

MATERIALS SCIENCE AND TECHNOLOGY NEWSLETTER

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SURFACE SCIENCE, ADHESION AND BIOTECHNOLOGY

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In this issue we would like to bring attention to two exciting events scheduled for early November 2012. The first is the upcoming SECOND INTERNATIONAL SYMPOSIUM ON SURFACE SCIENCE ASPECTS OF PHARMACEUTICAL SCIENCE, PHARMACOLOGY, COSMETICS AND BIOTECHNOLOGY, To be held November 7-9, 2012 at the Hampton Inn, Mid Hudson Valley, New York, USA. The second is the three day short course on the CHEMISTRY, PHYSICS AND MECHANICS OF ADHESION SCIENCE to be held, November 14-16, 2012, at the Courtyard by Marriott, Stewart-Newburgh, NY.

The November symposium is the second in a series dedicated to exploring the critically important role that surface interactions play in biological science and technology covering the whole range of topics from drug delivery mechanisms to the formulation of cosmetics. The issue of cellular adhesion, for example dominates a wide range of medical problems ranging from the recovery from surgery to the success or failure of implants. Not long ago it was nearly impossible to attack problems such as cell adhesion due to the extremely small size of individual cells and the complexity of the environment in which they interact. However, with the advent and ongoing refinement of extremely sensitive and accurate measurement techniques such as Atomic Force Microscopy (AFM) and the Surface Force Apparatus (SFA) we are now able to measure the adhesion of cells to a variety of surfaces under conditions similar to the in vivo environment. Progress in this area has been documented in a recent volume by Kendall et al which is reviewed below along with further details on the symposium.

Following the symposium, the MST staff will give the third presentation of the increasingly popular 3 day short course on the CHEMISTRY, PHYSICS AND MECHANICS OF ADHESION SCIENCE. This course is targeted toward the laboratory professional who needs to understand how adhesion issues affect his/her daily work and also toward management personnel who need to understand the impact that adhesion problems can have on manufacturing production and development projects. The course gives the most comprehensive treatment of adhesion science available, covering topics ranging from molecular interactions at interfaces to the adhesion of thin films, thick coatings and multilevel laminates.

I can think of no more apropos time to review the above volume as the topic is so central to the theme of the upcoming November symposium on SURFACE SCIENCE ASPECTS OF PHARMACEUTICAL SCIENCE, PHARMACOLOGY, COSMETICS AND BIOTECHNOLOGY. In fact all of the authors have been invited to speak at the symposium on various aspects of cellular and nanoparticle adhesion.

One of the major contributions which this volume brings to the field of cellular adhesion is to help clear up the basic nature of cell adhesion, in particular the role of "adhesion molecules". The authors first point out a number of commonly held misconceptions which in no particular order can be stated as follows:

1. Extracellular structures are essential for cellular adhesion to a surface
2. Species need to be alive for adhesion to occur
3. Adhesive molecules are required for cellular adhesion to occur

As the problem of cell adhesion is highly complex it is no wonder that a number of misconceptions have arisen with regard to the precise nature of cell adhesion. Simple observation always reveals the presence of extracellular material or "adhesion molecules" when cells aggregate so it is clearly quite logical to assume that these structures and molecules play an important role in cellular adhesion. This is quite true but the implied inference that cells cannot adhere to anything in the absence of these structures or molecules is clearly not true. As regards to basic adhesion, cells are like any other material. They can adhere to just about anything without assistance from external structures or molecules since all adhesion interactions are at bottom are electromagnetic. The authors in fact present very convincing data that extraneous material actually reduces the level of adhesion of cellular material to simple surfaces where the extra material tends to act as a contaminant which prevents the required intimate contact for maximal adhesion. Chapter 2 of the volume makes the case that, for the most part, it is the common van der Waals interactions that are responsible for the basic adhesion of cellular material. The van der Waals forces of course arise from the more basic electromagnetic interactions of atomic and molecular matter. The authors do not discuss the fundamentals of the electromagnetic interactions as that would lead them too far afield

and no wonder since any in depth discussion would lead directly to the wilds of quantum electrodynamics. An elementary discussion of the quantum electrodynamic nature of the van der Waals interaction has been given in a previous issue of the newsletter:

www.mstconf.com/Vol2No3-2005.pdf

The most cogent example of the action of van der Waals forces in biology is the remarkable behavior of the common gecko lizard. This simple creature has the uncanny ability to climb vertical surfaces of any material composition as easily as it walks in the horizontal plane while at the same time being some 100 times heavier than insects that perform the same feat. Details of how the gecko goes about its remarkable acrobatics have also been covered in a previous issue of the news letter:

Hamaker and the Miraculous Gecko:
www.mstconf.com/Vol3No1-2006.pdf

Without going into detail it turns out that a number of careful experiments have systematically ruled out the following possible mechanisms for gecko adhesion:

1. **ADHESION USING TINY HOOKS:** This mechanism is easily disproved since microscopic investigation of the gecko foot pad does not reveal any hook structure and at any rate such hooks would be entirely useless on flat smooth surfaces such as glass which the gecko manages with perfect aplomb.
2. **USE OF A SECRETED ADHESIVE MATERIAL:** Again careful investigation does not reveal any glands or other organisms which would be required to secrete the required adhesive and use of any adhesive material immediately raises the question of how the gecko manages to instantly release its grip on surfaces in order to move around.
3. **HOW ABOUT USE OF SUCTION:** Again no good. Measurements of the gecko's adhesion ability have been performed under vacuum giving no measurable effect which completely rules out any suction mechanism which requires an external atmospheric pressure in order to develop a sticking force.
4. **WHAT ABOUT ELECTROSTATIC INTERACTIONS:** This is getting a little closer but again no go. An electrostatic interaction would require the existence of free charges on opposite surfaces in order to develop the required force. Experiments were performed

using ionizing radiation which create a highly conductive atmosphere that would immediately discharge any existing free charges on the gecko's foot but again no significant decrease in the level of adhesion was observed.

5. **MAYBE CAPILLARITY FORCES ARE INVOLVED:** Capillarity forces would require the presence of free moisture in order to create the seal required to establish adhesion. Again careful experiments in ultra dry environments show no decrease in the level of adhesion.

The van der Waals forces overcome all of the above objections and the authors in a separate chapter also explain the complete reversability of the interaction. Thus van der Waals interactions it is.

So if extra cellular structures or adhesion molecules are not required for adhesion then what is their role? All available data suggests that these entities in fact modulate the level of cellular adhesion. As living entities cells sometimes need to adhere and sometimes not. In fact achieving the maximal adhesion allowed by the van der Waals interactions would be highly detrimental to cellular development since the cell would likely find itself trapped in an undesirable state. The so called "adhesion molecules" can sit between the cell and whatever substrate it needs to bind to and by simply adjusting their 3 dimensional conformation bring the level of adhesion to a suitable level which can be further adjusted as circumstances require.

Finally, another important feature of this volume is that it gives many examples of how the more advanced adhesion measurement tools such as Atomic force Microscopy and the Surface Force Apparatus are being used to painstakingly unravel the many secrets and intricacies of cellular interactions and adhesion. In addition a number of examples of recent molecular dynamic modeling studies are given where the basic molecular and atomic interactions are studied through large scale computer simulations. These simulations are one of the few ways we have to directly study the effect of micro brownian motion on atomic and molecular interactions. Unfortunately the wide range of topics covered make it impossible to cover all but a small fraction of the topics covered. However, in closing we can highly recommend this volume to all researchers with a need to understand more fully the fundamental adhesion phenomena which regulate all biological activity.

SHIFTING SANDS OF THE PUBLISHING INDUSTRY AND EFFECT ON MST SYMPOSIA

Passing of The Journal of Adhesion Science and Technology

Due to a number of wholly unanticipated and altogether regrettable circumstances the staff of MST CONFERENCES no longer have any association with the Journal of Adhesion Science and Technology (JAST) which was founded by the Director Dr. Mittal nearly 25 years ago. In essence an unfortunate business deal sold the journal out from under us with consequences that make it impossible to continue the effort. Thus papers presented at any of the MST symposia will no longer appear in JAST. However, a new journal is currently in the formative stages and will appear shortly and the archival volumes that have documented many of the 50 odd previous symposia will continue to appear.

Birth of Surface Innovations: a new journal on surface science and technology

On the brighter side we are happy to report on the creation of a new journal which should be of considerable interest to all readers of the newsletter.

The new journal called *Surface Innovations*¹ is being published with the intent to focus on advances made on protective, functional, and smart surfaces. *Surface Innovations* will be an interdisciplinary and international journal that will publish articles on scientific and engineering advances made in formulation and modification of surfaces and coatings in the following subject categories:

1. Superhydrophobic, oleophobic, superhydrophilic, oleophilic, and superwetting surfaces, including fundamentals governing wettability of such surfaces
2. Surface modifications and coatings for self-cleaning, controlled and/or reversible adhesion, sticking and/or friction, and other functionality
3. Materials with antimicrobial, antibacterial and/or antifungal surfaces
4. Antifouling coatings and paintings

¹ (more details are available at the journal web site: <http://www.icevirtuallibrary.com/sufi>)

5. Surfaces with enhanced biocompatibility or biological responses
6. Coatings that enhance anticorrosion, antireflection, structural coloration, or material self-healing
7. Processing and patterning of surfaces for enhancement of their functionality(ies).

The journal will publish interdisciplinary research and review articles that demonstrate the work being conducted and developed by leading institutions and organizations from around the world. Comments and discussions will also be considered in order to provide a forum for the clarification of terms, phenomena, and experimental protocols.

The potential contributors should also know that the journal will publish color pictures and figures free of charge and all issues of 2013 will be given free online access for the entire year.

Presenters at the upcoming November symposium will have the opportunity to publish their work in *Surface Innovations* and can contact the Editor-in-Chief (who plans to participate in the meeting) at the following address:

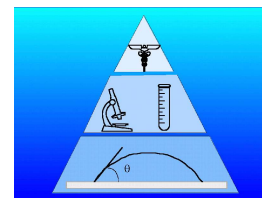
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SECOND INTERNATIONAL SYMPOSIUM ON SURFACE SCIENCE ASPECTS OF PHARMACEUTICAL SCIENCE, PHARMACOLOGY, COSMETICS AND BIO-TECHNOLOGY

November 7-9, 2012; Hampton Inn, Harriman Woodbury in Mid Hudson Valley, New York, USA

The staff of MST CONFERENCES are happy to announce the second symposium in the series on the surface science aspects of pharmaceutical science, pharmacology, cosmetics and bio-technology. The scope of the program will deal with all aspects which are critically dependent on understanding the nature of surface interactions which control the behavior and biological activity of



therapeutic formulations as well as cosmetic and biomedical technologies such as bio-adhesives, drug delivery systems, cosmetic formulations and gene chip arrays.

The overall focus of the symposium will of necessity be multi-disciplinary in nature involving researchers engaged in developing new drugs to surface scientists concerned with the detailed nature of surface interactions and their accurate measurement. It is indeed a prime objective of the symposium to bring these normally disparate groups together within a forum where needs, ideas and methodologies can be discussed and mutually beneficial collaborations encouraged.

It is well recognized that a wide range of critical biological interactions occur at or across surfaces including drug absorption, cellular adhesion, autoimmune reactions, skin inflammation and cell growth to name a few. Thus in order to control or modify these processes it is first critical to understand the fundamental nature of the surface interactions which control them. It is at this level that the surface scientist and the bio-technologist can collaborate to develop innovative technologies for drug delivery, cellular and bone repair, cosmetic formulations and advanced diagnostic methods such as gene chip arrays.

On the one hand, the pharmaceutical scientists and bio-technologists can elucidate the problems and methods of their disciplines with regard to issues relating to delivery and adsorption of drug metabolites, interactions leading to inflammation or implant rejection and adverse immune system response to medical treatments. The surface scientist, on the other hand, can demonstrate how the methods of surface analysis and measurement can be brought to bear on the problem of understanding the basic surface chemistry which controls these processes. As an example, the bio-technologist might explain the problems associated with a topical skin treatment whereas the surface scientist can demonstrate how contact angle measurements can be used to evaluate the wettability characteristics of skin and how this affects the absorption of and reaction with topical medications.

SYMPOSIUM TOPICS:

Needs of the Biomedical, Pharmaceutical and Cosmetic industries:

1. Interaction of biologically active molecules with tissue substrates.
2. Problems of drug delivery in vivo
3. Drug interactions with cellular surfaces relating to immune system response and

implant rejection

4. Interactions with biomaterial surfaces
5. Biocompatibility
6. Problems relating to drug encapsulation in capsules or tablets
7. Skin surface chemistry and interactions

Tools and Methodologies of Surface Science:

1. Surface analytical methods
 - a. ESCA, AUGER, SIMS ...
 - b. Atomic Force Microscopy
 - c. Contact Angle Goniometry
 - d. Surface Micro-Calorimetry
2. Theoretical concepts of Surface Science
 - a. Hamaker theory
 - b. JKR theory
 - c. Surface thermodynamics
 - d. Acid-Base interactions
3. Surface Chemistry Modification
 - a. Silane adhesion promoters
 - b. Chemical grafting
 - c. Plasma and radiation modification

Applications:

1. Drug Delivery Systems
 - a. Delivery through fabrics made with surface modified fibers
 - b. Advanced capsule and tablet technologies
 - c. Delivery using surface activated particles
 - d. Drug screening, label free detection
2. Advanced adhesives for mending bone fractures
3. Gene chip arrays
4. Immobilization strategies of biomolecules on solid surfaces
5. Cosmetic applications

Cross-Disciplinary Studies:

1. Use of Atomic Force Microscopy to study biological surfaces
2. Contact angle measurements on skin and dental tissues
3. Bioadhesives such as hydrogels
4. Advanced adhesive applications employing the GECKO effect
5. Applications of superhydrophobicity and the LOTUS LEAF effect

6. Micro/Nano Technology; e.g. smart implants using MEMS

LOCATION

Hampton Inn Harriman Woodbury
60 Centre Drive, Central Valley,
New York, 10917, USA

TEL: 1-845-782-9600

<http://hamptoninn3.hilton.com/en/hotels/new-york/hampton-inn-harriman-woodbury-NYCMRHX/index.html>

TO SUBMIT AN ABSTRACT OR GET ON
CONFERENCE MAILING LIST:

This symposium is being organized by MST Conferences under the direction of Dr. K. L. Mittal. 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 September 15, 2012 to the conference chairman by any of the following methods:

BY PHONE: 845-897-1654; 845-227-7026

BY FAX: 212-656-1016

E-mail: rhl@mstconf.com

ONLINE:

www.mstconf.com/SurfSciPharm2.htm

BY MAIL: SEND COMPLETED FORM BELOW TO

Dr. Robert Lacombe
Chairman
MST Conferences
3 Hammer Drive
Hopewell Junction, NY
12533-6124, USA

3- Day Impact Course:
**THE CHEMISTRY, PHYSICS
& MECHANICS OF
ADHESION SCIENCE**
November 14-16, 2012
Courtyard by Marriott,
Stewart-Newburgh, NY
SCENIC HUDSON VALLEY

LOCATION:

Courtyard By Marriott
Newburgh Stewart Airport
4 Governor Drive.
Newburgh, New York 12550 USA.

Phone: 1 845 567 4800

Fax: 1 845 567 9550

Web Site:

www.marriott.com/hotels/travel/hpnnb-courtyard-newburgh-stewart-airport.htm

Adhesion's Important Role Today

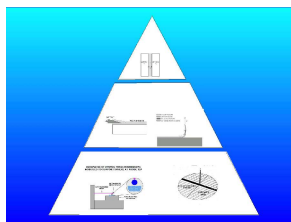
Adhesion plays an important role in many technologies and industries, viz., aerospace, microelectronics, automotive, thin films, optics, coatings, paint and so on. Broadly speaking, the topic can be divided into two categories: film or coating/ substrate combination, and adhesive joint. Films and coatings 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. Also, on top of the commonest applications just mentioned where adhesion plays a critical role, the science of adhesion is rapidly expanding into the realm of biotechnology and the pharmaceutical industry where issues of cell and particle adhesion are crucial in the realms of prosthetics and drug formulations.

Furthermore, the durability of the bond (on exposure to process chemicals, moisture, corrosives, etc.) is of great 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.

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)

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. Methods applicable to cells and other biological structures
- XV. 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 plasma. You will utilize the concept of acid-base interactions in improving adhesion, acquire basic skills for addressing adhesion failure problems. Analyze the alternatives and select the optimum technique for improving adhesion, and the durability. Know where help is available in emergency situations and learn how to select best measurement technique for a given application.

Instructors and Contact Information

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 is the former Editor-in-Chief of the Journal of Adhesion Science

and Technology which he founded in 1987 and developed into a major international journal over the past 25 years. 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 technology. He has taught a short course on adhesion measurement methods for the past 11 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 50 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. The instructors may be reached at the addresses below:

K .L. Mittal, Director
1983 Route 52, Suite C
P.O. Box 1280
Hopewell Junction, NY 12533-1280 USA
Tel. 845-897-1654
FAX: 845-897-2361
E-mail: klm@mstconf.com

R. H. Lacombe
Conference Chairman
3 Hammer Drive
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USA
Tel. 845-227-7026
FAX: 212-656-1016
E-mail: rhl@mstconf.com

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

REGISTRATION FORM: FILL OUT AND SEND TO DR. LACOMBE BY REGULAR MAIL, FAX OR AS EMAIL ATTACHMENT AT THE ADDRESS/PHONE NUMBER/E-MAIL ADDRESS GIVEN ABOVE

SYMPOSIUM ON SURFACE SCIENCE ASPECTS OF PHARMACEUTICAL SCIENCE, November 7-9, 2012, Presenting Author	\$395
SYMPOSIUM ON SURFACE SCIENCE ASPECTS OF PHARMACEUTICAL SCIENCE, November 7-9, 2012, Regular Attendee	\$595
SHORT COURSE ON CHEMISTRY, PHYSICS AND MECHANICS OF ADHESION SCIENCE: November 14-16, 2012	\$1295
Deduct 10% if more than 1 participant from same institution	
TOTAL REGISTRATION FEE	

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CHECK: Make check payable to MST Conferences, LLC and mail to: Dr. Robert H. Lacombe Course Organizer 3 Hammer Drive Hopewell Junction, NY 12533-6124, USA	

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(As it appears on card)