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Dr. Robert H. Lacombe
Chairman
Materials Science and Technology
CONFERENCES, LLC
3 Hammer Drive
Hopewell Junction, NY 12533-6124
Tel. 845-897-1654, 845-592-1963
FAX 212-656-1016
E-mail: rhlacombe@compuserve.com

WATER WATER EVERYWHERE AND NOT A DROP TO DRINK:

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EDITORIAL COMMENTS

.....
Water, water, every where,
And all the boards did shrink;
Water, water, every where,
Nor any drop to drink.
.....

The above lines from the poem entitled "Rime of the Ancient Mariner" by the English poet Samuel Taylor Coleridge, depicted the plight of 18th century sailors trapped in the windless doldrums surrounded by a vast ocean of undrinkable saltwater. Curiously a similar situation exists on the dry continents of the planet now in the 21st century.

This seeming incongruity was brought to light in a recent issue of C&E NEWS (October 15, 2018) in an article entitled "Can stripping the air of its moisture quench the world's thirst". Interestingly the dry regions of the planet suffer a conundrum analogous to that of the Ancient Mariner since the world's atmosphere contains roughly 10^{16} liters of water which is some 6 times more than in all the planet's rivers and yet there is no drinkable water since it is all vaporized. The consequences for the planet's human population are rather dire considering the following data from the World Health Organization:

- It is estimated that more than half of the World's population have insufficient water for at least one month out of the year.
- Some 500 million have insufficient water throughout the entire year.
- Since the World's population is estimated to reach roughly 10 billion by 2050 the severity of the problem can only get worse.

In light of the above situation there is an ongoing effort to bring about technologies that will be able to reliably and cheaply extract water from the local atmosphere and, as you may have already guessed, the surface tension and contact angle properties of water are a critically important factor in achieving this result.

It is curious to note also that the Namibian darkling beetle has already got a big head start on us as it has been extracting moisture from the air of the Namibian desert for some thousands of years. One species in particular operates on the desert coast of West Africa on the so called "skeleton coast" due to the number of ship wrecks scattered thereon. Little in the way of life can survive there due to the arid desert conditions but the beetle does just fine. In the evening when an ocean fog drifts ashore it points its head seawards and erects its wings, which have a bumpy lotus leaf style surface morphology, in a sort of shallow trough. As the fog condenses on the upper part of the wings droplets form due to a waxy coating which makes the wings superhydrophobic. The drops then promptly roll down the trough surface into the beetle's mouth supplying all the moisture it needs.

A number of small companies are starting to get into the act through what is called bio-inspiration by mimicking the tricks of Nature's creations such as the darkling beetle. Among university groups that are getting into the game is the collaboration of Jonathan Boreyko at the Fluids and Interfaces lab at Virginia Tech and Brook

Kennedy an industrial design professor also at Virginia Tech. These investigators took note of existing fog harvesting methods which use fine window screen style meshes to capture moisture particles from the air. This approach, however, had the twin problems of too fine a mesh which will clog and too coarse a mesh which will fail to capture the droplets. These workers circumvent these problems by constructing what they call a “fog harp” which is a mesh of fine parallel wires which avoid the clogging problem since there are no cross wires to cause a clog.

This approach has been taken to the next level by Tak-sing Wong and Simon Dai at Penn State and the University of Texas at Dallas respectively. These researchers follow the “fog harp” approach by etching parallel micro-grooves into a surface and further apply a slippery coating to the surface in much the same manner as the leaves of rice plants and the carnivorous pitcher plant as shown in Fig. (1).

These approaches are very encouraging but Prof. Jas Pal Badyal at the Durham University in the UK points out that the major hurdle blocking wide scale implementation of these technologies is cost. Dr. Badyal and his group are attempting to address this problem by using coated inexpensive nonwoven fabrics which have a fibrous surface structure which gives the required surface morphology. Combined with an appropriate coating an inexpensive “fog harp” style moisture collector can apparently be achieved (Colloids Surf. A 2017, DOI: 10.1016/j.colsurfa.2017.05.071).

In all of this work it is clear that a key issue has been constructing surfaces with particular micro-scale morphologies and appropriate surface tension.

The creation of a surface with the correct surface tension and morphology as

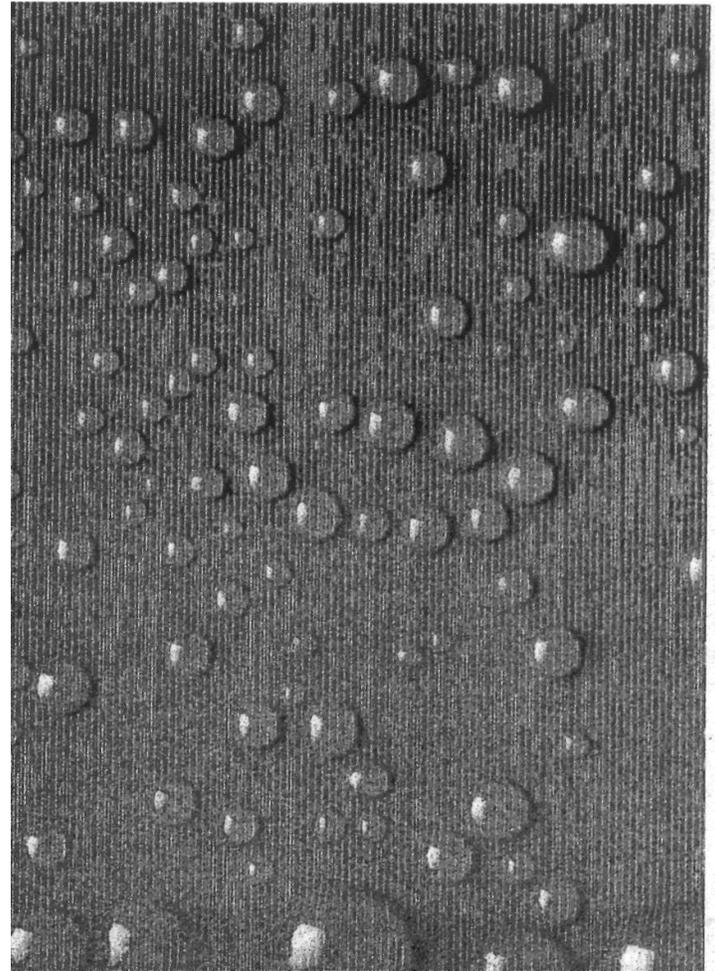


Figure 1 Adaptation of “fog harp” principle to a smooth surface with parallel grooves etched into it. The surface morphology in concert with a hydrophobic coating give rise to droplets which can roll down the surface into a catch basin. Adapted from Wong and Dai: (Sci.Adv.2018,DOI: 10.1126/sciadv.aag0919)

determined by the water drop contact angle is what makes these technologies work. Thus we add another important application of liquid to solid contact interactions which include but are not limited to:

- Adhesion
- Adsorption
- Lubrication
- Catalysis
- Solid-liquid reaction kinetics
- Heat transfer
- Electrical conduction
- Micro/nano fluidic devices

These and other issues will be the subject

of the upcoming:

12'th International Symposium on Contact Angle, Wettability and Adhesion: to be held June 17-19, 2020 at the Homewood Suites by Hilton, at Newburgh Stewart International Airport, New Windsor, NY

Full details on this meeting are given in the announcement [reprinted below](#).

Also of interest is the upcoming short course covering general adhesion behavior but also including much tutorial

information on contact angle behavior at an introductory level for the beginner:

3- Day Impact Course on The Chemistry, Physics & Mechanics of Surface Science and Adhesion, November 13-15, 2019, Courtyard by Marriott, Stewart-Newburgh, New York.

Full details on the short course also [reprinted below](#).

The conference director and I cordially invite all readers of the Newsletter to join us at either or both of these events.



CALL FOR PAPERS: TWELFTH INTERNATIONAL SYMPOSIUM ON CONTACT ANGLE, WETTABILITY AND ADHESION

Homewood Suites by Hilton, at Newburgh Stewart International Airport,
180 Breunig Rd., New Windsor, NY 12553 USA

JUNE 17-19, 2020

SYMPOSIUM HISTORY AND MOTIVATION

In his opening remarks at the first symposium in this series Professor Robert Good pointed out that Galileo in the 17th century was quite likely the first investigator to observe contact angle behavior with his experiment of floating a thin gold leaf on top of a water surface. Since that time contact angle measurements have found wide application as a method for determining the energetics of surfaces. This, in turn, has a profound effect on the wettability and adhesion of liquids and coatings to surfaces.

This symposium will be concerned with both the fundamental and applied aspects of contact angle measurements. Issues such as the applicability and validity of various measurement techniques and the proper theoretical framework for the analysis of contact angle data will be of prime concern.

In addition, a host of applications of the contact angle technique will be explored including but not limited to: wettability of powders, fibers, wood products, paper, polymers and monolayers. Further focus will be on the use of contact angle data in evaluating surface modification procedures, determining relevance of wettability to adhesion, the role of wettability in bioadhesion, ophthalmology, prosthesis and in the control of dust in mining and milling applications.

AUDIENCE AND PARTICIPATION

The primary focus of this symposium will be to provide a forum for the discussion of cutting edge advancements in the field and to review and consolidate the accomplishments which have been achieved thus far.

SUBMITTING A PAPER

This symposium is being organized under the direction of Dr. K. L. Mittal, Editor, Reviews of Adhesion and Adhesives and by MST Conferences. Please notify the conference chairman of your intentions to present a paper as early as possible. An abstract of about 200 words should be sent by January 31, 2020 to the conference chairman by any of the following methods:

E-mail: rhl@mstconf.com

FAX: 212-656-1016

Regular mail:

Dr. Robert H. Lacombe
Conference Chairman
3 Hammer Drive
Hopewell Junction, NY 12533

Contact by phone: 845-897-1654;
845-592-1963

Full conference details and registration via the Internet will be maintained on our web site:

www.mstconf.com/Contact12.htm

SYMPOSIUM TOPICS:

Factors Influencing Contact Angle Measurements:

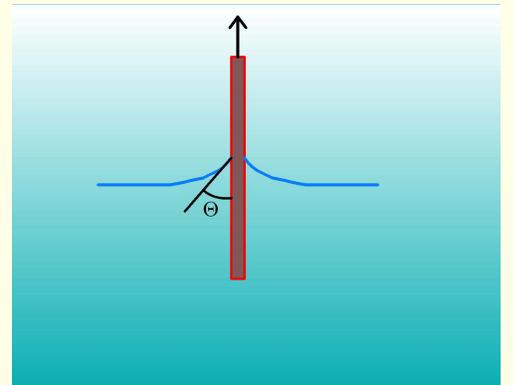
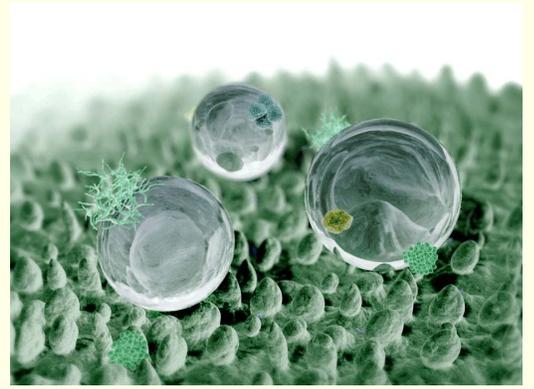
- ◆ Static and dynamic contact angles, effect of surface flaws and surface roughness on wetting.
- ◆ Effect of pore size distribution
- ◆ Effects of velocity and viscosity of liquid on solid-liquid interfacial behavior.
- ◆ Interaction forces including: van der Waals, Acid-Base, Hydrogen bonding, ...etc

Wettability Behavior and Surface Characterization of Various Materials:

- ◆ Contact angle interpretation and hysteresis.
- ◆ Wettability of various material surfaces including but not limited to: wood, elastomers, silicon wafers, pharmaceutical powders, metals, polymers, paper, particles, fibers... etc.
- ◆ Surface treatments to modify wettability behavior.
- ◆ Superhydrophobicity
- ◆ Electrowetting

Wettability, Adhesion and Applied Aspects of Contact Angle Measurements:

- ◆ Effect of surface energetics on adhesion.
- ◆ Biological applications including protein and bacterial adhesion.
- ◆ Fine particle adhesion and control of dust.
- ◆ Other technological applications including: printing, agriculture, pharmaceuticals, textiles and paper.



ORGANIZERS AND CONTACT INFORMATION

Dr. Kash Mittal, Director
HERITAGE EXECUTIVE SUITES
Suite 1, 2537 Route 52
Hopewell Junction, NY 12533
USA
Tel: 845-897-1654
Cell: 845-702-0366
E-mail: klm@mstconf.com

Dr. Robert Lacombe
HERITAGE EXECUTIVE SUITES
Suite 1, 2537 Route 52
Hopewell Junction, NY 12533
USA
Tel: 845-897-1654
Alt: 845-592-1963
E-mail: rhl@mstconf.com

3- Day Impact Course

The Chemistry, Physics & Mechanics of Surface Science and Adhesion

November 13-15, 2019

Courtyard by Marriott, Stewart-Newburgh

New York

SCENIC HUDSON VALLEY



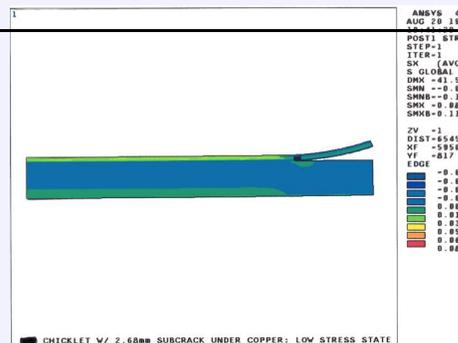
Topics to be Covered

- I. Surface Contamination and Cleaning
- II. Theories or Mechanisms of Adhesion
- III. Contact Angle, Wettability and Adhesion
- IV. Investigation of Interfacial Interactions
- V. Surface Modification Techniques including Plasma
- VI. Ways to improve Adhesion of Organic Coatings
- VII. Silanes and Other Adhesion Promoters
- VIII. Adhesion Aspects of Thin Films
- IX. Adhesion Measurement of Films and Coatings
- X. Basics of Adhesion Measurement
- XI. Residual Stress and Material Mechanical Properties
- XII. Setting Adhesion Requirements for Coating Applications
- XIII. Adhesion Measurement at Atomic and Molecular Level
- XIV. Fundamental Adhesion Applications

How You Will Benefit From This Course

You will understand advantages and disadvantages of a range of adhesion measurement techniques. You will be able to select the right surface cleaning technique including the use of atmospheric plasmas. You will utilize the concept of acid-base interactions in improving adhesion and acquire basic skills for addressing adhesion failure problems, analyze the alternatives and select the optimum technique for improving adhesion and structure durability. Know where help is available in emergency situations and learn how to select the best measurement technique for a given application.

First discovered by Europeans in 1609 when Henry Hudson sailed his ship the Half Moon into Newburgh Bay, the HUDSON VALLEY has since been visited by a long list of remarkable adventurers, explorers and statesmen. These influential men and women determined the early history and culture of America from the 18th century onward. From the time of the Revolutionary war when George Washington established his headquarters in a stone fortress in Newburgh on through the tumultuous years of the 19th century which witnessed the revolutionary changes brought on by the industrial revolution, the Hudson Valley has been the scene of landmark developments in commerce, technology and American culture.



Audience: Scientists and professional staff in R&D, manufacturing, processing, quality control/reliability involved with adhesion aspects of coatings and adhesion sensitive applications.

Level: Beginner- Intermediate; introduction/overview

Prerequisites: Elementary background In chemistry, physics or materials science.

Duration: 3 days

Course fee and materials: \$1,295, includes break refreshments, complete set of lecture notes and copy of handbook and reference guide ADHESION MEASUREMENT METHODS: THEORY AND PRACTICE, (CRC PRESS, 2006)

Learn From Internationally Recognized Professionals

This course is being taught by Drs. Kash Mittal and Robert Lacombe. Dr. Mittal is an internationally recognized authority on adhesion and surface science topics. He was Editor-in-Chief of the Journal of Adhesion Science and Technology one of the premier international journals in adhesion science for 25 years since 1987 and is currently editor of Reviews of Adhesion and Adhesives a prestigious journal that accepts papers by invitation only. He has also edited over 100 books dealing with all aspects of adhesion and surface and interface technology. His accomplishments in this field have recently been recognized at a special symposium in his honor at the 240th meeting of the American Chemical Society held in Boston, MA, August 2010. He has received many awards and honors and has given this course worldwide.

Dr. Lacombe has been involved in adhesion and surface science technology as a scientist and engineer in the microelectronics industry dealing with problems arising in the development and manufacture of multilevel thin film structures at the heart of modern computer and hand held device technology. He has taught a short course on adhesion measurement methods for the past 15 years and has published an authoritative handbook and reference volume on this topic which will be made available to all students who attend the course.

Drs. Mittal and Lacombe have jointly organized over 60 international symposia dealing with all aspects of adhesion phenomena and surface science and have attracted the participation of the world's leading researchers on these topics. Much of the content of the course has been derived from this long and productive interaction with the world's leading investigators in adhesion and surface science. It is expected that the student will benefit not only from the extensive experience of the instructors but also from face to face discussions on topics of particular interest.

Adhesion's Important Role Today

Adhesion plays an important role in many technologies and industries, viz., aerospace, microelectronics, automotive, thin films, optics, coatings, paint and so on. Broadly speaking, the topic can be divided into two categories: film or coating/substrate combination and adhesive joints. Films and coating are used for a variety of purposes and irrespective of their intended function, these must adhere adequately to the underlying substrate. So the need for understanding and controlling the factors affecting adhesion is quite patent.

Furthermore, the durability of the bond (on exposure to process chemicals, moisture, corrosives, etc.) is of paramount concern and importance. This course presents an overview of the chemistry, physics and mechanics of adhesion in regard to understanding fundamental adhesion mechanisms. You will learn how to improve and control them and the latest adhesion measurement techniques which are being used to evaluate the PRACTICAL ADHESION of coatings and laminate structures.

Emphasis is given to methods which can be carried out in a manufacturing environment as well as in the lab environment which give results that are directly relevant to the durability and performance of the structures under investigation. The effects of coating elastic properties and residual stress are considered as well as other external influences which affect durability under use conditions.

INSTRUCTORS AND CONTACT INFORMATION

Dr. K. L. Mittal & Dr. R. H. Lacombe
Heritage executive Suites
2537 Route 52, Suite 1
Hopewell Junction, NY 12533
Tel. 845-897-1654 & 845-592-1963
E-mail: klm@mstconf.com ; rhl@mstconf.com

For detailed information and registration: www.mstconf.com/AdhesionCourse.htm