BMM 311L Biomaterials and Biomechanics Laboratory, Spring 2020

Instructors: Assist. Prof. Dr. Ersin Emre Oren & Dr. Fatma Kübra Erbay Elibol
Teaching Assistants: Büşra Demir and Çağlanaz Akın

EXPERIMENT 5: Surface Properties and Contact Angle Measurement Test

---

1. Scope

The aim of this experiment is to understand the *hydrophobicity/hydrophilicity* properties of different material surfaces by measuring the contact angle, which is the angle, conventionally measured through the liquid, where a liquid/vapor interface meets a solid surface.

2. Introduction

The topic of wetting has received tremendous interest from both fundamental and applied points of view. It plays an important role in many industrial processes, such as oil recovery, lubrication, liquid coating, printing, and spray quenching.

Wetting is the ability of a liquid to maintain contact with a solid surface, resulting from intermolecular interactions when the two are brought together. It is now a center of attention in nanotechnology and biomaterials studies due to the advent of many nano/biomaterials over the past two decades.

Wettability studies usually involve the measurement of contact angles as the primary data, which indicates the degree of wetting, when a solid and liquid come in contact. The contact angle is an angle that a liquid creates with a solid surface or capillary walls of a porous material when both materials come in contact together. This angle is determined by both properties of the solid and the liquid and the interaction and repulsion forces between liquid and solid and by the three phase interface properties (gas, liquid and solid). Those interactions are described by cohesion and adhesion forces which are intermolecular forces. The balance between the cohesive forces of similar molecules such as between the liquid molecules (i.e. hydrogen bonds and Van der Waals forces) and the adhesive forces between dissimilar molecules such as between the liquid and solid molecules (i.e. mechanical and electrostatic forces) will determine the contact angle created in the solid and liquid interface. Small contact angles (<90°) correspond to high wettability, while large contact angles (>90°) correspond to low wettability.

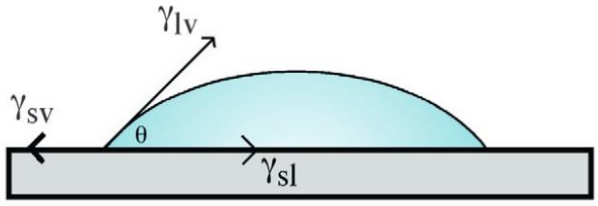

Figure 1. Schematic illustration of a liquid drop showing the quantities in Young's equation

Surface tension is a significant property that affects the interaction between the surfaces and the surrounding environment. Contact angle are measured by using Young`s Equation.

Young`s Equation: $\theta = \text{acos}\left(\frac{\gamma_{sv} - \gamma_{sl}}{\gamma_{lv}}\right)$

Where, γ is the surface tension between the respective surfaces of solid (s), liquid (l) and gas (v).

3. Test Specimen and Laboratory Equipment

The test specimens are eight different surfaces: empty slide, dilute ODTS* coated slide, dense ODTS coated slide, Teflon tape, AAO membrane**, ODTS coated AAO membrane, parafilm (plastic paraffin film) and organically contaminated AAO membrane. Liquids which will be used in this experiment are water and silicon oil.

*ODTS: Octadecyltrichlorosilane is an organometallic chemical used to decrease surface energy.
**AAO membrane: Anodized aluminum oxide membrane is a biomaterial having high porosity.

Figure 2. Schematic illustration of droplets of identical volume displaying gradually decreasing contact angles due to the surface energy gradient.

4. Experiments and Procedure

Liquid will be dribbled on the surface. Then the droplet on the surfaces will be photographed sideways.

The angle between the droplet and surface will be measured using the Image J Program. You can download Image J from http://imagej.nih.gov/ij/.

This procedure will be repeated for each liquid for eight different surfaces.

Compare the data you get graphically considering the Young's Equation. Comment on the surface properties.

References

[1] Yuehua Yuan and T. Randall Lee, Contact Angle and Wetting Properties, Chapter 1, Surface Science Techniques, Springer Series in Surface Sciences.

Safety in Laboratory

1. Eye protection must be worn during the tensile test.
2. Wait for the Teaching Assistant before beginning the laboratory exercise so that they can guide you through testing your first sample.
3. Before beginning a test or moving/resetting the universal testing machine, make sure all items including hands, hair, etc. are clear of the machine.

Grading

Lab reports: (70%)*
Short exam at end of 3rd and 6th experiments: (30%)
* Late delivered reports will lead to lose of 10 points/day.
* Each group delivers one report.

Labs

TOBB ETÜ Technology Center, B06 (Experiments 1-4), 201 (Experiments 5), 206 (Experiment 6).

Contacts

Büşra Demir, TOBB ETÜ Technology Center, Room 209
Çağlanaz Akın, TOBB ETÜ Technology Center, Room 209