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CONTACT ANGLE AND ADHESIVE SCIENCE

EDITORIAL COMMENTS

This issue of the newsletter takes up the topic of contact angle measurement and adhesive applications in conjunction with a book review on a recently released volume on adhesion science. I was struck by two observations upon reading the volume. The first was the amazing ubiquity of adhesives in our everyday lives and the second was the still very primitive understanding we have of the behavior of adhesives and the process of formulating adhesives for specific applications. In addition there is the question of the subtle role that surface energies play in determining adhesive performance. More on these topics in the editorial essay.

In addition this issue of the NEWSLETTER presents the preliminary program for the upcoming 10th in the symposium series on CONTACT ANGLE, WETTABILITY AND ADHESION which will be held July 13-15, 2016 at the Stevens Institute of Technology in Hoboken, New Jersey. All readers of the newsletter are invited to join us at the Stevens Institute for what promises to be a most engaging and informative meeting

Finally we would like to bring every ones attention to the next session of the short course on:

THE CHEMISTRY, PHYSICS AND MECHANICS OF ADHESION SCIENCE

The course will be given again this coming May 10-13, 2016 at the Marriott Inn in Newburgh, NY and all readers of the NEWSLETTER are invited to join us this coming May in Newburgh or simply to pass the word along to colleagues or associates who might be interested.

EDITORIAL ESSAY:

BOOK REVIEW ON:

ADHESION SCIENCE: PRINCIPLES AND PRACTICE

Steven Abbott, (DEStech Publications, Inc., 2015)

Though the title would give the impression of dealing with the broad topic of adhesion science the volume is in fact closely focused on the topic of adhesives technology. This is not only a good thing but a necessary one also since dealing with the general topic of adhesion would require an encyclopedia series as opposed to a relatively compact volume.

What struck me most upon reading the volume was the amazing ubiquity of adhesive applications which we encounter in our everyday lives and the broad range of thermal-mechanical requirements that these applications require. Have a look around your local supermarket if you are not convinced about pervasiveness of adhesives in our day to day lives. Every glass jar has an adhesive attaching the label, every cardboard box is held together with an adhesive, all the bubble pack packages containing everything from paperclips to cutlery are sealed with an adhesive. Even going over to the fresh produce tables with fruits and vegetables laid out completely bare of any packaging materials whatever one finds sneaky little labels adhered to nearly everything with the items PLU code printed on it. It is not an exaggeration to say that the entire contents of the store are held together with an adhesive of one kind or another.

Looking around my office I see the ever present Postit® notes plastered on nearly every vertical and horizontal surface as well as interleaving the pages of most of the volumes on my bookshelf. Thinking about it one realizes the that the Postit note is a rather remarkable technology in that the note must adhere quickly to a broad range of surfaces without any surface pretreatment whatever and must also be cleanly removable without damaging the surface in question. Thus the Postit note puts a stake in the ground at one end of the adhesive performance spectrum which requires rapid easily reversed adhesion to a wide range of surfaces without regard to any sort of surface treatment other than perhaps blowing off some dust.

Going to the other end of the spectrum we find the adhesives which are used to glue together high performance aircraft. The requirements for this application are totally the opposite from those of the Postit note. All surfaces are carefully cleaned and treated with special primers. Maximal joint strength is required over a wide range of temperature and environment conditions giving a bond that needs to be totally irreversible.

Sitting between the extremes of the Postit note and aircraft glue is a vast range of intermediate applications ranging from gluing together the common cereal box to gluing the windshield onto your automobile. Consider the cereal box. Here fairly strong adhesion is required since the container cannot fall apart too easily but the adhesion cannot be too strong since the consumer has to be able to open the package without excessive force. On top of these requirements the adhesive material must be inexpensive and easily applied without surface preparation since the manufacturing volumes involved are enormous.

The case of adhering to windshield glass presents an entirely different set of requirements. In case you are not aware, many windshields in the newer car models are glued to the frame. Not only that but you also find that the rearview mirror is also glued to the glass. I can attest directly to this fact since the rearview mirror on my car fell off recently and needed to be reattached. The requirements here are dramatically opposite to the cereal box. First the bond must be permanent. Second the bond must withstand a wide range of temperature cycling from say 10 degrees F below zero in Winter to over 100 F in summer for a vehicle parked in the sun. Third the adhesive must withstand extensive exposure to ultra violet radiation from the sun. Given these requirements I thought it best to go to the auto parts store and purchase an adhesive specially formulated for attaching rearview mirrors.

The procedure for attaching my mirror was more like using aircraft glue than bonding a cereal box. First the glass and the attachment button were cleaned with acetone to remove all residual adhesive. Second a primer layer had to be applied to the glass and allowed to set for a specific time. Finally I was directed to apply only a thin layer of the adhesive to the attachment button which was then pressed in place for a full minute to get initial attachment. An hour or so or curing time was needed to achieve full strength before the mirror could be attached to the button.

Getting back to the volume under review it is clear upon cursory reading that the author has spent considerable time in the adhesives formulation business. The table of contents gives an indication of the flavor of the topics covered:

1. Some basics: Reviews the rudiments of adhesion measurement and adhesion failure mechanisms.

2. The Myths around Surface Energy and Roughness: An entertainingly provocative review of the concepts of surface energy and surface roughness as applied to adhesives technology.

3. Intermingling and Entanglement: Brings into focus the critically important role of the adhesive bulk properties on its adhesion performance. In particular the crucial role of polymer molecular weight and chain segment mobility are discussed in regard to achieving high adhesion strength.

4. Time is the Same as Temperature: Discusses the critical importance of the concept of Time Temperature Superposition in determining the thermal-mechanical properties of all adhesive formulations.

5. Strong Adhesion with a Weak Interface: Review of the important topic of pressure sensitive adhesives.

6. Formulating for Compatibility: Discusses the importance of polymer solution thermodynamics in the development of adhesive formulations.

7. Measuring Adhesion: Perils and Pitfalls: Gives a review of the most common adhesion measurement methods used for evaluating adhesive formulations.

8. Putting Things into Practice: Gives a comprehensive summary of how all the above topics can work together in the “scientific” design of adhesive formulations.

Topics 2 and 3 above are of most interest to the subject of modifying surface energies through the use of plasma technology and other methods. The essential point of chapter 2 is that the role of surface energy in promoting adhesion to crystalline polymers is basically misunderstood. It is well known that it is difficult to adhere anything to crystalline polymers such as poly(ethylene) PE, poly(ethylene-terepthalate) PET and poly(propylene) PP. It is also well known that plasma treatment greatly improves the adhesibility of all of these materials. The question is what is going on?

The standard answer is that plasma treatment is improving the surface energy of these materials thus allowing greater wetting as well as stronger interactions at the interface via the creation of functional groups. Contact angle measurements are a very effective means for measuring the change in surface energy achieved by the plasma treatment. The author argues persuasively, however that improving the surface energy is not the major cause of improved adhesion after plasma treatment. Looking at polyethylene for example, standard analysis reveals the surface energy to be roughly 32 mJ/m^2 (milli joules per square meter). Plasma treatment will typically raise the surface energy to something like 42 mJ/m^2 or about a 30% increase. This figure, however, does not square with the observed increase in peel test adhesion which can be in the range of 10 to 100 J/m^2 (joules per square meter) or several orders of magnitude larger than the increase in surface energy.

Further suspicion is cast on the surface energy argument by the comparison of poly(ethylene terephthalate)PET to poly(vinyl chloride) PVC. The surface energies of these two polymers are close to

43 mJ/m^2 but it is well known that it is difficult to adhere to PET compared to PVC. Again we have wonder what is going on?

A clue begins to emerge in the case of PE. This polymer comes in two basic forms one of low density LDPE and one of high density HDPE. The high density form is essentially one long completely linear chain of CH_2 units and therefore tends to be highly crystalline. The low density form, however, is composed of linear strings of CH_2 units broken up at intervals by short side chains of CH_2 units terminating in a CH_3 group. The many side chains of the LDPE prevent it from attaining the same level of crystallinity as its HDPE cousin thus resulting in lower density. It is also known that it is easier to adhere to low density PE than the high density form. If we combine this with the fact that the poorly adhesionable PET is a highly crystalline polymer and the easily adhesionable PVC is totally amorphous then we have to suspect that it is the level of crystallinity that is key in determining adhesability.

It is at this point that the mechanisms of chain intermingling and chain entanglement enter the picture. In essence amorphous polymers have a high degree of chain segment mobility which allows them to interpenetrate and form entanglements which give rise to high levels of energy dissipation when trying to pull them apart. Think of trying to pull part two lengths of string that have been randomly jumbled together. It is these strongly dissipative effects that give rise to the apparent strong adhesion observed in peeling apart these intermingled and entangled layers.

Now the question becomes what is the role of plasma treatment in improving the adhesionability of crystalline polymers? Aside from improving the wettability of the treated surface the most obvious mechanism is the disruption of the surface crystalline layers of the polymer. Plasma treatment always involves the making and breaking of chemical bonds and in the case of crystalline polymers we postulate that the plasma field breaks up a significant amount of surface crystallinity creating an amorphous layer with highly mobile chain segments capable of intermingling and entangling with applied surface layers. The existing level of surface energy must be sufficient to allow for a reasonable amount of wetting, but beyond that it does not add significantly to the overall peel removal energy which is dominated by the dissipative effects of chain interpenetration and entanglement.

Prof. Abbott points out that the adhesion mechanisms described above have a strong influence on how the typical adhesive is formulated. The redoubtable formulator is generally faced with the prospect of joining two poorly or wholly uncharacterized surfaces and his customer wants an inexpensive and easily applied glue that will hold these surfaces together with just the right amount of strength and durability called for. He has to assume that the surface energies will be in a reasonable range to give sufficient wetting without the need to perform any sort of involved surface analysis or surface preparation aside from a perfunctory cleaning. Plasma treatment will be a very handy tool when dealing with difficult surfaces such as the crystalline polymers but it must be remembered that all that is required is to sufficiently break up the crystallinity of just the top most surface layer in order to get chain interpenetration. Over treatment must be avoided so that one does not create a layer low molecular weight rubble that could act as a weak boundary layer and thus give even poorer adhesion than the original untreated surface.

As luck would have it not only did my rearview mirror fall off but also the soles of my cycling shoes delaminated. Thus I got to try out a totally different kind of adhesive from what I used to attach my mirror. Commonly called shoe goo it is apparently some kind of silicone polymer formulation. No surface preparation is required other than blowing out any loosely adhered debris. Contrary to the rearview mirror formulation there is no primer layer required and the glue is applied in a fairly thick layer and spread out as evenly as possible with a stick to give good coverage and penetration into all the nooks and crannies of the mating surfaces. After application of the glue I pressed together the mating surfaces under the weight of an inverted 10 pound sledge hammer in order to make maximal contact and then allowed everything to set and cure over a period of a day or two.

Thus the world of adhesives turns out not only to be very commonplace in our day to day lives but also rather subtle, deceptive and nonintuitive in terms of the science and technology required to create truly effective and useful formulations. The requirements from one application to another can be diametrically opposite and the formulator has but a limited number of theoretical tools available which must be carefully handled. Though contact angle measurements may not play a major role in applied adhesive technology they can nonetheless be quite significant in terms of easily detecting deleterious surface contamination and ensuring that the surface energies are sufficient to allow for adequate wetting of the adhesive to the surfaces to be bonded.

The reader interested in further exploring this most engaging topic is encourage to refer to Prof. Abbott's fine volume.

PRELIMINARY PROGRAM
TENTH INTERNATIONAL SYMPOSIUM ON
CONTACT ANGLE, WETTABILITY AND
ADHESION

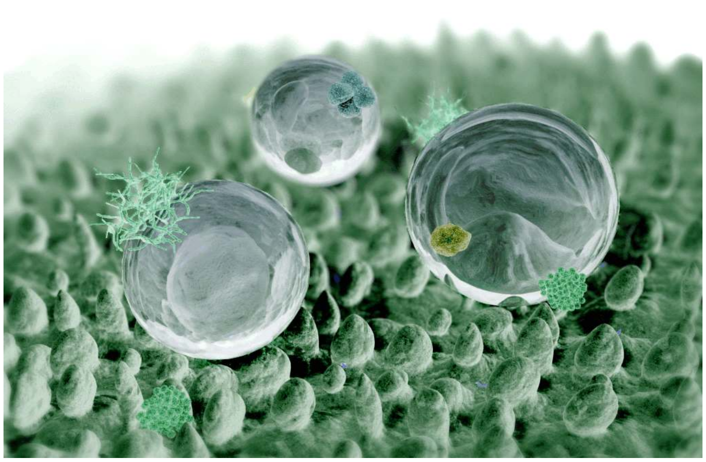
Stevens Institute of Technology,
Hoboken, New Jersey, July 13-15, 2016

SYMPOSIUM HISTORY AND MOTIVIATION

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 February15, 2016 to the conference chairman by any of the following methods:

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Regular mail:

Dr. Robert H. Lacombe
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Full conference details and registration via the Internet will be maintained on our web site:

www.mstconf.com/Contact10.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.

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The following is a sample of the papers to be presented: (Note the given address is for highlighted presenter and may not apply for all coauthors)

NOVEL APPLICATIONS

Edward Bormashenko, Yelena Bormashenko, Roman Grynyov, Hadas Aharoni, Gene Whyman and Bernard P. Binks; Ariel University, Physics Department, P.O.B. 3, 40700, Ariel, ISRAEL; Self-Propulsion of Liquid Marbles: Leidenfrost-Like Levitation Driven by the Marangoni Flow

Junqi Yuan, Jian Feng and Sung Kwon Cho; Dept. of Mechanical Engg. & Materials Science, University of Pittsburgh, Pittsburgh, PA 15261; Control of Floating Objects by Di-electrowetting

H. Jennissen; Institute of Physiological Chemistry, University of Duisburg-Essen, Hufelandstr. 55, D-45122 Essen, GERMANY; Complex and Imaginary Contact Angles: a Radically New Development for Advancing Our Understanding of Wetting, or Just a Whim of Applied Mathematics?

D.G. Waugh, J. Lawrence, A. Gillett and C.H. Ng; Laser Engineering and Manufacturing Research Group, Faculty of Science and Engineering, University of Chester, Thornton Science Park, Pool Lane, Ince, Chester CH2 4PU, UK; Laser Surface Treatment: Modulating Wettability Characteristics of Materials to Control Biological Cell Adhesion and Growth

Thomas Bahners, Jörg Müssig, Milan Kelch, and Jochen S. Gutmann; Universität Duisburg-Essen,NETZ / DTNW gGmbH, Carl-Benz-Straße 199, 47057 Duisburg,GERMANY; Improvement of Fiber-matrix Adhesion and Damping in Cellulose/polyolefin Composite Materials by Means of Photochemical Fiber Surface Modification

WETTING AND FLUID FLOW

Adya Karthikeyan, Sylvain Coulombe and Anne-Marie Kietzig; Surface Wetting and Surface Tension of Stable and Unstable Carbon Nanotube Nanofluids

Youhua Jiang, Wei Xu, Mohammad Amin Sarshar, Chang-Hwan Choi; Department of Mechanical Engineering, Stevens Institute of Technology, Hoboken, New Jersey, USA; A Generalized Model of Advancing and Receding Contact Angles for Patterned Surfaces

Choongyeop Lee, Seunggeol Ryu and Youngsuk Nam; Department of Mechanical Engineering, Kyung Hee University, Yongin-city, KOREA; Water Penetration Through Copper Mesh During Drop Impact: Influence of Surface Wettability

Birgitt Boschitsch Stogin, Xianming Dai, and Tak-Sing Wong; Department of Mechanical and Nuclear Engineering and the Materials Research Institute, The Pennsylvania State University, University Park, PA, USA; Wenzel Wetting on Slippery Rough Surfaces

PATTERNED SURFACES AND SUPERHYDROPHOBICITY STUDIES

Savvas G. Hatzikiriakos; Department of Chemical and Biological Engineering, The University of British Columbia, Vancouver BC, V6T 1Z3, CANADA; Controlled-Superhydrophobicity on Metallic Substrates Using Fs Laser Ablation

Ridvan Ozbay, Ali Kibar, and Chang-Hwan Choi; Department of Mechanical Engineering, Stevens Institute of Technology, Hoboken, New Jersey, USA;
Bubble Adhesion on Superaerophobic Surfaces: Effects of Surface Morphology

Mohammad Amin Sarshar, Chris Swartz, Chang-Hwan Choi; Department of Mechanical Engineering, Stevens Institute of Technology, Hoboken, NJ 07030, USA; Icephobicity of Superhydrophobic Surfaces: Effects of Environmental Conditions

Salma Falah Toosi, Sona Moradi, Narges Hadjesfandiari, Jayachandran N. Kizhakkedathu,and Savvas G. Hatzikiriakos; Department of Chemical and Biological Engineering, The University of British Columbia, Vancouver BC, V6T 1Z3, CANADA; The Effect of Superhydrophobicity on the Bacterial Adhesion on Polymeric Surfaces

Yusong Tu; College of Physics Science and Technology, Yangzhou University, 88 South University Ave., Yangzhou, Jiangsu 225009, P.R. CHINA ; Water-COOH Composite Structure with Enhanced Hydrophobicity Formed by Water Molecules Embedded into Carboxylic Acid-Terminated Self-Assembled Monolayers

Zuankai Wang; Department of Mechanical and Biomedical Engineering, City University of Hong Kong, HONG KONG; Bioinspired Materials: the Quest for the Maximum Water Repellency and Multifunctional Application

Muhammad Zahid; Istitutio Italiano di Tecnologia, Smart Materials (Nanophysics), Via Morego, 30, Genova 16163 ITALY; Multi-layer Polymer Treatment for Breathable-hydrophobic and Water Repellent Cotton Fabrics

EFFECT OF PLASMA TREATMENT

Edward Bormashenko; The Ariel University Center of Samaria, 40700, Ariel, ISRAEL; Cold Plasma treatment of Liquid Surfaces

Edward Bormashenko; The Ariel University Center of Samaria, 40700, Ariel, ISRAEL: Electrical Charging of Surfaces under the Cold Plasma Treatmen

Jean-Michel Hardy, Mirela Vlad, Luc Stafford, Bernard Riedl; Centre de recherches sur les matériaux renouvlables, Faculté de Foresterie, de géographie et de Géomatique, Université Laval, Quebec (QC) G1V 0A6, CANADA; Plasma Treatment of Wood: Are Extractives Responsible for Time Dependent Phenomena?

Hernando S. SALAPARE III* and Frédéric GUITTARD; Université de Nice-Sophia Antipolis, CNRS, Laboratoire de Physique de la Matière Condensée (LPMC), UMR 7336, Parc Valrose, 06100 Nice, FRANCE; Superhydrophobicity of Candle Soot Film Deposited on Rf Plasma-treated Poly(ethylene Glycol-co-1,3/1,4 Cyclohexanedimethanol Terephthalate) (PETG)

ADVANCED MEASUREMENT STUDIES

Eric Loth; University of Virginia, Room 308 MEC, 122 Engineer's Way P.O. Box 400746, Charlottesville, VA 22904; Micro-dynamics of Wetting (High Spatial and Temporal Resolution)

Lasse Makkonen; Principal Scientist, VTT Technical Research Centre of Finland, Box 1000, 02044 VTT, FINLAND; Determining the Surface Energy of a Solid by Contact Angles

Davide Rossi , Antonio Bettero, Nicola Realdon, Paola Pittia; Department of Pharmaceutical and Pharmacological Sciences, University of Padova, ITALY; Development of a Method for Contact Angles Measurements at Perfluoropolyether/perfluoropolyether Interface Employing Fomblin Hc/25" PFPE as " Fluid Film " for Surface Energy Characterization of Some Water Solutions

Sara L. Schellbach, Sergio N. Monteiro[2] and Jaroslaw W. Drelich; Department of Materials Science and Engineering, Michigan Technological University, 1400 Townsend Dr., Houghton, MI 49931, USA; A Novel Method for Contact Angle Measurements on Natural Fibers having Non-Uniform Cross Sections and Rough Surface

Michael Schmitt; Universität des Saarlandes, Physikalische Chemie, Campus B2 2, D-66123 Saarbrücken GERMANY; Fundamentals of Reproducible/ Enhanced Contact Angle Analyses

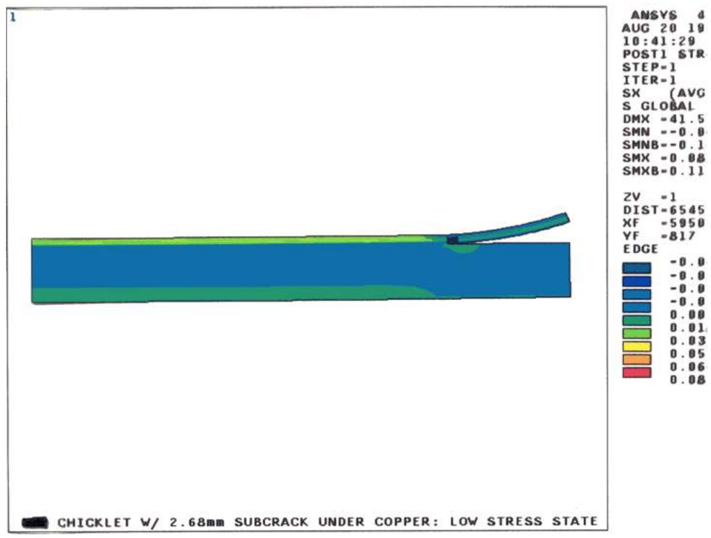
Konrad Terpiłowski, Marta Tomczyńska-Mleko, Stanisław Mleko and Emil Chibowski; Maria Curie Sklodowska University, Department of Chemistry Phisical Chemistry-Interfacial Phenomena, Str. Plac Marii Curie Sklodowska 5 Lublin 20-031, POLAND; The Surface Properties of Biopolymers Obtained with the Presence of Gluten

Bob Mbouyem Yimmou, Bernard Riedl, Roger Hernández, Géraldine Bazuin; Centre de recherches sur les matériaux renouvelables, Faculté de foresterie, de géographie et de géomatique, Université Laval, Québec (QC) G1V 0A6, CANADA; Surface Energy Characterization of Fire Retardant Treated Wood Veneers

THEORETICAL STUDIES

Lasse Makkonen; Principal Scientist, VTT Technical Research Centre of Finland, Box 1000, 02044 VTT, FINLAND; Young's Equation Revisited

Lasse Makkonen; Principal Scientist, VTT Technical Research Centre of Finland, Box 1000, 02044 VTT, FINLAND; A Quantitative Theory of Contact Angle Hysteresis



3- DAY IMPACT COURSE
THE CHEMISTRY, PHYSICS & MECHANICS OF ADHESION SCIENCE

May 11-13, 2016
Courtyard by Marriott, Stewart-Newburgh
New York

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

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)

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.

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

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