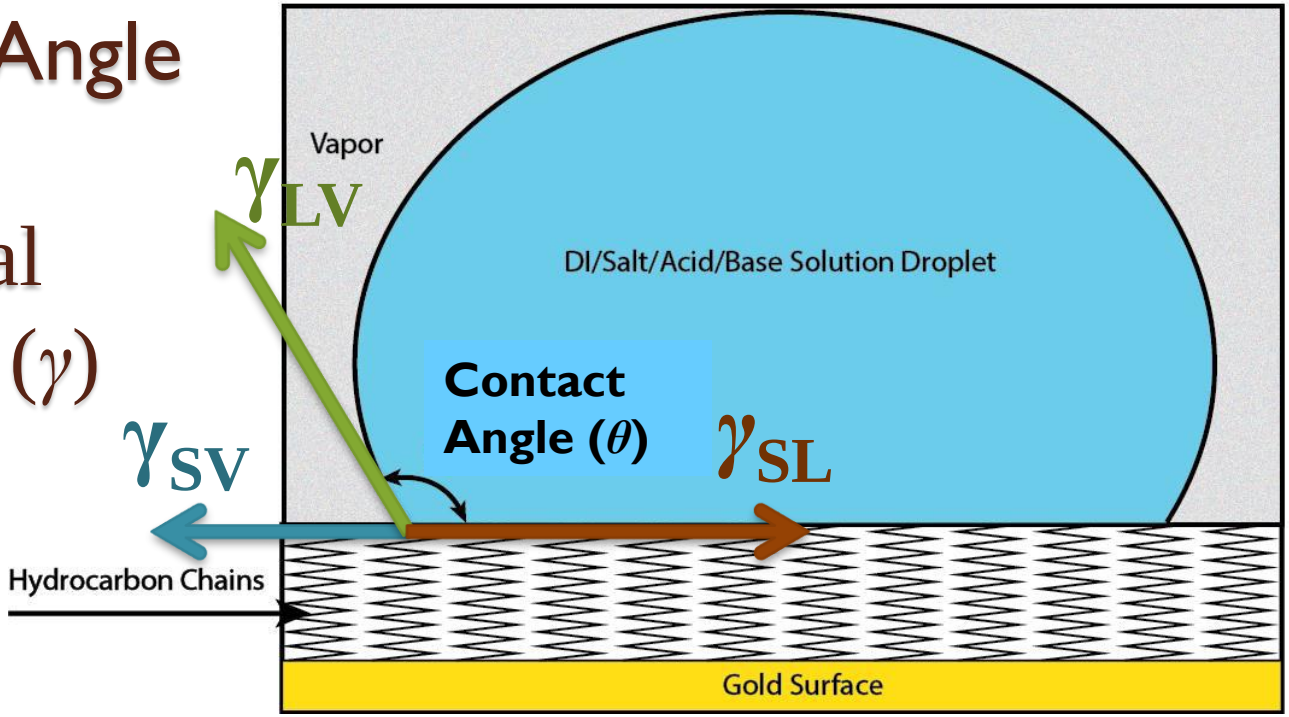
Contact Angle Measurement



Contact Angle Goniometer

Syringe Pump

Contact Angle (θ) and Interfacial Energies (γ)



Young's Equation : $\gamma_{SL} = \gamma_{SV} - \gamma_{LV} \cos \theta$

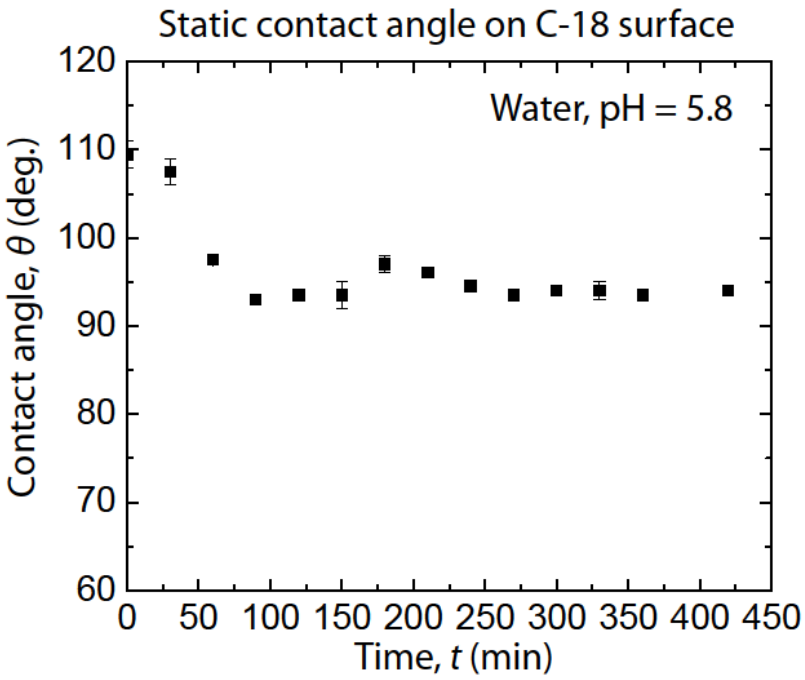
Known value:

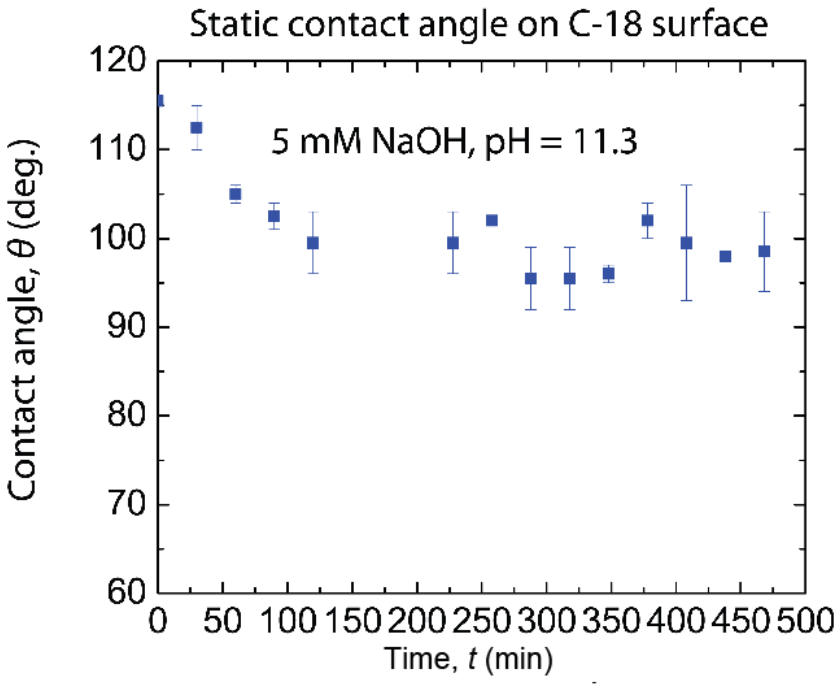
$\gamma_{SV} = 25$ mJ/m^2

$\gamma_{LV} = 72$ mJ/m^2

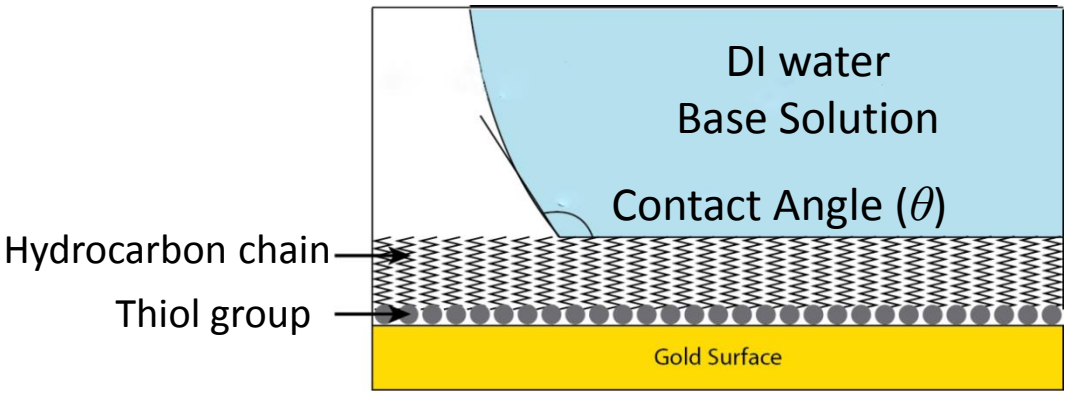
γ_{SL} (mJ/m^2) = energy between the hydrocarbon surface and liquid

Static Contact Angle on C-18 Hydrocarbon Chain

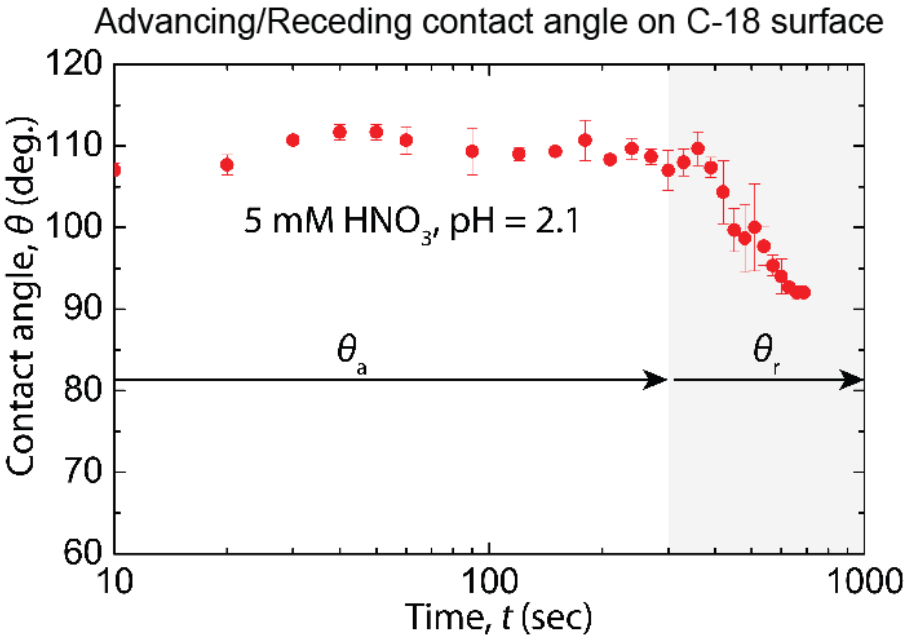


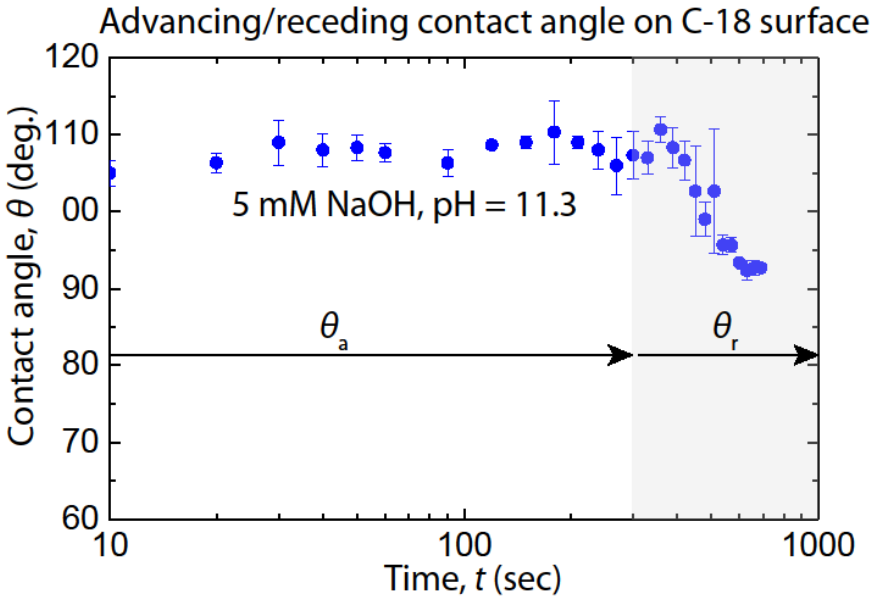


- Contact angle changes with time
- Interfacial energy changes with time
- Evaporation may cause this, due to changes in surface hydration
- Higher pH has higher contact angle values.



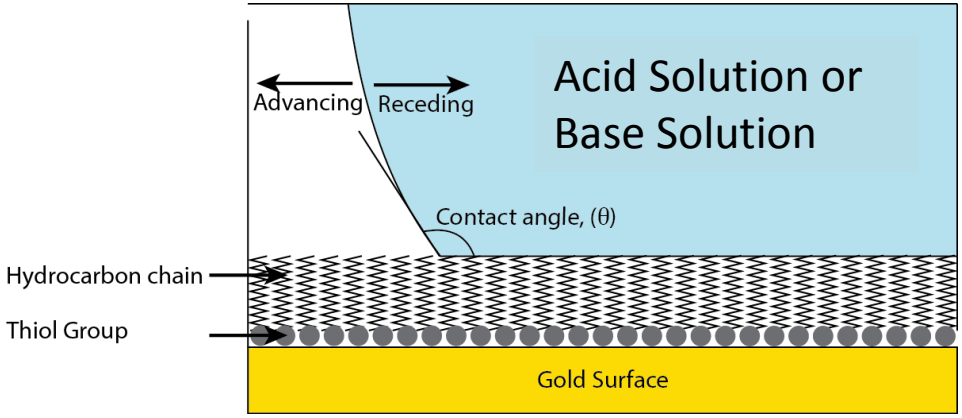
Advancing and Receding Contact Angle Measurement on C18 Hydrocarbon Chain



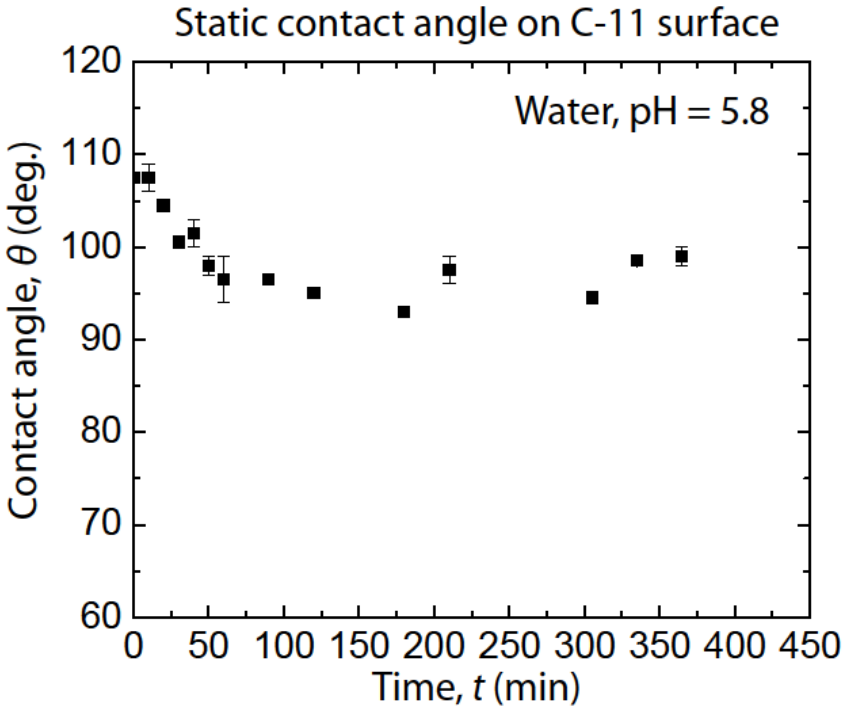


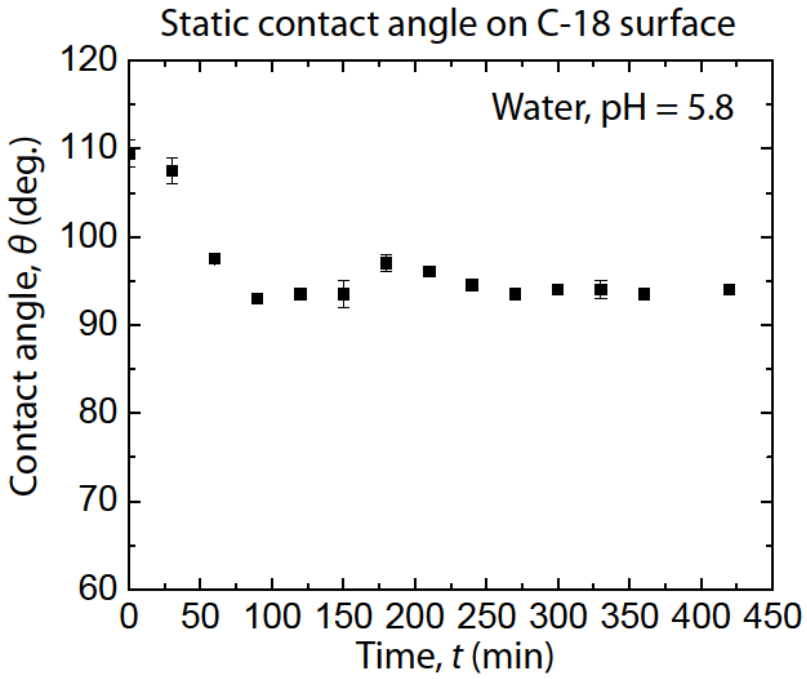
Changes in contact angle:

1. Surface hydration
2. Re-orientation of surface's molecules

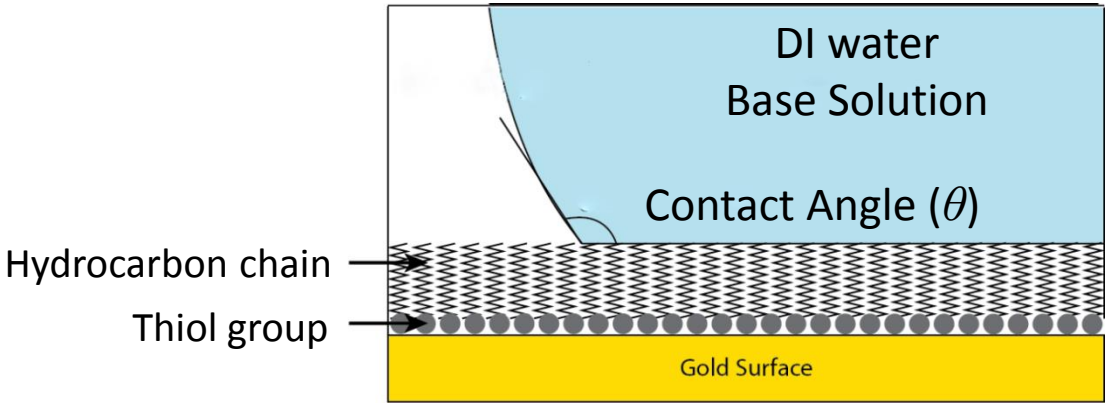


Static Contact Angle Measurement, Comparing Different Hydrocarbon Chain Lengths

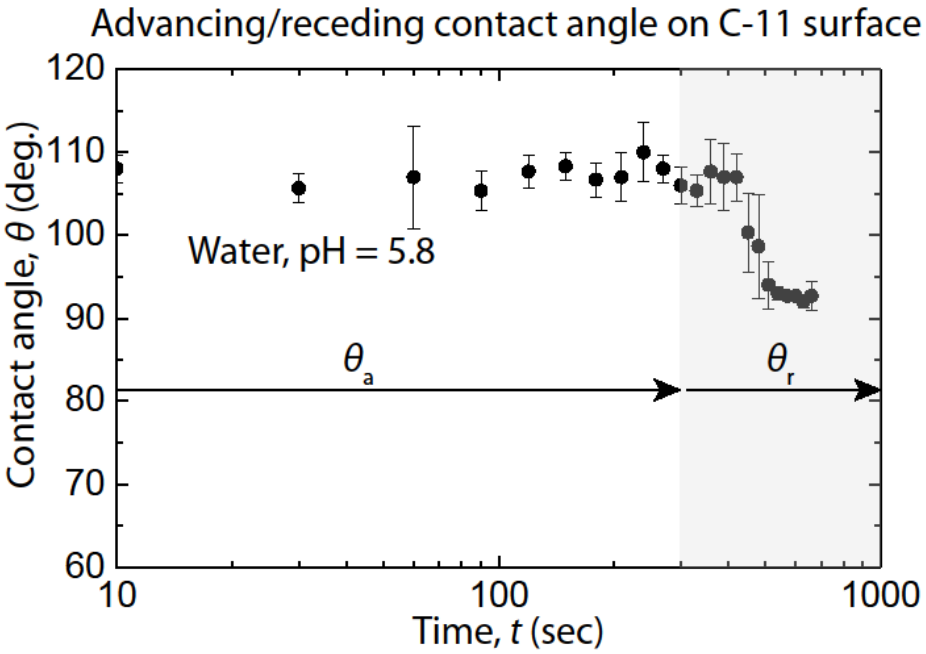


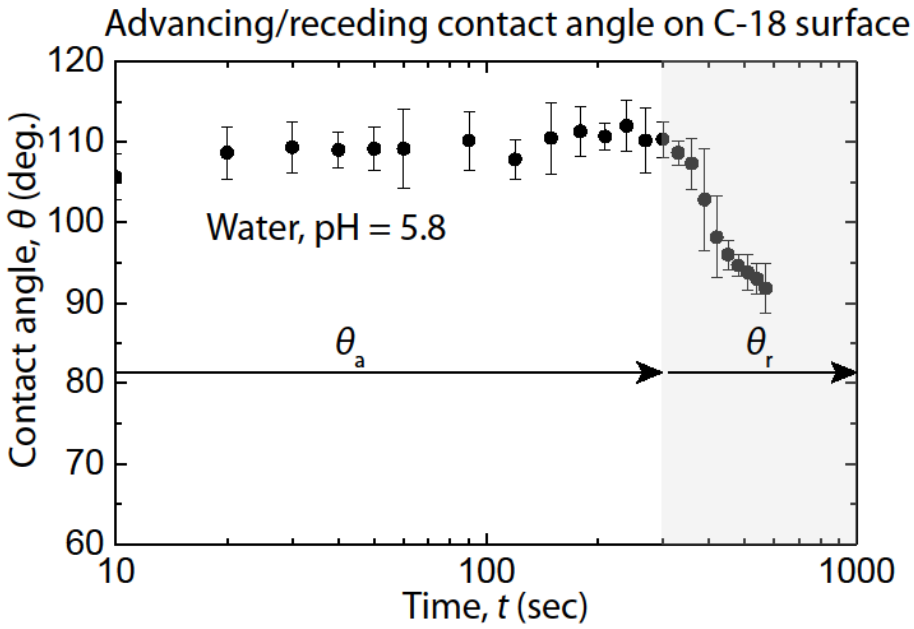


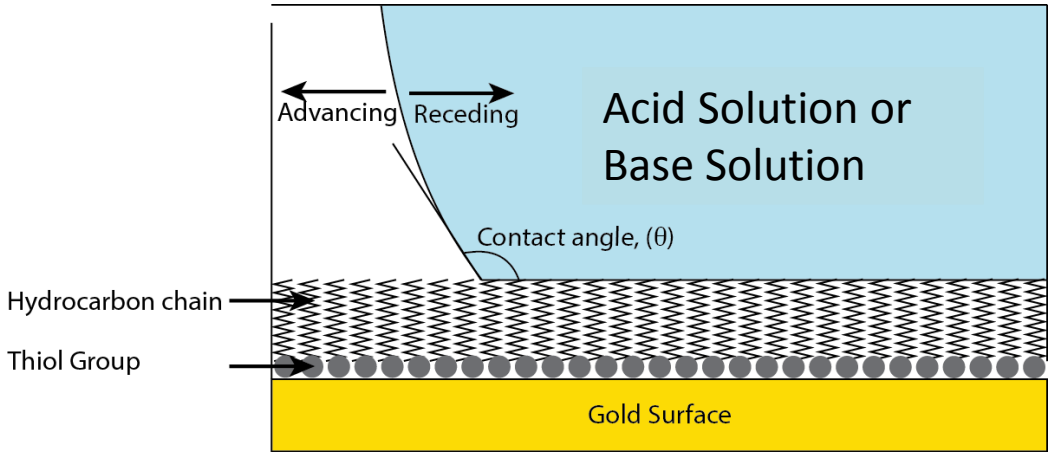
- Contact angle changes with time.
- Contact angle is weakly dependent on the hydrocarbon chain length.



Advancing and Receding Contact Angle Measurement, Comparing Different Hydrocarbon Chain Lengths







Summary of Contact Angle

- Measured contact angle for DI water, NaOH and HNO_3 on C-18 and C-11 hydrocarbon chain surfaces.
- Contact angle changes with time, likely due to surface hydration.
- Contact angle is weakly dependent on the hydrocarbon chain length.
- Higher the pH , higher is the interfacial energy.
- Change in the interfacial energy can be calculated by Young's equation.
- Understanding changes of interfacial energy is important to manufacturing industry, bio-materials, or pharmaceuticals.

Future Plan

- Studying factors that contribute to the changes of contact angle over time.
- Using different methods to create hydrophobic surfaces (e.g. directly deposit hydrocarbon chain on mica surface without gold-thiol bonds) to see the changes in contact angle.
- Computer simulations to determine the interfacial energy of hydrophobic interfaces.

Acknowledgements

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