Hydrocarbon Interactions: Determination of Interfacial Energy through Contact Angle Measurements

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Abstract

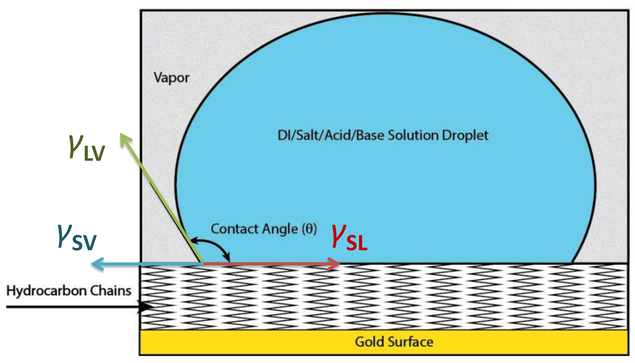
Hydrophobic interaction is known as a strong attraction between nonpolar molecules in water. This interaction plays an important role for survival and function of most biological substances, like phospholipid bilayer membrane. However, the question on the energy of hydrophobic interaction has not been answered. In this project, we examine the changes of hydrophobic interaction through contact angle measurement to compliment the forces observed in Surface Force Apparatus. We use Young's law to help us determine the interfacial energy at the 18 hydrocarbon air-water interface and 11 hydrocarbon air-water interface.

Young's law

Relationship between Contact Angle (θ) and Interfacial Energy (γ).

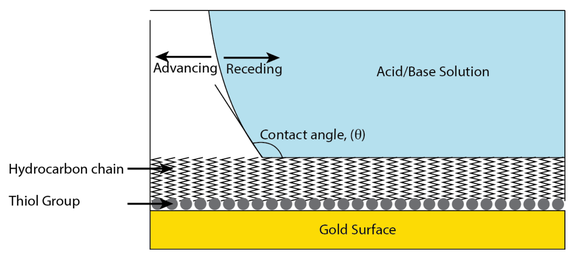
Young's Equation : $\gamma_{SL} = \gamma_{SV} - \gamma_{LV} \cos\theta$

γ : Interfacial energy (mJ/m^2)
θ : Contact angle (degree,^{O})

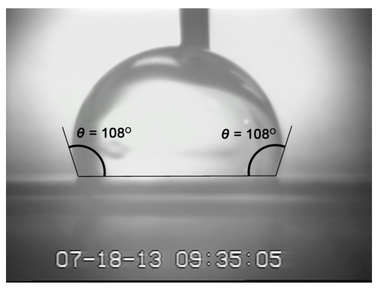


Methods

- Preparing hydrophobic surfaces by attaching 18 hydrocarbon chain length (C-18) and 11 hydrocarbon chain length (C-11) on gold surfaces.
- Static contact angle measurements were performed by letting DI water, HNO_3, and NaOH sit on C-18 and C-11 surfaces for 6-7 hours.
- Dynamic contact angles were measured by advancing and receding the same solutions on C-18 and C-11 surfaces at a constant rate of 2μL/min.

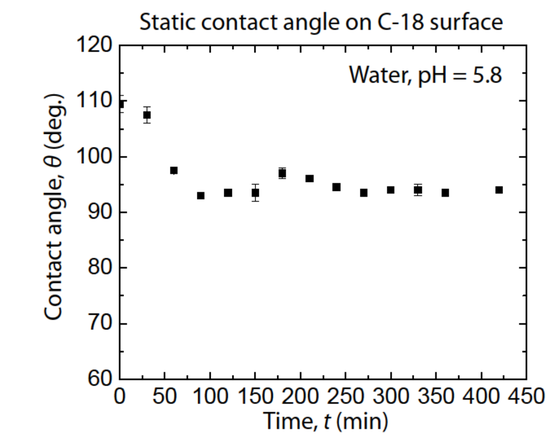


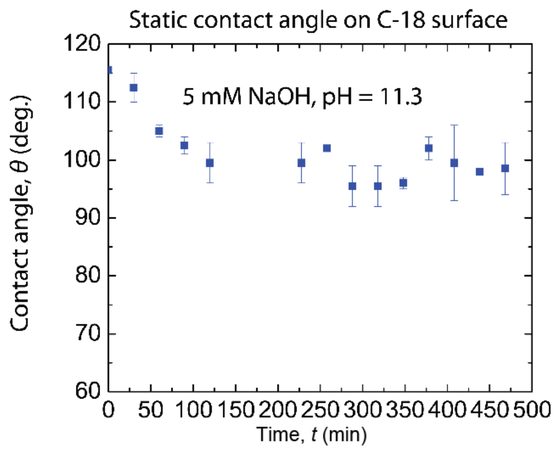
Measurements

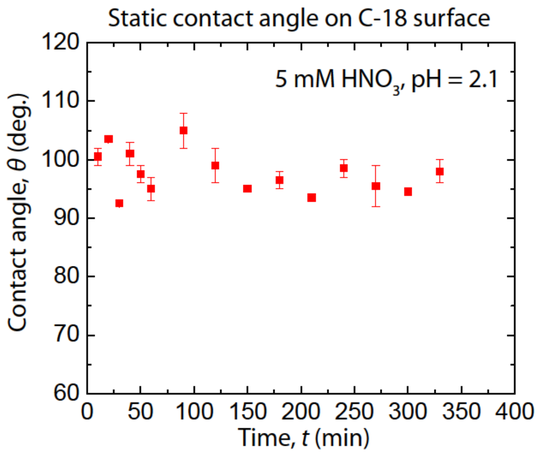


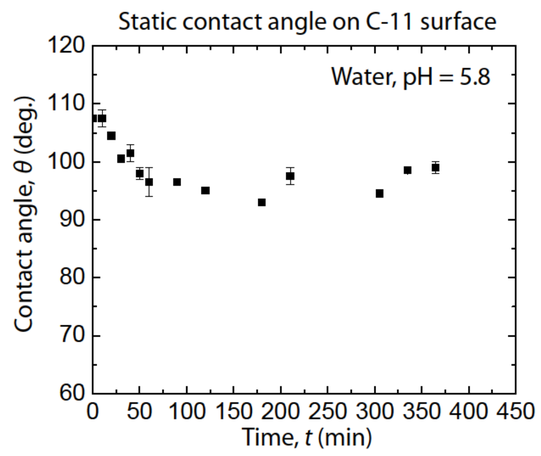
Advancing drops of HNO_3 on C-18 surface at a constant rate of 2 μL/min.

Static Contact Angle

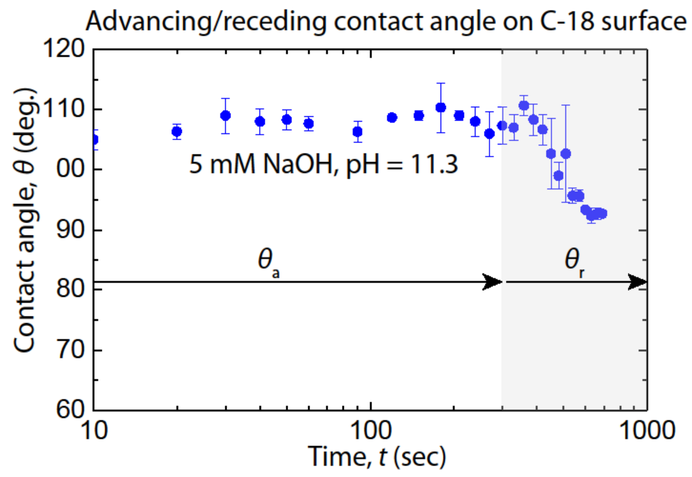


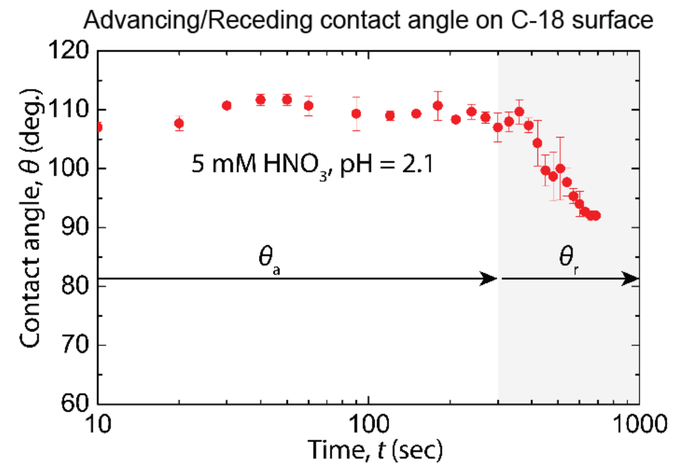


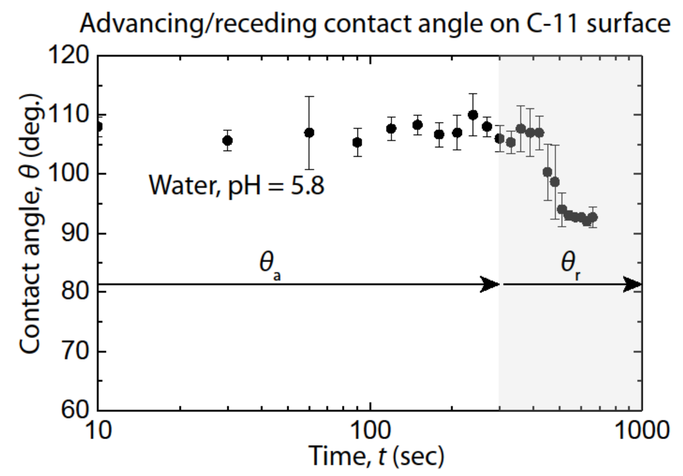




Dynamic Contact Angle







Conclusion and Future Plan

- Observe that static contact angle changes with time, likely due to surface hydration.
- Observe that contact angle stays constant while advancing; however, it decreases from about 110^O to 92^O while receding solutions on both C-18 and C-11 surfaces.
- Conclude that contact angle is weakly dependent on the hydrocarbon chain length.
- Solution with higher pH has higher interfacial energy at the hydrocarbon air-water interface.
- Studying factors that contribute to the changes in contact angle over time.
- Computer simulations to determine the interfacial energy of hydrophobic interfaces.

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