

# **MATERIALS SCIENCE AND TECHNOLOGY NEWSLETTER**

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## **SURFACE SCIENCE , ADHESION AND 100 AT 65**

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## EDITORIAL COMMENTS

In this issue of the newsletter, in addition to the usual announcements and technical discussion of surface science topics, we also celebrate the 65<sup>th</sup> birthday of the MST CONFERENCES director Dr. Kash Mittal and his 100<sup>th</sup> edited volume. Thus the slightly cryptic 100 at 65 in the subject line. Kash's herculean accomplishment was also celebrated in great detail at the 240<sup>th</sup> meeting of the American Chemical Society held in Boston Massachusetts on August 22-26, 2010. In all 71 papers were presented in 9 different sessions covering a wide range of topics ranging from "Interfaces and Adhesion" to "Dental and Medical Adhesion". The presenters hailed from all over the globe and included the majority of Kash's close friends and colleagues with whom he has been interacting over the last 35 years starting in 1975. Curiously enough his first volume also dealt with an American Chemical Society meeting on "Adsorption at Interfaces"<sup>1</sup> held in Los Angeles in April 1974 in honor of Kash's thesis advisor Dr. Robert D. Vold. Full details of the Boston meeting are available online at the ACS web page [www.acs.org/boston2010](http://www.acs.org/boston2010).

This issue also announces the inauguration of a three day short course on the "Chemistry, Physics and Mechanics of Adhesion Science" to be given December 6-8, 2010 by Dr. Mittal and myself. This course offers an overview of adhesion science covering much of the material presented at the Boston meeting mentioned above but encapsulated in a condensed format so as to be readily assimilated by technical professionals from industry, research institutes and academia with a need to understand both the practical/applied and theoretical aspects of this wide ranging field.

Finally, in keeping with the primary function of the newsletter we announce two symposia coming up in June 2011:

**EIGHTH INTERNATIONAL SYMPOSIUM ON POLYMER SURFACE MODIFICATION: RELEVANCE TO ADHESION;** To be held June 20-22, 2011, Danbury Connecticut, USA

**EIGHTH INTERNATIONAL SYMPOSIUM ON SILANES AND OTHER COUPLING AGENTS;** To be held June 22-24, 2011, Danbury Connecticut, USA

The first symposium in the Polymer Surface Modification series was held in 1993 in Las Vegas

Nevada under the auspices of Skill Dynamics, an IBM Company. Interest in this topic has expanded ever since that inaugural meeting leading up to widespread interest in the emerging atmospheric plasma technique which will be one of the major topics at the June meeting. Further commentary on this technique are covered in a technical note below.

The first symposium in the Silane series: "Silanes and Other Coupling Agents" was hosted in 1991 by the Dow Corning Corporation in honor of Dr. Edwin P. Plueddemann. Dr. Plueddemann was a near legendary pioneer in the field of silane adhesion promoters and also a good friend of Dr. Mittal who organized this symposium on his behalf. Ironically, Dr. Plueddemann passed away just weeks before the symposium was held and therefore was unable to enjoy the great honor bestowed on him at the meeting.

### 100 AT 65

#### The Early Days

At this point it is appropriate to give a short introduction as to how Kash and I became involved both as professional colleagues and close friends over the past 33 years. It all started in 1977 when we both joined the polymer group at the IBM E. Fishkill site in Hopewell Junction, NY. Though not that well known, the E. Fishkill facility was a huge semiconductor manufacturing facility employing some 10,000 + engineers, scientists and support staff all engaged in the manufacture of semiconductor chips and ceramic substrates which went into IBM's mainframe machines. The site manufactured raw silicon wafers which were processed ab initio into fully functional devices which were then encapsulated in ceramic packages ready for mounting on circuit boards. It would be no exaggeration to say that E. Fishkill was the full equivalent of Silicon Valley contained within a single company. The premier technology to come out of E. Fishkill was the multichip ceramic module which was essentially a 6 inch square ceramic laminate containing some 60 + levels of wiring and supporting 100 plus semiconductor chips. Needless to say this technology generated a vast number of materials and adhesion related problems which was where Kash and I came into the picture. The polymer group was formed due to the critical need to understand and properly implement these materials into E. Fishkill's device and substrate technologies. Any number of development efforts were stymied due to adhesion failure and material degradation problems which Kash and I were called on to address leading to lifelong careers in adhesion science and materials technology for both of us. However, whereas I was a creature of the

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<sup>1</sup> "Adsorption at Interfaces", ACS SYMPOSIUM SERIES NO. 8, American Chemical Society, Washington, D.C. 1975

laboratory involved in setting up experiments and performing detailed analyses of stress buildup in laminate structures, Kash was a man of the library keeping track on all the latest developments in adhesion and materials processing going on in universities, companies and research institutes world wide. A prime example of Kash's activities was the organization and documentation of a 3 day international symposium on polyimides and other high temperature polymers held November 1982 in Ellenville, New York under the auspices of the Society for Plastics Engineers. Some 69 technical papers were given at this symposium by 130 authors from all over the globe. Kash documented the entire meeting in a two volume work<sup>2</sup> which still stands as the first and most authoritative single publication on this topic.

It was certainly clear by 1982 that Kash had found his calling as an eminent chronicler of materials science in general and adhesion and surface science in particular. This is amply documented in Table I which gives a list of his first 100 books starting from 1975 to 2009. Two somewhat startling facts are clearly established from this table. One is the range of topics covered. Kash's books cover 4 separate and very different subjects including surfactants in solution, high temperature polymers, surface science and adhesion, and surface contamination and cleaning. The second point is that the 100 books were produced in a time span of 34 years giving an average productivity of close to 3 per year!

One could go on to recount the innumerable adventures Kash and I had struggling with the computer industries materials and surface science related problems but I think this is a good place to stop and leave the remaining history for future publications. Now it is simply fitting to close with a Photograph of Kash standing beside a portion of his life's work and a table cataloguing the entire output of 34 years of creative labor.



**Figure 1** Dr. Kash Mittal at age 65 standing next to a portion of his publishing output

### **TABLE I: CONDENSED LIST OF EDITED BOOKS BY DR. KASH MITTAL BY AGE 65.**

<b>NO</b>	<b>TITLE</b>	<b>PUBLISHER/DATE</b>
1	Adsorption at Interfaces	ACS Symposium Series No. 8, American Chemical Society, Washington, D.C., 1975.
2	Colloidal Dispersions and Micellar Behavior	ACS Symposium Series No. 9, American Chemical Society, Washington, D.C., 1975
3	Micellization, Solubilization, and Microemulsions, Vol. 1	Plenum Press, New York, 1977.
4	Micellization, Solubilization, and Microemulsions Vol. 2	Plenum Press, New York, 1977.
5	Adhesion Measurement of Thin Films, Thick Films and Bulk Coatings	American Society for Testing and Materials, Philadelphia, PA, 1978.
6	Solution Chemistry of Surfactants Vol. 1	Plenum Press, New York, 1979.
7	Solution Chemistry of Surfactants, Vol. 2	Plenum Press, New York, 1979.
8	Surface Contamination: Genesis, Detection, and Control, Vol. 1	Plenum Press, New York, 1979.
9	Surface Contamination: Genesis, Detection, and Control, Vol. 2	Plenum Press, New York, 1979.
10	Solution Behavior of Surfactants: Theoretical and Applied Aspects, Vol. 1	Plenum Press, New York, 1982.

<sup>2</sup> "Polyimides: Synthesis, Characterization and Applications", Vols. 1 and 2, Ed. K. L. Mittal (Plenum Press, NY, 1984).

11	Solution Behavior of Surfactants: Theoretical and Applied Aspects, Vol. 2	Plenum Press, New York, 1982.	29	Surfactants in Solution (New Delhi Proceedings), Vol. 7	Plenum Press, New York, 1989.
12	Physicochemical Aspects of Polymer Surfaces, Vol. 1	Plenum Press, New York, 1983.	30	Surfactants in Solution (New Delhi Proceedings), Vol. 8	Plenum Press, New York, 1989.
13	Physicochemical Aspects of Polymer Surfaces, Vol. 2,	Plenum Press, New York, 1983.	31	Surfactants in Solution (New Delhi Proceedings) Vol. 9	Plenum Press, New York, 1989.
14	Adhesion Aspects of Polymeric Coatings	Plenum Press, New York, 1983.	32	Surfactants in Solution (New Delhi Proceedings) Vol. 10	Plenum Press, New York, 1989.
15	Surfactants in Solution (Lund Proceedings) Vol. 1	Plenum Press, New York, 1984.	33	Particles on Surfaces 2: Detection, Adhesion and Removal	Plenum Press, New York, 1989.
16	Surfactants in Solution (Lund Proceedings) Vol. 2	Plenum Press, New York, 1984.	34	Polymers in Information Storage Technology	Plenum Press, New York, 1989.
17	Surfactants in Solution (Lund Proceedings) Vol. 3	Plenum Press, New York, 1984.	35	Metallized Plastics 1: Fundamental and Applied Aspects	Plenum Press, New York, 1989.
18	Adhesive Joints: Formation, Characteristics and Testing	Plenum Press, New York, 1984.	36	Particles in Gases and Liquids 2: Detection, Characterization and Control	Plenum Press, New York, 1990.
19	Polyimides: Synthesis, Characterization and Applications, Vol. 1	Plenum Press, New York, 1984.	37	Acid-Base Interactions: Relevance to Adhesion Science and Technology,	VSP, Utrecht, The Netherlands, 1991.
20	Polyimides: Synthesis, Characterization and Applications	Plenum Press, New York, 1984.	38	Particles on Surfaces 3: Detection, Adhesion and Removal	Plenum Press, New York, 1991.
21	Surfactants in Solution (Bordeaux Proceedings), Vol. 4	Plenum Press, New York, 1986.	39	Metallized Plastics 2: Fundamental and Applied Aspects	Plenum Press, New York, 1991.
22	Surfactants in Solution (Bordeaux Proceedings), Vol. 5	Plenum Press, New York, 1986.	40	Surfactants in Solution (Gainesville 1990 Proceedings), Vol. 11	Plenum Press, New York, 1991.
23	Surfactants in Solution (Bordeaux Proceedings), Vol. 6	Plenum Press, New York, 1986.	41	Silanes and Other Coupling Agents	VSP, Utrecht, The Netherlands, 1992.
24	Treatise on Clean Surface Technology, Vol. 1	Plenum Press, New York, 1987.	42	Metallized Plastics 3: Fundamental and Applied Aspects,	Plenum Press, New York, 1992.
25	Surface and Colloid Science in Computer Technology	Plenum Press, New York, 1987.	43	Particles in Gases and Liquids 3: Detection, Characterization and Control	Plenum Press, New York, 1993.
26	Opportunities and Research Needs in Adhesion Science and Technology	Proceedings of The NSF Workshop on Adhesion Science and Technology held in Lake Tahoe, CA, October 14-16, 1987, published in 1988.	44	Contact Angle, Wettability and Adhesion	VSP, Utrecht, The Netherlands, 1993.
27	Particles on Surfaces 1: Detection, Adhesion and Removal,	Plenum Press, New York, 1988.	45	Handbook of Adhesive Technology	Marcel Dekker, New York, 1994.
28	Particles in Gases and Liquids 1: Detection, Characterization and Control	Plenum Press, New York, 1989.	46	Plasma Surface Modification of Polymers: Relevance to Adhesion	VSP, Utrecht, The Netherlands, 1994.
			47	Particles on Surfaces: Detection, Adhesion and Removal	Marcel Dekker, New York, 1995.

48	Fundamentals of Adhesion and Interfaces	VSP, Utrecht, The Netherlands, 1995.	66	Polyimides and Other High Temperature Polymers: Synthesis, Characterization and Applications, Vol. 1	VSP, Utrecht, The Netherlands, 2001.
49	Adhesion Measurement of Films and Coatings	VSP, Utrecht, The Netherlands, 1995.	67	Metallized Plastics 7: Fundamental and Applied Aspects	VSP, Utrecht, The Netherlands, 2001.
50	Polymer Surface Modification: Relevance to Adhesion	VSP, Utrecht, The Netherlands, 1996.	68	Adhesive Joints: Formation, Characteristics and Testing, Vol. 2	VSP, Utrecht, The Netherlands, 2002.
51	Polyimides: Fundamentals and Applications	Marcel Dekker, New York, 1996.	69	Particles on Surfaces 7: Detection, Adhesion and Removal	VSP, Utrecht, The Netherlands, 2002.
52	Surfactants in Solution (Caracas 1994 Proceedings)	Marcel Dekker, New York, 1996.	70	Contact Angle, Wettability and Adhesion, Vol. 2	VSP, Utrecht, The Netherlands, 2002.
53	Polymer Surfaces and Interfaces: Characterization Modification, and Application	VSP, Utrecht, The Netherlands, 1997.	71	Adsorption and Aggregation of Surfactants in Solution, (Gainesville 2000 Proceedings)	Marcel Dekker, New York, 2003.
54	Metallized Plastics: Fundamentals and Applications	Marcel Dekker, New York, 1998.	72	Adhesion Aspects of Polymeric Coatings, Vol. 2	VSP, Utrecht, The Netherlands, 2003.
55	Metallized Plastics 5&6: Fundamental and Applied Aspects,	VSP, Utrecht, The Netherlands, 1998.	73	Handbook of Adhesive Technology, 2nd Edition	Marcel Dekker, New York, 2003.
56	Adhesion Promotion Techniques : Technological Applications	Marcel Dekker, New York, 1999.	74	Surface Contamination and Cleaning, Vol. 1	VSP, Utrecht, The Netherlands, 2003.
57	Handbook of Microemulsion Science and Technology	Marcel Dekker, New York, 1999.	75	Polyimides and Other High Temperature Polymers: Synthesis, Characterization and Applications, Vol. 2	VSP, Utrecht, The Netherlands, 2003.
58	Particles on Surfaces 5&6: Detection, Adhesion and Removal	VSP, Utrecht, The Netherlands, 1999.	76	Particles on Surfaces 8: Detection, Adhesion and Removal	VSP, Utrecht, The Netherlands, 2003.
59	Emulsions, Foams and Thin Films	Marcel Dekker, New York, 2000.	77	Contact Angle, Wettability and Adhesion, Vol. 3	VSP, Utrecht, The Netherlands, 2003.
60	Apparent and Microscopic Contact Angles	VSP, Utrecht, The Netherlands, 2000.	78	Polymer Surface Modification: Relevance to Adhesion Vol. 3	VSP, Utrecht, The Netherlands, 2004
61	Acid-Base Interactions: Relevance to Adhesion Science and Technology, Vol. 2	VSP, Utrecht, The Netherlands, 2000.	79	Silanes and Other Coupling Agents, Vol. 3	VSP, Utrecht, The Netherlands, 2004
62	Silanes and Other Coupling Agents, Vol. 2	VSP, Utrecht, The Netherlands, 2000.	80	Polyimides and Other High Temperature Polymers: Synthesis, Characterization, and Applications Vol. 3	VSP/Brill, Leiden, The Netherlands, 2005.
63	Polymer Surface Modification: Relevance to Adhesion, Vol. 2	VSP, Utrecht, The Netherlands, 2000.	81	Adhesion Aspects of Thin Films, Vol. 2	VSP/Brill, Leiden, The Netherlands, 2005.
64	Adhesion Measurement of Films and Coatings, Vol. 2	VSP, Utrecht, The Netherlands, 2001.	82	Atomic Force Microscopy in Adhesion Studies	VSP/Brill, Leiden, The Netherlands, 2005.
65	Adhesion Aspects of Thin Films, Vol. 1	VSP, Utrecht, The Netherlands, 2001.	83	Contact Angle, Wettability and Adhesion, Vol. 4	VSP/Brill, Leiden, The Netherlands, 2006.

84	Particles on Surfaces 9: Detection, Adhesion, and Removal	VSP/Brill, Leiden, The Netherlands, 2006.
85	Polymer Surface Modification: Relevance to Adhesion, Vol. 4	VSP/Brill, Leiden, The Netherlands, 2007
86	Silanes and Other Coupling Agents, Vol. 4	VSP/Brill, Leiden, The Netherlands, 2007
87	Adhesion Aspects of Thin Films, Vol. 3	VSP/Brill, Leiden, The Netherlands, 2007
88	Polyimides and Other High Temperature Polymers: Synthesis, Characterization and Applications, Vol. 4	VSP/Brill, Leiden, The Netherlands, 2007
89	Developments in Surface Contamination and Cleaning: Fundamentals and Applied Aspects	William Andrew Publishing, Norwich, NY, 2008.
90	Surfactants in Tribology	CRC Press, Boca Raton, FL, 2008.
91	Contact Angle, Wettability and Adhesion, Vol. 5	VSP/Brill, Leiden, The Netherlands, 2008.
92	Electrically Conductive Adhesives	VSP/Brill, Leiden, The Netherlands, 2008.
93	Polymer Surface Modification: Relevance to Adhesion, Vol. 5	VSP/Brill, Leiden, The Netherlands, 2009.
94	Silanes and Other Coupling Agents, Vol. 5	VSP/Brill, Leiden, The Netherlands, 2009.
95	Polyimides and Other High Temperature Polymers: Synthesis, Characterization and Applications, Vol. 5	VSP/Brill, Leiden, The Netherlands, 2009.
96	Superhydrophobic Surfaces	VSP/Brill, Leiden, The Netherlands, 2009.
97	Contact Angle, Wettability and Adhesion, Vol. 6	VSP/Brill, Leiden, The Netherlands, 2009.
98	Adhesion Aspects in Dentistry	VSP/Brill, Leiden, The Netherlands, 2009.
99	Handbook of Sealant Technology	CRC Press, Boca Raton, FL, 2009.
100	Developments in Surface Contamination and Cleaning: Fundamentals and Applied Aspects, Vol. 2	Elsevier, 2009.

the newsletter will be devoted to the new and innovative Atmospheric Plasma Treatment technology. When this newsletter was inaugurated in 1999 the main atmospheric surface treatments were the corona and flame methods. Both of these early technologies were related to the plasma method in that they created ionic species which interacted with the surface undergoing treatment to alter the surface chemistry in various ways. However, the true plasma methods were carried out under partial vacuum where a vapor species was activated by either a radio-frequency (RF) or microwave (MW) electromagnetic field and then allowed to interact with the surface being treated. The fact that the plasma had to be excited under vacuum basically limited the process to batch mode on relatively small surfaces.

The corona and flame methods demonstrated that at least in principle an active plasma can exist at atmospheric pressure. However, it was not until the development of carefully fabricated nozzles that plasma fields similar to those created by the vacuum methods could be generated at atmospheric pressure. Papers dealing with the Atmospheric Plasma method did not appear in any of the Polymer Surface Modification symposia until the fourth symposium in 2003 when 3 papers were presented. The technique rapidly gained attention and by the seventh symposium in 2009 six papers were presented. Currently the atmospheric plasma technique is approaching full maturity with industrial scale setups in operation modifying the surface properties of polymer sheets and auto body parts.

As an example of the amazing progress being made in the atmospheric plasma method, figure 2 shows an example of the technique being applied to treat large auto body parts. This figure shows an example of the atmospheric pressure method being applied to an automobile fender using the Openair<sup>®</sup> technology as developed by the Plasmatreat company.<sup>3</sup> In order to obtain durable and load-bearing adhesive joints between plastics or metals it is first necessary to create the right conditions. In automotive engineering, the Openair<sup>®</sup> atmospheric-pressure plasma technology developed by Plasmatreat is used globally in many different applications for the pretreatment of

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<sup>3</sup> Readers interested in further details can contact the company at either of the following addresses: **USA:** Plasmatreat US LP, 2541 Technology Drive, Suite 407, Elgin, IL 60124 Phone: +1 847 783-0622; info@plasmatreat.com; www.plasmatreat.com; **CANADA:** 2810-1 Argentia Road, Mississauga, ON, CANADA L5N 8L2, Phone: +1 905 816-2350

## ADVANCES IN SURFACE PLASMA TREATMENT: THE ATMOSPHERIC PLASMA METHOD

In keeping with the upcoming eighth event in the POLYMER SURFACE MODIFICATION symposium series to be held this coming June in Danbury Connecticut, the technical editorial for this issue of

material surfaces. Whether applied to windscreens or instrument panels, headlights, seals for electronic components, EPDM profiles or whole body parts, this plasma technology ensures simple, reliable and solvent-free pretreatment prior to bonding, foaming and painting processes.

### Surface tension modification

Surface tension is the most important measure for evaluating the likelihood of adhesion of an adhesive layer or surface coating. In car body construction, for reasons of weight-saving, individual subassemblies are nowadays often no longer made of steel or aluminium sheet, but rather of high-performance plastics. The likelihood of a plastic adhesively bonding depends essentially on its surface tension which should be higher than that of the adhesive. This, however, is frequently not the case and so it becomes necessary to carry out a suitable surface pretreatment. Secure adhesion of a two-pack polyurethane adhesive to SMC or PPO is achieved by pretreatment with plasma. In this way surface tension values of more than 72 mN/m become possible on many non-polar plastics. A decisive advantage of the technique consists in the fact that not only incompatible substrates can now be made to adhere to one another, but also that water-based adhesives, and often UV-based adhesives as well, adhere to highly adhesion-resistant surfaces such as nonpolar plastics. Figure 3 illustrates graphically how the surface tension of a polymer coating is improved as a function of nozzle spacing and processing speed. Starting off at a value of roughly 30 mN/m and rising to 70 mN/m after treatment clearly illustrates the effectiveness of the atmospheric plasma treatment process.

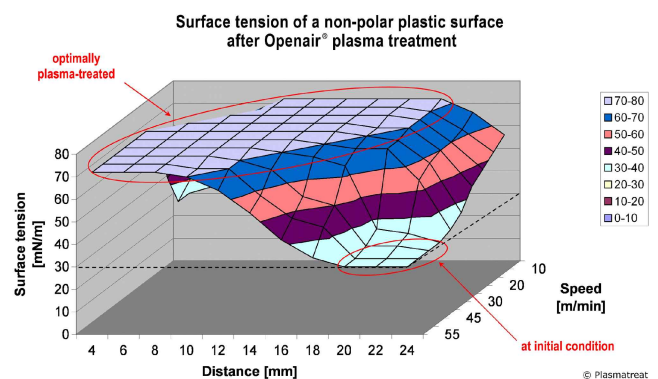
### Using plasma treatment instead of primer

To Michael Stege, former specialist consultant for adhesives and sealants in process engineering at Volkswagen AG, Germany the reasons for using the new plasma technology were obvious. For the "Golf IV" Volkswagen an additional bonded door seal was developed for improving driving comfort by damping wind noise. This self-adhesive seal made of EPDM rubber was to be additionally fixed at the ends by means of adhesion points composed of a MS polymer adhesive. To improve the adhesion of the adhesive this rubber has to be pretreated. An absolute requirement was that this should be done by means of a solvent-free and hence environmentally friendly system. After comparing different corona and plasma systems, with particular value being attached to great process latitude, VW chose the rotating plasma jets of the Openair® system. Stege reports that the process



**Figure 2** Among the large number of pretreatment methods in industrial processes the use of environmentally friendly and cost-saving methods is steadily growing in importance in automotive engineering. The atmospheric plasma technology Openair® not only provides surfaces with ultrafine cleaning and great improvement of adhesion, but is also often the only way of producing secure joints.

eliminates several working steps when the seals are pretreated with plasma directly before application of the adhesive. As a result of this highly effective pretreatment not only the otherwise essential precleaning of the bonding surfaces but also the application of solvent-free primer just before bonding is rendered unnecessary. Furthermore, the Plasmatrete process had the great advantage of reproducibility when the system parameters were precisely monitored. The positive consequence for Volkswagen was that the pot life of a primer no



**Figure 3** The graph shows a plastic surface that was pretreated with plasma as a function of the spacing and speed of the nozzle head. After treatment the surface becomes polar and its surface tension rises from 30 to > 72 mN/m with great processing latitude.

longer needed to be taken into account, There were no longer any emissions of solvent nor any logistical concerns relating to the supply of primer. Since then atmospheric plasma has been nearly universally adopted on Volkswagen production lines.

## UPCOMING MST SYMPOSIA AND SHORT COURSES

### SHORT COURSE ON CHEMISTRY, PHYSICS AND MECHANICS OF ADHESION SCIENCE

**To be held December 6-8, 2010 in Orlando, Florida**

MST CONFERENCES is happy to announce a new course offering which for the first time will be given jointly by the two principals Drs. Mittal and Lacombe. Course participants will have the benefit of learning from their over 40 years of collective experience in the field of surface science and adhesion.

Adhesion plays an important role in many technologies and industries, viz., 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 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. Also the durability of the bond (on exposure to process chemicals, moisture, corrosives, etc.) is of grave concern and importance. This course presents an overview of the chemistry, physics and mechanics of adhesion in regard to understanding fundamental adhesion mechanisms, 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 and 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 complete set of lecture notes plus copy of handbook and study supplement: **ADHESION MEASUREMENT METHODS: THEORY AND PRACTICE, (CRC PRESS, 2006)**

#### Topics to Be Covered

- ▶ Surface Contamination and Cleaning
- ▶ Theories or Mechanisms of Adhesion
- ▶ Contact Angle, Wettability and Adhesion
- ▶ Investigation of Interfacial Interactions
- ▶ Surface Modification Techniques and Other Ways to Improve Adhesion of Organic Coatings
- ▶ Silanes and Other Adhesion Promoters
- ▶ Adhesion Aspects of Thin Films
- ▶ Adhesion Measurement of Films and Coatings
- ▶ Basics of adhesion measurement
- ▶ Role of residual stress and material mechanical properties in adhesion
- ▶ Problem of setting adhesion requirements for coating applications
- ▶ Adhesion measurement at atomic and molecular level (fundamental adhesion)
- ▶ Applications

#### How You Will Benefit From This Course

- ▶ Understand advantages and disadvantages of a range of adhesion measurement techniques.
- ▶ Select the right surface cleaning technique and 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
- ▶ Learn how to select best measurement technique for a given application.

#### Instructors and Contact Information

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**Web site for detailed information and registration:**

[www.mstconf.com/AdhesionCourse.htm](http://www.mstconf.com/AdhesionCourse.htm)

## CALL FOR PAPERS

### **EIGHTH INTERNATIONAL SYMPOSIUM ON POLYMER SURFACE MODIFICATION: RELEVANCE TO ADHESION**

**To be held June 20-22, 2011; Danbury,  
Connecticut, USA**

This symposium continues the tradition set by the first in the series entitled: "Polymer Surface Modification: Relevance to Adhesion" which was held in Las Vegas, NV, 1993. As with its predecessors, this symposium will be concerned with the technological areas where surface modification is a key technology which allows for the processing and manufacture of products which would otherwise be unobtainable.

Proper adhesion characteristics are vital to the success of any practical implementation of polymer materials. Though polymers are generally not very adhesionable, careful surface modification can result in greatly improved adhesion without altering bulk properties.

This symposium is organized to bring together scientists, technologists and engineers interested in all aspects of polymer surface modification, to review and assess the current state of knowledge, to provide a forum for exchange and cross-fertilization of ideas, and to define problem areas which need intensified efforts.

The invited speakers have been selected so as to represent widely differing disciplines and interests, and they hail from academic, governmental and industrial research laboratories. This meeting is planned to be a truly international event with participation from research groups from academia and industry worldwide.

## **AMONG TOPICS TO BE COVERED ARE:**

### **SURFACE MODIFICATION TECHNIQUES**

- ▶ Plasma, ultraviolet, corona, laser, ion beam, atmospheric plasma, flame ...
- ▶ Mechanical roughening
- ▶ Monolayer deposition, grafting and wet chemical

### **POLYMER SURFACE MODIFICATION FOR ADHESION IMPROVEMENT OF**

- ▶ Metal layers (metallized plastics)
- ▶ Organic coatings, inks, composites, adhesive joints, microorganisms

### **APPLICATIONS AND SURFACE CHARACTERIZATION**

- ▶ Packaging, composites
- ▶ Biomedical applications
  - i. implants
  - ii. sterilization
  - iii. improved cell adhesion
- ▶ Microelectronics, aerospace, marine...
- ▶ All methods for characterization of surface chemistry and morphology, (ESCA, SIMS, AFM ...)

## CALL FOR PAPERS

### **EIGHTH INTERNATIONAL SYMPOSIUM ON SILANES AND OTHER COUPLING AGENTS**

**To be held June 22-24, 2011, Danbury,  
Connecticut, USA**

This symposium continues the tradition set by the first symposium in this series: "Silanes and Other Coupling Agents" which was hosted in 1991 by the Dow Corning Corporation in honor of Dr. Edwin P. Plueddemann. As with its predecessors, this symposium will be concerned with the technological areas where the use of surface primers such as silanes is critical to the success of many technologies.

Historically the silanes have been used as coupling agents for thin films in the microelectronics industry and in glass fiber composites where the use of silanes has been an enabling factor in the success of many manufactured products. Quite surprisingly, silanes have also found a role in biotechnology as specific coupling agents for bonding polynucleotides to the so-called "gene chips" and also in cosmetic applications.

This symposium is organized to bring together scientists, technologists and engineers interested in all aspects of coupling agent technology, to review and assess the current state of knowledge, to provide a forum for exchange and cross-fertilization of ideas and to define problem areas which need intensified efforts. The invited speakers have been selected so as to represent widely differing disciplines and interests, and they hail from academic, governmental and industrial research laboratories. This meeting is planned to be a truly international event with participation from research groups from academia and industry worldwide.

#### **AMONG TOPICS TO BE COVERED ARE:**

- ▶ Mechanisms of silanes action.
- ▶ Role of silanes in adhesion of coatings, composites and adhesive joints.
- ▶ Deposition techniques:
  - solution
  - plasma
  - vapor
  - electrochemical
- ▶ Non-silane adhesion promoters.
- ▶ Plasma polymerized coatings as adhesion promoters.
- ▶ Relevance of silanes in durability of bonds.
- ▶ Applications:
  - coatings, corrosion inhibitors
  - adhesive joints, composites
  - biological applications: dental, gene chip
  - cosmetics
  
- ▶ Silane surface characterization.
  - Standard: contact angle, FTIR,...
  - Advanced: neutron scattering, ...

These symposia are being organized by MST Conferences under the direction of Dr. K. L. Mittal, Editor-in-Chief, Journal of Adhesion Science and Technology (JAST). 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 15, 2011** to the conference chairman by any of the following methods:

E-mail: [rhl@mstconf.com](mailto:rhl@mstconf.com)

FAX: 212-656-1016

Contact by phone: 845-897-1654; 845-227-7026

Regular mail:

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

For the surface modification symposium:  
<http://mstconf.com/surfmod8.htm>

For the silane symposium:  
<http://mstconf.com/silanes8.htm>