Contact Angles: Measurements, Interpretation and Modern Applications

Lecturer: Professor Jaroslaw Drelich (Michigan Technological University, USA)

Course description:

Research on surfaces and coatings with controlled wetting characteristics has exploded in the last decade. New terms such as superhydrophobicity and superhydrophilicity were introduced to describe exceptionally weak and strong, respectively, interactions of materials and coatings with bulk water, controlled entirely by surface topography and material chemistry. Although manipulation of surface characteristics is nothing new, and was explored by the mineral processing and textile industries several decades ago, a renewed interest in surfaces/coatings of controlled wettability has been driven by an emerging market for products with engineered surfaces. Some common examples include water-repellant, snow- and ice-phobic products and formulations, water anti-fogging screens, windows and lenses, anti-fouling coatings, microfluidic devices, coatings for enhanced boiling heat transfer, foils for food packaging, and many others. The popularity of this sub-discipline of surface chemistry can also be attributed to the simplicity of contact angle measurements, although both measurements and interpretation of contact angles are often obfuscated by wide-spread misconceptions and misunderstandings. In this 5-day workshop, the physics behind wetting phenomena on solid surfaces will be reviewed in detail, along with a discussion on new developments and modern applications of contact angle and wetting phenomena concepts.

Syllabus of the lecture:

Day 1 – 05/19/2014: Introduction to Capillarity

1) Defining surfaces and interfaces
2) Surface of liquid (molten solid) and surface tension; effect of temperature; effect of curvature
3) Capillarity and its practical consequences: bubbles and drops; liquid-liquid and liquid-solid spreading; capillary penetration; capillary adhesion
4) Surface tension measurements techniques
5) Adsorption at liquid-gas surface; surface tension for two-component solutions; surfactant solutions; Gibbs adsorption equation
6) Surface free energy of solid and methods of measurement

Day 2 – 05/20/2014: Defining Contact Angles

1) What is the contact angle and what does it represent? Young's equation and its derivation
2) Defining hydrophilic and hydrophobic surfaces: classical approach versus new developments
3) Real surfaces of solids: how different are they from liquid surfaces, and why they not always represent what we expect

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4) Cassie and Wenzel equations: how to derive them? Meaning
of contact area and contact line; symmetrical versus random
surface pattern
5) Contact angle hysteresis on real solid surfaces and effects behind it; defining equilibrium, stable and metastable, advancing and receding contact angles
6) Importance of measurements of both advancing and receding contact angles
7) Can the equilibrium contact angle be measured?

Day 3 – 05/21/2014: Learning to Measure Contact Angles

1) Contact angle measurement techniques for macroscopic specimens
2) Guidelines to measurements of meaningful contact angles using the sessile-drop technique
3) Common mistakes in contact angle measurements reported in modern literature
4) Surface free energy versus critical surface tension of wetting
5) Analysis of solid surface free energy from measured contact angles; are we there yet?
6) Contact angle measurement techniques for powders and fibers; do we understand what we measure?

Day 4 – 05/22/2014: Other Flavors of Contact Angles

1) Liquid pancakes, microscopic droplets and line tension effects
2) Temperature effect on contact angle
3) Contact angles for surfactant solutions
4) Contact angle titration
5) Electrowetting
6) Photoresponsive surfaces
7) Centrifugal adhesion balance
8) Dynamic versus static contact angles, and introduction to spreading

Day 5 – Friday, 05/23/2014: Smart Coatings and Products

1) New concepts: superhydrophobicity, superoleophobicity, superhydrophilicity, superwetting, etc.
2) Physics behind superhydrophobicity and superhydrophilicity
3) Designing superhydrophobic and superoleophobic surfaces; critical role of entrant texture and hierarchical structure
4) Examples of nanostructured coatings, films and surfaces of controlled wettability
5) Temperature and pH responsive surfaces/coatings
6) Applications of superhydrophobic, superoleophobic, superhydrophilic and superwetting coatings and examples of commercial successes

TERMINY WYKLADÓW			
Data	**Dzień tygodnia**	**Godzina**	**Sala**
19 maj 2014	poniedziałek	9.00-12.00	LUWR (Chemia A)
20 maj 2014	wtorek	9.00-12.00	LUWR (Chemia A)
21 maj 2014	środa	9.00-12.00	LUWR (Chemia A)
22 maj 2014	czwartek	9.00-12.00	LUWR (Chemia A)
23 maj 2014	piątek	9.00-12.00	LUWR (Chemia A)

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