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FOCUSING ON CONTACT ANGLE, PARTICLE REMOVAL AND WOOD ENGINEERING

IN THIS ISSUE

EDITORIAL COMMENTS

It is our pleasure in this issue of the newsletter to announce two symposia in the continuing series on **CONTACT ANGLE, WETTABILITY AND ADHESION** and **PARTICLES ON SURFACES** to be held the week of July 14, 2008 at the University of Maine at Orono. In addition it is our special privilege to be holding these symposia in concert with Prof. Douglas Gardner of the Advanced Engineered Wood Composites Center at the University who is organizing **THE 4TH INTERNATIONAL CONFERENCE ON ADVANCED ENGINEERED WOOD AND HYBRID COMPOSITES** to be held the week before the CONTACT ANGLE symposium. Since wettability and adhesion are key concepts in the development of composites of all kinds the two conferences back to back nicely compliment each other. We in fact expect a significant amount of cross participation between the two symposia.

Apropos to the CONTACT ANGLE symposium, the editorial essay in this issue will explore the remarkable durability and longevity of the contact angle experiment. The concept was first proposed in 1804 by Thomas Young (Essay on the " Cohesion of Fluids, " Phil. Trans., 1805, p. 65) at a time when the term science barely existed in the dictionary and today, some 203 years later, is one of the hottest topics in science and technology as can easily be seen by a quick glance at the list of papers in the CONTACT ANGLE symposium printed at the end of this newsletter. In particular the reader should note the session on topics in **WOOD SCIENCE** in the CONTACT ANGLE symposium which clearly provides an example of the relevance of the CONTACT ANGLE concept to a matter of very current interest in applied technology. I know of no other subject in the applied sciences that has had such a robust history. As we will also be dealing with the problem of **PARTICLES ON SURFACES** it is also fitting that we point out that contact angle measurements can be used to detect particle contamination as will be expanded upon further in this issue's editorial essay.

Thus it all comes together at the University of Maine this Summer beginning the week of July 6th with the **WOOD AND HYBRID COMPOSITES** symposium and ending the week of July 14 with **PARTICLES ON SURFACES**. We invite all readers of the newsletter to join us at one or more of the above symposia and, if you have a little extra time, you should also try to enjoy the countryside and seashore of the state of Maine which has long been regarded as a Summer vacationland in the US. On the Maine Coast, you'll find elegant Country Inns and Bed and Breakfasts, luxury resorts, family motels, and fabulous full service campgrounds. Discover Maine Vacations that cater to every taste and budget. Those interested in the great variety of vacation activities can go the following website for further details: http://www.visitmaine.net/lodging.htm .

CONTACT ANGLE, A SURFACE SCIENCE CONCEPT FOR ALL SEASONS

As past readers of the MST Newsletter have long been aware, the common thread running through all of the MST CONFERENCES symposia is the concept of surfaces and their interactions with the surrounding ambient and other surfaces both solid and liquid. Though the amount of material at the surface of a typical solid object amounts to but an infinitesimal fraction of the bulk[1], the surface nonetheless dominates much of the objects interactions with the outside world. A significant part of the reason why contact angle measurements are so popular stems from the fact that the shape of a drop of liquid on a solid surface reflects quite sensitively the strength of the molecular interactions occurring between the drop and the surface. The quantitative assessment of this interaction turns out to be a rather subtle and complex proposition, but one can nonetheless get a qualitative idea as to the strength of the interaction by observing the angle the drop makes with the surface. A large angle causing the drop to bead up indicates a weak interaction and poor wettability, whereas a shallow angle reflects a strong interaction and thus good wetting. This simple rule allows one to draw a number of useful observations concerning the surface energetics of a given surface compared to the surface tension of the test liquid. However, trying to go further and infer quantitatively the surface free energy of the solid in question gets one into deep water very quickly. It is thus the question of how to interpret the contact angle behavior of a given material with respect to its known atomic and molecular structure and interactions that keeps the topic at the forefront of current theoretical and experimental research.

However, the difficult nature of interpreting contact angle behavior is not the only aspect of this topic that sustains such a large amount of activity in both industrial and academic research. The fact that surfaces are so important in a wide range of applied technologies is quite likely even more important in determining the interest in contact angle behavior, since contact angle measurements

[1] Take for instance a nearly spherical lump of matter 1 cm in radius, then assuming that the surface comprises the outer 1 nanometer shell, a simple calculation shows that the amount of material in this shell amounts to roughly one ten millionth of the total.

are by far the easiest and cheapest method of getting a first look at the energetics of a given surface. In this regard we would like to share with the reader a number of specific applications where surface behavior and contact angle measurements have come into play in a significant way. We are indebted to Carl Clegg of the ramé-hart instrument co., one of our colleagues and a participant in previous CONTACT ANGLE symposia, for sharing with us the following examples of how contact angle measurements have figured into a surprisingly wide diversity of applications. Much additional information on this topic can be found at Carl's website www.ramehart.com .

Contact Angle and the Electrical Power Industry

We start by having a look at what at first glance would seem to be a most unlikely corner of modern applied science and technology: the electric power industry. C. Roero[2] and others have shown how contact angle can be used to characterize the materials and various surface treatments used on high-voltage transmission lines. One of the problems to solve is understanding how to reduce "wet noise" caused after periods of precipitation. This hum is caused by the interaction of electric field (varying sinusoidally at 120Hz in the US) and the water droplets that remain on the lines and insulators. By exposing sessile drops to an electric field, researchers are able to better understand the efficacy of hydrophobic coatings and materials designed to reduce this nuisance and improve the efficiency of transmission. Understanding the surface treatments can help material scientists develop or improve products that will eject the water or otherwise minimize the wet noise and also the accompanying energy loss.

The problem of "wet noise" was first studied in the late 1960s by E. R. Taylor, et al. More recent studies employing contact angle measurements take the earlier work of answering the "what" to newer levels of understanding by answering the "why" and "how to fix" this condition. The early studies showed how water droplets in an electrical field would deform and how strong field strengths could result in a loss of charge and the emission of undesirable sound. More recent work shows how a hydrophilic surface, for instance, produces smaller droplets with low contact angles. These types of drops deform less and thus lower the level of noise and associated energy loss during the half hour drying period which follows rainfall.

The other variable studied is the speed of evaporation and how it might be accelerated by using specific materials or surface treatments. It was determined that the factors that affect overall noise and speed of evaporation are: the drop size, the surface condition, and the relative field strength. As the field strength is increased, the drops become more pointed but flatter at the base resulting in a decrease in contact angle. Roero showed also that for 50µL to 100µL-sized drops, as the contact angle decreased from 90˚ to about 10˚, the instability voltage (aka, voltage collapse) roughly doubled. For smaller drops the increase in voltage collapse was closer to 200%.

The result of these studies is a number of new and innovative materials. One such material[3] developed and marketed by Tyco Electronics is an insulation product made from a polymeric material (developed by Raychem) with an additive of flourine-substituted compounds which results in a material with greatly higher hydrophobicity. Another material developed by GE[4] consists of a silicone polymer and an inorganic hydrophobicity imparting particulate (HIP). These particulates can be found in layered silicate minerals such as kaolinite, halloysite, montmorillonite, vermiculite, and others, as well as three-dimensional silicates such as feldspars, zeolites and ultramarines. In short, extensive underlying research -- including contact angle measurements of sessile drops -- has allowed and continues to allow researchers and scientist to characterize materials and surface treatments used in the transmission of high-voltage current. Such research has led to numerous innovative products and materials that both increase the efficiency of transmission systems by reducing voltage collapse and also reducing undesirable noise thus increasing the quality of life for those that live near power transmission lines.

The Power of Ice Over the Power Industry

The above example clearly illustrates the usefulness of surface science as aided by contact angle measurements in the power industry, but our next example demonstrates that the issue can extend far beyond usefulness. It turns out that water can cause more that voltage losses and undesirable noise in power lines as was dramatically illustrated by the ice storm of 1998 which hit Southeastern Canada and the Northeastern US.

Ice storms are often winter's worst hazard. More slippery than snow, freezing rain or glaze is tough

[2] "Contact Angle Measurements of Sessile Drops Deformed by a DC Electric Field", Contact Angle, Wettability and Adhesion, Vol. 4, Ed. K. L. Mittal, (VSP, Leiden, 2006) pp. 165-176.

[3] US Patents 6,653,571 and 4,189,392

[4] US Patent 6,582,825

and tenacious, clinging to every object it touches. A little can be dangerous, a lot can be catastrophic.

Ice storms are a major hazard in all parts of Canada except the North, but are especially common from Ontario to Newfoundland. The severity of ice storms depends largely on the accumulation of ice, the duration of the event, and the location and extent of the area affected. Based on these criteria, Ice Storm'98 was the worst ever to hit Canada in recent memory. From January 5-10, 1998 the total water equivalent of precipitation, comprising mostly freezing rain and ice pellets and a bit of snow, exceeded 85 mm in Ottawa, 73 mm in Kingston, 108 in Cornwall and 100 mm in Montreal. Previous major ice storms in the region, notably December 1986 in Ottawa and February 1961 in Montreal, deposited between 30 and 40 mm of ice - about half the thickness of the 1998 storm event!

The extent of the area affected by the ice was enormous. At the peak of the storm, the area of freezing precipitation extended from Muskoka and Kitchener in Ontario through eastern Ontario, western Quebec and the Eastern Townships to the Fundy coasts of New Brunswick and Nova Scotia. In the United States, icing coated Northern New York and parts of New England. The effect of this storm on the power industry is dramatically illustrated in figure (1).

The following is a list of the direct consequences on the Canadian population:

- At least 25 deaths, many from hypothermia.
- About 900,000 households without power in Quebec; 100,000 in Ontario.
- About 100,000 people took refuge in shelters
- Residents were urged to boil water for 24 to 48 hours.
- Airlines and railwayS discouraged travel into the area
- 14,000 troops (including 2,300 reservists) deployed to help with clean up, evacuation and security.
- Millions of residents forced into mobile living, visiting family to shower and share a meal or moving in temporarily with a friend or into a shelter.

Each of the above listed consequences of the storm was either directly or indirectly due to the fact that

Figure 1 Dramatic evidence of the power of ice on the power industry. One hundred foot tall towers carrying power lines are seen here bent like blades of grass in the aftermath of the 1998 ice storm that hit southeastern Canada and the Northeastern US.

the storm had knocked out nearly all of the electrical power serving southeastern Canada. Prolonged freezing rain brought down millions of trees, 120,000 km of power lines and telephone cables, 130 major transmission towers each worth $100,000 and about 30,000 wooden utility poles costing $3000 each. The damage in eastern Ontario and southern Quebec was so severe that major rebuilding, not repairing, of the electrical grid had to be undertaken. What it took human beings a half century to construct took nature a matter of hours to knock down.

As a result of the havoc wreaked by the storm, the Canadian government has now apparently developed an interest in ways to prevent ice accumulation on power lines, and, you guessed it, using contact angle measurements to unveil the underlying surface interactions between ice and power lines is one of the approaches being taken. Evidence of this can easily be seen in the preliminary program for the CONTACT ANGLE symposium in a paper in the SUPERHYDROPHOBIC BEHAVIOR session by Dr. D. Sarkar who is Chair on Atmospheric Icing Engineering of Power Networks at the University of Quebec. His paper entitled "Superhydrophobic Binary Structures: Preparation, characterization and Ice Adhesion" should be of great interest to those in the electrical power industry that are involved with this problem.

Contact Angle and Surface Particle Contamination

If the use of contact angle measurements to solve problems in the electrical power industry is not surprising enough one has to be positively amazed that contact angle measurements have also made intrusions into the wholly unrelated discipline of determining surface cleanliness. Perhaps not so amazed, however, if we remember that contamination is basically A surface interaction phenomenon and that contact angle measurements are very sensitive to these interactions.

Contact Angle has long been known as a superior direct method for quantifying surface cleanliness. Indirect methods include Gravimetric Analysis, Ultraviolet Spectroscopy, and Optical Particle Counter. These methods typically require environmentally hostile solvents and are ideal for small parts only due to the large amounts of solvents that would be required for larger samples. While newer indirect methods such as total organic analysis are more environmentally friendly, these technologies are still being developed and have yet to gain widespread acceptance.

Direct methods are more frequently used for measuring cleanliness and include the following:

1. **Magnified Visual Examination** - The part is inspected under a microscope for contamination. This method is adequate only when gross contamination needs to be removed. The method is low cost but does require personnel who are trained and detail-oriented.

2. **Black Light Test** - This method requires a dark room, black light, i.e. visible ultraviolet, and an inspector. It works on the principle that contaminants will fluoresce under black light. This method requires a special room and does not work on parts which themselves fluoresce. Like the magnified inspection method, it is valuable only for gross contamination inspection and works well only on small parts.

3. **Water Flow Test** - This method requires that a stream of water be flowed over the part. If the water sheets evenly, thus indicating high wettability, the part is considered relatively free of contaminates. Contrariwise, if the water beads up or channels, this would indicate the presence of contaminants and the part is rejected for further cleaning. This method can be ineffective if there are surfactants or other contaminants which could promote sheeting and thus indicate a false negative. Additionally, this method does not work on parts that are so small that water cannot be flowed across them.

4. **Gravimetric Method** - This method requires the part to be weighed before being contaminated and then after contamination. After cleaning, the part is dried and weighed. The difference between the first and second weights represents the amount of residual contamination. This method requires an extremely accurate scale and is of value only for gross analysis.

5. **Optically Stimulated Electron Emission (OSEE)** - With this test, ultraviolet light of a fixed wavelength is shined on the surface in question. The light stimulates the emission of electrons from the test surface which, in turn, are measured as current. Any contamination will lower the flow of electrons and thus the current measured. This method requires a calibration standard for each part and does not work with contaminants which do not fluoresce.

6. **Direct Oxidation Carbon Coulometry (DOCC)** - This method employs a combustion chamber set at a high fixed temperature (above 700˚ C). Oxygen is introduced to combust carbon-based contaminants into carbon dioxide - which in turn is then measured by CO_2 coulometric detection. The method can be very sensitive but also very expensive. It works only on small parts and can cause damage to parts and plating that are sensitive to high temperatures. The method can only detect carbon-based contaminants.

7. **X-Ray Photoelectron Spectroscopy (XPS)** - This method fires x-rays on a surface under a vacuum. The electrons which are released are quantified by element type. This process is very slow and requires sophisticated costly equipment making it impractical for most applications.

Having reviewed the most popular methods for detecting surface contamination, we now have a look at what the contact angle method has to offer. This method works on the principle that most contaminants will cause water droplets to bead up.

It requires a CA goniometer and a relatively clean work area. Based on the tool being used, this method is ideal for small parts as well as large parts. The test liquid (deionized water) must be pure and contaminant-free. After a water droplet is dispensed, the goniometer is used to measure the contact angle. A low angle (say 20˚) indicates high wettability and thus high cleanliness while a high angle, say 90˚ or more, indicates the presence of contaminants. There are some materials, such as PTFE, which exhibit high hydrophobicity even when fully clean. For these materials, the CA method may not be well-suited. For most metals and polymers and silica-based materials, however, CA testing is fast, efficient, and highly accurate.

In the manufacturing of semiconductors, each subsequent layer of film stack on a wafer must be super clean in order for successive layers to adhere properly. Likewise, the top surfaces of wire bonding lands and passivating films on semiconductor dies must be ultra clean in order to provide good current flow and reliable encapsulation. On some surfaces, such as silicon dioxide on semiconductor wafers, the surface can be made so clean that the resulting contact angle is 1˚.

Thus the contact angle measurement method again comes to the fore to provide an analytical tool for investigating a surface sensitive phenomenon. Readers interested in pursuing this problem further, including the availability of the latest measurement equipment are encouraged to contact our colleague Carl Clegg at rame-hart for full details: (carl@ramehart.com).

All that Glitters may not be Diamond: Contact Angle Measurements as a Tool of Gemology

Just when you think you have pretty well exhausted all the applications of the contact angle measurement method, yet another off beat example pops out of the woodwork. Again our colleague Carl Clegg has brought our attention the work of one Martin Haske, an MIT-trained engineer who worked on precision inertial and stellar inertial guidance systems used both in the Apollo and Fleet Ballistic Missile programs before becoming a professional gemologist. Mr. Haske developed the Adamas software used by gemologists to identify and grade gems and is also interested in using the contact angle method to qualify diamond gems.

The idea of measuring the contact angle of water on inorganic minerals as well as different diamond substitutes dates back at least 30 years. Some of the earliest work apparently goes back to studies done by Drs. K. Nassau and H. Schonhorn which was conducted at Bell Labs in Murray Hill, New Jersey, during the 1970's. In their study, they pointed out that diamond substitutes have a contact angle quite different from a genuine diamond, but that irradiation can greatly alter the contact angle by modifying a thin surface layer. One curious characteristic of a real diamond is that it is hydrophobic -- that is, not easily wetted with water. In the mines of South Africa, they use a primitive but effective separation technique wherein crushed rock is washed with water over a bed of grease. The diamonds will adhere to the grease while the other minerals will wash away.

There existed a need for a way to identify diamonds and distinguish genuine diamonds from look-alikes. The hardness test (using a tungsten carbide point) will scratch everything -- except a real diamond. The other tests included a reflectometer, refractometer, and specific gravity check. Each of these tests have there own limits. So it was proposed that a Contact Angle (CA) test be developed whereby a simple non-destructive measurement could be employed to assist in the identification of diamond and diamond look-alikes.

The test involved the preparation and measurement of the contact angle as detailed in the 6 steps as shown in figure (2). The cleaning step was found to be quite important as most of the errors could be traced back to contaminants or films of grease or soap. It was discovered, however, that in some cases gems (including diamonds) that had been irradiated exhibited lower contact angles -- which could lead to misidentification. In every case however, these samples -- when polished (to remove the effects of irradiation) and reexamined -- measured as expected. And so it was concluded

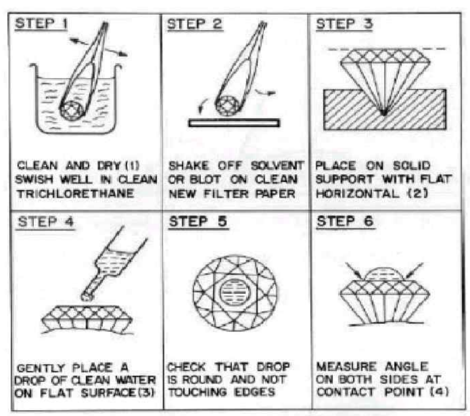

Figure 2 Six step method for determining the authenticity of a diamond gem using contact angle measurements.

that contact angle measurements can be used alongside other tests to assist gemologists and appraisers in the identification and authentication of diamonds and other gems. Again the reader who is interested in pursuing this topic further is encouraged to contact our colleague Carl Clegg mentioned above for details.

Testing Rare Coins for Authenticity or Truth in Surface Science

To complete our gallery of examples of applications of the contact angle technique we go on to something completely different: the testing of rare coins for authenticity. The story we are about to tell again comes form our colleague Carl Clegg who is apparently something of an amateur Numismatist (Websters: One who studies or collects coins, paper money, medals or tokens)

Between 1732 and 1772 Spain minted in the New World a series of coins commonly referred to by numismatists as columnarios. (They are also often referred to as Pillar Dollars, Pieces of Eight, and Spanish Milled Dollars.) The first coin listed in the popular Red Book of Coins is the columnario -- it is in fact the predecessor of the dollar and circulated on par with the dollar through the first half of the 18th century.

Prior to 1732 the majority of coins minted by Spain were crudely hammered coins referred to as cobs. A specimen dated 1669 is shown in figure (3). One of the primary problems with this coin was shaving. Unscrupulous merchants and individuals would shave a small piece of silver from the edge of each coin that came through their hands. A small shaving from many coins could ultimately amount to a valuable hoard. While this was illegal (and punishable by death) it was very difficult to catch the perpetrators as the uneven edges did not lend to detection and in most cases people did not have precise tools for measuring the weight of the coins they exchanged.

This lead to the columnario in 1732 which was a revolutionary concept at the time and a major change to the way coins were minted in the New World. Columnarios were minted using a screw press and then a secondary process added a milled edge. This new coin immediately stopped the practice of shaving as it was impossible to tamper with the edge of a columnario without damaging the milled floral edge.

Some 234 years after the last columnario was minted, these beautiful coins have become much sought afer by numismatists and are highly collectible. The majority of columnarios were minted in Mexico -- such as the 1749 specimen shown in figure (4). They were also minted in Guatemala, New Granada (present-day Columbia), Lima (Peru), Potosí (Bolivia), and Santiago (Chile). They are found in 8 reales denominations (as shown in figure (4)) as well as 4 reales, 2 reales, 1 real, and 1/2 real.

Currently one of the biggest distractions to the collector is the wide proliferation of fake columnarios. While most common date varieties in average grade will sell for under $200 USD, there are many varieties with uncommon dates and from non-Mexican mints that can command values in the thousands. Consequently, there is an underground market for fake columnarios. Unscrupulous individuals trade in these fake coins with many changing hands on eBay. It is currently estimated that between 20 and 30% of columnarios that are listed on eBay are not authentic. Many collectors don't find out their coins are fakes until years later when they try to resell them.

Some fakes are genuine coins that have been altered -- perhaps the date is changed or some other modification is made in order to change a $150 coin into $750 coin. In most cases alterations can be detected by inspection and by comparison. People have been making fake coins for centuries. Some are quite crude and most specimens from previous generations are quite easy to detect based on visual diagnostics. Currently, however, there is a new class of fakes entering the market which are expertly made using advanced technologies. These fakes are the subject of this study.

There are myriad diagnostics used in authenticating columnarios. These include the weight test: the coin is weighed and if it is outside of an acceptable range, points are deducted. This test alone is not definitive. Many authentic coins are sea salvaged and, after sitting in salt water for over 200 years, a

Figure 3 Example of an early Spanish coin which was hammered from silver known as a cob.

thin volume of surface has been eaten away and so these coins weigh in low. Likewise, there are many fakes that pass the weight test with flying colors. The diameter test is also easy to administer. Unlike today's coins, columnarios vary in diameter slightly due to the edge-milling process which was done by hand on an edge-milling machine. Points are deducted if the coin is outside of an acceptable range. The edge test is also useful but not definitive. Some authentic columnarios have a floral edge in one direction while others change direction midway. The number of floral patterns can range from the high 30's to the high 40's. There are also a variety of visual diagnostics that are used to detect fakes the results of which can add or remove points.

The point system helps raise red flags and detect expertly made fakes which otherwise might go undetected. One diagnostic that is especially difficult to test is the metallurgical evaluation. Prior to this study, we relied almost exclusively on what's known as the ring test. The coin is lightly spun on a table top and the ring sound is compared with the ring of columnarios that are known to be authentic. Fakes made from lead or other non-precious metals and alloys are quite easy to detect based on its ring and one often can flunk a coin even when it passes other tests.

Alas many of the new fakes will pass the ring test. This brings us to the need to better understand both the metal content and the surface qualities that result from the method of manufacture of the coin we're testing. If we were allowed to drill a small hole in the side of the coin and extract a few small pieces of metal, it would be easy to send this to a lab for diagnostic evaluation. Unfortunately, if the coin proves to be authentic, no one is interested in it if has a hole drilled in it -- or is otherwise altered by a destructive test. Hence this approach is unacceptable.

This brings us to the use of simple surface analysis. We began by assembling a collection of 20 columnarios which are known to be authentic based on all of the above diagnostics outlined above and which have come from reputable sources. First, we selected the field above the reverse (side with date on it) crown. It's the largest field anywhere on the coin. Next, we used acetone on a cotton swab to remove any residual surface contaminants on this field. Generally it's poor practice to "clean" coins as it can result in hairline scratches which lower the value of the coin. Consequently, we were very careful to roll, not swipe, the swab in order to reduce the chance scratching the coin.

We dispensed 5μL of deionized distilled water on the field and measured the contact angle. The range for this lot was between 35.1 and 59.1 degrees. This turned out to be a wider range than we anticipated but upon further study, we noticed that the more hydrophilic drops were on coins that had been previously cleaned (and thus had a polished surface) while the drops with larger contact angles were on coins that under magnification had porosity issues -- typically the result of sea damage but even non-sea salvage coins can develop environmentally-induced surface damage. These coins exhibited lower surface energy.

Figure 4 Example of a Spanish columnario designed with a milled edge to thwart the common practice of shaving.

With this comparison data collected and tabulated, we were now ready to test our questionable coins. We have two columnarios dated 1732 -- one of which is shown in figure (5). These coins appear to be sea salvage. Using the weight test, ring test, diameter test, and all the visual diagnostic tests we currently use (including comparing the test coin feature for feature with an authentic coin of the same variety), we conclude that these are authentic

Figure 5 Example of a highly authentic looking but fake columnario which passes all standard numismatic tests but fails contact angle examination.

coins. Still, there is something about these coins that shake your confidence and which leaves you questioning your opinion and method. I should point out that authenticating coins is both an art and a science. The empirical results (science-side) say it's okay while your gut (art-side) says it's not.

We tested both of these coins by our contact angle test using the exact same procedure we used on the sample of 20 known authentic coins. We were quite surprised when the contact angles on these two coins ranged between 77.1 and 78.3 -- significantly higher than the range of the good coins. This test alone flunked our coins and rendered them fake.

This has been a very important study as the coins in question are dated 1732 which is the rarest year of all -- aka as the key date. An authentic sea salvaged 1732 similar to the coin shown in figure (4) sold recently at auction (Ponterio Sale 138, Lot 170) for $7,000USD. If this pair of coins proved to be authentic they could collectively fetch in excess of $14,000USD at auction. As fakes they are virtually worthless.

Ultimately, despite all of the scientific tests, it's always worth getting an objective second opinion. These coins were taken to a noted numismatist, Daniel Sedwick, also a noted expert on Spanish American coinage, and Numismatist and Dealer Mike Dunigan of Texas. Both agreed that they were dubious. The latter suggested that the coins were manufactured using a method called spark-erosion. In this process an authentic coin is submerged in an electrolytic bath and then electrically charged. This charge causes sparks to jump across the shortest distance between the authentic coin and a die. The die is then used to manufacture a fake coin. The edges are milled using a secondary process and the result is a coin that passes all visual and empirical diagnostics...all but one that is, the contact angle test.

Summary

I think the above examples go a long way to explain the longevity, robustness and current popularity of the contact angle measurement method by simply demonstrating an astonishing range of practical applications. There is more to it though in terms of basic science also as the quantitative interpretation of contact angle data raises many questions relating to the fundamental interactions of matter at surfaces.

Thus one has, in what is nominally a rather simple experiment, a window into the atomic and molecular nature of the world at surfaces. Surfaces which affect all of us in subtle and many times unexpected ways. We therefore invite all readers of the newsletter to join us at the University of Maine this Summer for what promises to be a most informative and stimulating symposium on what has to be one of the oldest yet still very young discipline of contact angle measurement. In addition, I have it on good authority that our colleague Carl Clegg will be in attendance and those who wish to delve into any of the above topics in greater detail can converse directly with the master "contactangleist" himself.

PARTICLES EARTH BOUND AND PLANETARY

Normally at this point in the Newsletter it would be apropos to take up an appropriate book review dealing with one or more of the topics at hand. Though there are many volumes which could be reviewed, there is always the drawback that due to limitations of space many excellent papers get overlooked. To get around this problem, at least partially, we will instead focus here on individual papers that deal directly with the symposia topics that are going to be covered this Summer at the University of Maine. In particular we will look at the impact of particle contamination on space exploration and the more earthly topic of using contact angle measurements as a method of detecting surface contamination.

Dust on Mars or How to Keep a Very Remote Surface Clean

At first glance you would think that we have more than enough problems with particle contamination here on earth to be concerned much with the dust on the planet Mars. However, as you may be aware, the US Space Agency NASA currently has two robotic Rovers on Mars called SPIRIT and OPPORTUNITY that are there to explore as many aspects of Martian geology as possible and also perhaps ferret out possible evidence for the existence of organic life forms. Unfortunately, one well known feature of the Martian landscape is its dust storms which can range from small localized "Dust Devils" to colossal planet wide maelstroms. All this dust can collect on the Rover's solar panels thereby shutting down power to the unit and thus terminating a very expensive planetary mission. Fortunately this event has yet to occur but the possibility remains ever present and is thus a continuing concern of the Space Agency. All of this is covered in a most engaging paper by M. K. Mazumdar et. al.[5] presented at the 9th

[5] "Solar Panel Obscuration by Dust and Dust Mitigation in the Martian Atmosphere", M. K.

International Symposium on Particles on Surfaces held in Philadelphia, PA, June 2004.

Previous Mars missions established that the planet is covered with dust particles ranging in size from under one μm to 50 μm in diameter and these are blown around by recorded winds of 32 m/s or greater. (roughly 72 mph which rates as a category 1 hurricane here on Earth) As just noted the dust is blown around by either localized dust devils or large planet encircling storms which occur on average every 3 years. One of the consequences of all this dust is that it can dramatically affect the performance of the solar panes since as little as 1.5 mg/cm^2 can reduce the power output by more than 90%. Thus it becomes fairly critical to have some method of removing dust accumulation from the solar panels.

One of the major challenges, of course, in keeping the solar panes clean is that they are some 78 million kilometers distant, and even at the speed of light it takes roughly 4 and ½ minutes for any signal to reach the Rover vehicle. It is thus necessary to have some sort of automatic mechanism for dust removal which can be programmed to activate whenever the power output of the solar panels falls below some predetermined level. In this regard the authors propose a fairly nifty mechanism for dust removal which could have quite useful applications even here on earth for solar panels on the top of tall buildings which would be inconvenient not to say dangerous to clean manually. The basic idea involves the use of an array of parallel wires to which a sinusoidally varying voltage is applied which will push particles along by a sort of time varying push-pull mechanism. Figure (6) gives a rough schematic representation of how such a scheme can work. First one should note that the dust particles will carry a charge either due to a triboelectric mechanism caused by particle-particle collisions or by the electric field gradient close to the wires. Thus in the top row of wires depicted in figure (6) we see a positively charged particle that has had one or more electrons knocked off by one of the aforementioned mechanisms. The particle is repelled by the positively charged wire to the left and attracted to the negatively charged wire on the right and thus starts moving right toward the negatively charged wire. However, as soon as the particle arrives over the desired wire it now sees a positive charge due to the sinusoidally varying

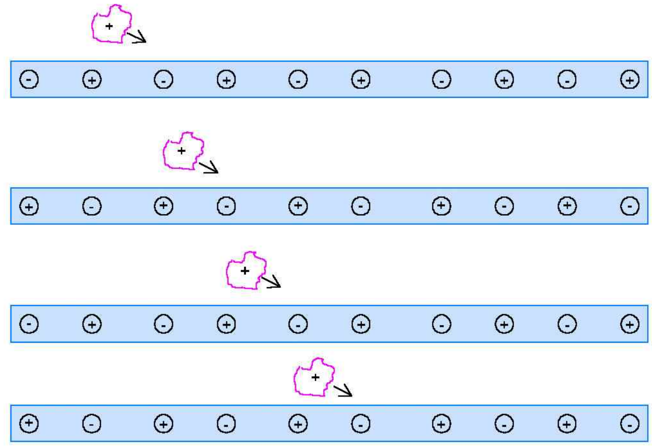

Figure 6 Motion of charged dust particle near a grid array of wires with a sinusoidally varying voltage.

voltage and is thus again repelled and driven toward the now negatively charged particle on the right. If the voltage frequency is adjusted just right the particle always sees a repulsive force on the left and an attractive one on the right and is therefore continuously driven to the right till it is ejected from the grid array altogether. Figure (7) shows an example of the effectiveness of this mechanism for simulated Martian dust on a wire grid array. As is apparent from the photographs, the results are quite impressive given the fact that the procedure

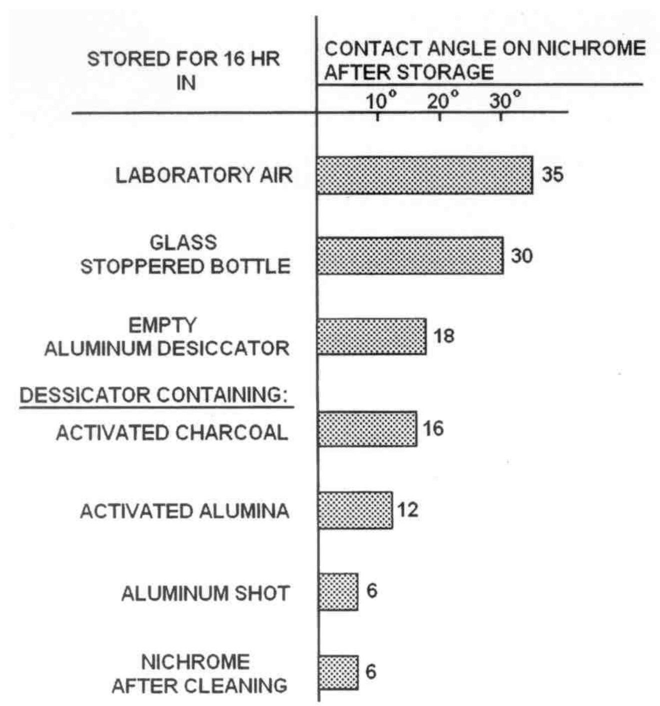

Figure 7: Post storage recontamination of nichrome samples kept under different conditions for 16 hours after initial cleaning. From Birch et. al. footnote (6).

Mazumdar, A. S. Biris, C. E. Johnson, C. U. Yurteri, R. A. Sims, R. Sharma, K. Pruessner, S. Trigwell and J. S. Clements, in Particles on Surfaces 9: Detection, Adhesion and Removal, Ed. K. L. Mittal (VSP, Leiden, 2006) pp. 167-195.

can be carried out remotely from a distance of 78 million miles. Those who have a further interest in this topic will be able to engage Prof. Mazumdar directly at the symposium as he will be presenting further aspects of this work at the upcoming PARTICLE symposium in Maine.

CLEANING AND CONTACT ANGLE REVISITED OR ONCE IT IS CLEAN HOW DO YOU KEEP IT THAT WAY?

We conclude our overview of the relationships between contact angle measurements and surface cleaning with a look at the important problem of keeping clean surfaces clean after they are removed from the cleaning process. As the old adage goes "Nature abhors a vacuum" and a clean surface is nothing if not a vacuum in the sense of being a large expanse of just one material phase. It is well known in fact that ultra clean metal and metal oxide surfaces are very efficient magnets for just about any form or contamination if not kept under high vacuum.

Birch et. al.[6] in a recent paper explore the use of contact angle measurements to follow the recontamination of nichrome and aluminum surfaces that had been cleaned by heating to 500 °C under vacuum. Figure (8) shows the results for a nichrome surface which was chosen due to its high affinity for contaminants. At time zero the contact angle with water was measured at 6 degrees indicating an exceptionally clean surface. However, after 16 hours exposed to laboratory air the contact angle shoots up nearly a factor of 6 to 35 degrees. The average layman may find this surprising as indoor air is assumed to consist of little more than just air. However, anyone doing sensitive surface analysis such as X-ray Photoelecton Spectroscopy will hardly be surprised. One of the problems commonly encountered in this type of work is trying to examine a sample that has just been treated in a nearby chemical hood. Just the act of moving the sample from an adjacent room to the spectrometer can introduce a significant amount of ambient contamination that can affect subsequent surface analysis results.

Curiously enough keeping the sample in a glass bottle does not help much as can be seen from the figure. The contact angle of glass bottle stored

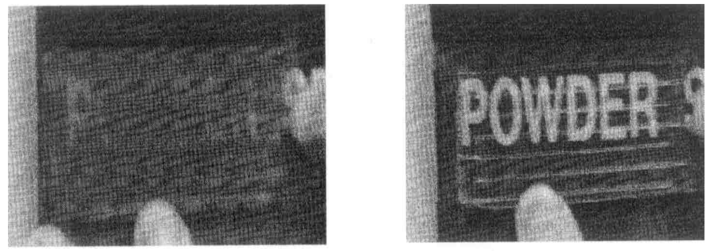

Figure 8 Example of dust removal by array of electrically charged wires from Mazumdar et. al. in footnote 5.

sample is up by a factor of 5 to 30 degrees. This again will not surprise those who do sensitive surface analysis work who get samples to analyze that were prepared at a remote site and sent for analysis through the mail in a carefully sealed container. Matters improve somewhat on moving to an aluminum desiccator but again the contact angle is still up by nearly a factor of 3. Matters start to improve significantly however when one uses a desiccator along with a "getter" material which also has a high affinity for contaminants. From the figure one can see that the best getter is the aluminum shot which is nothing more than small aluminum spheres heated to 500 °C to create an oxide surface. In this case one has a very large surface area which is strongly attractive to contaminants and the figure shows that it attracts practically all of the contaminants leaving the test surface in a near pristine condition with a contact angle of 6 degrees.

To test this concept further the authors did a much longer term study of both aluminum and nichrome surfaces stored in a desiccator with aluminum shot for up to 360 hours. Figure (9) shows the results indicating that whereas the aluminum surface remains as clean as it started the nichrome contact angle slowly increases to 16 degrees which is indicative of its high affinity for ambient contamination.

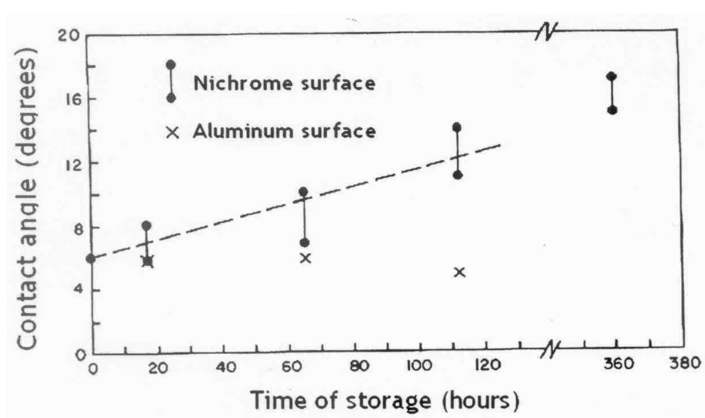

Figure 9 Long term study of recontamination of freshly cleaned nichrome and aluminum surfaces kept in an aluminum desiccator with aluminum shot for up to 360 hours. From Birch et. al. in footnote (6).

[6] "Wettability Techniques to Monitor the Cleanliness of Surfaces", William Birch, Alain Carré and Kashmiri L. Mittal, in Developments in Surface Contamination and Cleaning: Fundamental and Applied Aspects, Ed. Rajiv Kohli and K. L. Mittal (William Andrew, Norwich, New York, 2008) pp. 693-723.

The authors go on to examine other aspects of the use of contact angle measurements in the detection and control of surface contamination. In particular they point out the advantage of using contact angle measurments with a more precise surface analysis tool such as Time of Flight Secondary Ion Mass Spectroscopy (TOF-SIMS) which can not only detect the presence of contaminants but also indicate their precise chemical makeup. Again we invite all of the readers of the Newsletter to join us at the University of Maine this Summer where many of the experts on these matters will be gathered for what promises to be a most enlightening and enjoyable symposium series.

WOOD SCIENCE, CONTACT ANGLE AND PARTICLE SYMPOSIA TO BE HELD FROM JULY 6 TO 18

Listed below are the preliminary programs for both the CONTACT ANGLE and PARTICLE symposia along with the related program for the 4th INTERNATIONAL CONFERENCE ON ADVANCED ENGINEERED WOOD & HYBRID COMPOSITES. The WOOD COMPOSITES program is being organized by our colleague Prof. Douglas Gardner program leader for the Wood Science and Technology program at the University of Maine and by Prof. Habib Dagher the Director of the Advanced Engineered Wood Composites Center. Prof. Gardner is also the local host for the CONTACT ANGLE and PARTICLE symposia and members of his group will be participating in the CONTACT ANGLE symposium. We extend our special thanks to Prof. Gardner for his kind hospitality and we expect a significant cross participation among the three symposia. Those interested in registering for the WOOD COMPOSITES symposium can do so most conveniently by going to the conference web site at www.aewc.umaine.edu/conference . Full information on registering for the CONTACT ANGLE and PARTICLE symposia is given at the end of the Newsletter.

4TH INTERNATIONAL CONFERENCE ON ADVANCED ENGINEERED WOOD & HYBRID COMPOSITES; JULY 6-10, HARBORSIDE HOTEL AND MARINA, BAR HARBOR, MAINE

CONFERENCE SCHEDULE

Sunday, July 6, 2008

5:30 – 7:30 pm Welcoming Reception Bar Harbor Club; *Sponsored by Hodgdon Yachts,* Hors d'oeuvres, cash bar, networking

Monday, July 7, 2008
Opening Session

Welcome: Habib Dagher, Director, The AEWC Center, University of Maine, Orono, ME

Keynote Address: *Wood Industry Marketing Initiatives,* Tom Williamson, APA – The Engineered Wood Association, Tacoma, WA (co-authored by B.J. Yeh, APA – The Engineered Wood Association, Tacoma, WA)

Keynote Address: *Computational Modeling of Wood and Wooden Structures* Josef Eberhardsteiner, Institute for Mechanics of Materials and Structures, Vienna, AUSTRIA (co-authored by K. Hofstetter, Institute for Mechanics of Materials and Structures, Vienna, AUSTRIA)

9:30 am Coffee Break
Sponsored by Correct Building Products

9:45 am – 12:30 pm Session I. Adhesion/Panels

Plenary Speaker: A.D. Pugel, Senior Scientist, Louisiana-Pacific Corporation, Franklin, TN, *The Development of a Strand Lumber Process at an Existing Oriented Strand Board (OSB) Facility: LP-Building Products, Houlton, Maine*

Evaluation of Resin Systems Used for Meeting New Product Applications for Medium Density Fiberboard, T. S. Connolly, Plum Creek Timber Co, Columbia Falls, MT, M. Malmberg, Hexion Specialty Chemicals

Engineered Wood Composite I-Joists Using Corrugated Hardwood Veneer Panels, L. Denes, E. Lang, J. Davalos, West Virginia University, Morgantown, WV

Moisture-Related Durability of Wood Adhesive Bonds, C. Frihart, USDA Forest Products Laboratory, Madison, WI

Introduction of a New Bio-material Panel Product – eCor Panel, R. Noble, Noble Environmental Technologies, La Jolla, CA, J. Hunt, USDA Forest Products Laboratory, Madison, WI, H. Gu, Noble Environmental Technologies, Madison, WI

Development of a Continuous Process for the Production of Lightweight Panels, J. Luedtke, University of Hamburg, GERMANY, J. Welling, Johann Heinrich von Thuenen-Institut, GERMANY, H. Thoemen, M. Barbu, University of Hamburg, GERMANY

Bamboo Composite: A Sustainable Material for High-Performance Applications, Z Cai, J. Winandy, USDA Forest Products Laboratory, Madison, WI

Formaldehyde-Free Wood Adhesive Offers Environmentally-Friendly Alternative To Traditional Wood Adhesives, D. Mullen, Hercules Ventures, Wilmington, DE, J. Wescott, H2H Innovations

12:30 – 2:30 pm Business Lunch

2:30 – 5:00 pm Session II. Composites for Defense and Homeland Security

Plenary Speaker: E. Greene, Eric Greene Associates, Inc., Annapolis, MD
Mark V.1 Patrol Craft, R. Lindyberg, The AEWC Center, University of Maine, Orono, ME

A System Evaluation of the Modular Ballistic Protection System (MBPS), C. Quigley, F. Kostka, K. Horak, R. Devine, Natick Soldier Research, Devel., and Engineering Command, Natick, MA

Blast Resistant Wood Structures, H. Dagher, The AEWC Center, University of Maine, Orono, ME

Concrete Filled FRP Arch, D. Bannon, H. Dagher, R. Lopez-Anido, L. Parent, The AEWC Center, University of Maine, Orono, ME

Design and Testing of Marine Composite Shipping Containers, A. Viselli, H. Dagher, Maine Secure Composites, Orono, ME

5:00 – 7:00 pm Poster Session

A partial list of posters includes:

Effect of Grafting and Fiber Loading on Dynamic Mechanical Properties of Oil Palm Fiber Reinforced Polyvinyl Chloride, N. Ibrahim, W. Yunus, M. Rahman, M. Ahmad, K. Dahlan, Universiti Putra Malaysia, Selangor, MALAYSIA

Fatigue Crack Detection in Polymer Matrix Composite Joints Using Embedded Fiber Bragg Grating Strain Sensors, R. Silva-Munoz, R. Lopez-Anido, The AEWC Center, University of Maine, Orono, ME

Fire-Rated Composite Panels, J. Scheid, Highcrest Wood Products, Inc., Medford, OR

Formation of the Density Profile and Its Effects on the Bending Properties of Medium Density Fiberboard (MDF) Influenced by Press Speed and Pressure, Z. Candan, T. Akbulut, Istanbul University, A. Sisci, C. Ilhan, M. Vicil, Kastamonu Integrated Wood Industry and Trade Inc., TURKEY

Insulative Composite Wood Framing Members: A Solution for Thermal Bridging, L. Magnusson, K. Beevers, J. Bingham, SolidJoint Research, Inc., Cambridge, MA

Mechanical Properties of Thermoplastic Composites Filled with Microcrystalline Cellulose, A. Kiziltas, D. Gardner, Y. Han, C. West, The AEWC Center, University of Maine, Orono, ME

Natural Flax Fibre Reinforced Aliphatic-Aromatic Co-polyester Biocomposites, B. Guduri, G. Phiri, Council for Scientific and Industrial Research, Pretoria, SOUTH AFRICA

Understanding the Design Process for Timber Rivet Connections, R. Taylor, American Wood Council, Washington, DC

7:00 pm Downeast Lobster Bake

Tuesday, July 8, 2008

8:00 – 12:00 noon Session III. Trends in Green Building: Composite Materials
A seminar offered in partnership with the Wood-Based Composites Center

Session Moderators: C. Frazier & L. Caudill, Wood-Based Composites Center, Blacksburg, VA

The Green Building Movement: Commercial vs. Residential Trends, V. Worden, The Green Building Initiative, Portland, OR

The Role of Life Cycle Assessment in Sustainable Construction, W. Trusty, The Athena Institute, Merrickville, ON, CANADA

Implications of Green Building Trends on Engineered Wood Composites, T. Williamson, APA – The Engineered Wood Association, Tacoma, WA

Green Building?— How About Good Building?— Defects in Engineered Lumber Products in Residential Construction, J. Bouldin, Protechs Home Inspection, Blacksburg, VA

The Social Footprint of Current Wood Adhesive Technologies, C. Frazier, Virginia Tech, Blacksburg, VA

Open panel discussion involving all speaker

8:00 – 10:15 am Session IV. Marine Composites: ONR-Next Navy Composites (N2C)

Plenary Speaker, J. Lesko, Virginia Tech, Blacksburg, VA, *Next Navy Composites (N2C): Program Overview*

Design and Durability: Composites Residual Strength Prediction, N. Post, Virginia Tech, Blacksburg, VA

Design and Durability: Material to Structure Probabilistic Modeling, J. Lua, Blacksburg, VA

Sensing for Damage Quantification and Prognosis: Doubler-Plate Joints, R. Lopez-Anido, The AEWC Center, University of Maine, Orono, ME

Multifunctional Integration and Manufacturing: Pultrusion and VARTM, T. Plaisted, Luna Innovations, Blacksburg, VA

A Viscoelastic Continuum Damage Model Applied to a Polymer Matrix Composite Under Cyclic Loading, R. Sullivan, Mississippi State University, Mississippi State, MS

10:15 – 10:30 am Coffee Break
Sponsored by Havco Wood Products

10:30 – 12:30 noon Session V. Modeling

Numerical Modeling of the Heat and Mass Transfer Phenomena Involved in the MDF Hot Pressing Process, Z. Kavazovic, A. Fortin, A. Cloutier, Université Laval, Quebec, CANADA

Minimizing the Weight of a Flooring Strip: A Shape Optimization Approach, J. Deteix, G. Djoumna, A. Fortin, A. Cloutier, Université Laval, Quebec, CANADA, P. Blanchet, FPInnovations-Forintek Division, Quebec, CANADA

A Three-Dimensional Anisotropic Viscoelastic Maxwell Model for Aging Wood Composites, G. Djoumna, J. Deteix, A. Fortin, A. Cloutier, Université Laval, Quebec, CANADA, P. Blanchet, FPInnovations-Forintek Division, Quebec, CANADA

Lattice Modeling, E Nagy, The AEWC Center, University of Maine, Orono, ME

Tuesday Afternoon Free time for meetings with AEWC faculty and/or staff or for time to enjoy Maine's coast

Wednesday, July 9, 2008

8:00 – 12:30 Session VI. Wood and Natural Fiber Plastic Composites

Plenary Speaker: Wayne Song, Futuresoft Technologies, Inc., Manalapan, NJ, *WPC Trends in China From Both the Local Perspective and How These Trends May Impact North America in the Future*

Palltrusion Process and Advantages, R. Perrault, Pallmann Maschinenfabrik, Zweibruecken, GERMANY

Beetle-Killed Spruce from Alaska's Kenai Peninsula in Manufacture of Wood-Plastic Composites, E. Lowell, Pacific Northwest Research Station, Portland, OR, V. Yadama, Washington State University, Pullman, WA, D. Nicholls, Pacific Northwest Research Station, Sitka, AK, N. Peterson, Washington State University, Pullman, WA

Nanoparticle Impregnated Kenaf Fibers for the Reinforcement for Polymer Matrix Composites, J. Shi, S. Lee, S. Shi, H. Barnes, Mississippi State University, Mississippi State, MS

Effect of Seawater Aging on Flax/PLLA Biocomposites, A. LeDuigou, Université de Bretagne Sud, Lorient Cedex, FRANCE, P. Davies, Department ERT/MS-IFREMER, Plouzané, FRANCE, C. Baley, Université de Bretagne Sud, Lorient Cedex, FRANCE

Material Handling Considerations for Extrusion of Wood and Hybrid Composites, K. Larson, Colortronic North America, Flint, MI

Adding Value to Wood Plastic Composites Through Species Selection, J. Kim, D. Harper, A. Taylor, University of Tennessee, Knoxville, TN

Testing of Unique Coupling Agents and Processing Aids in Wood Plastic Composites, M. Sain, University of Toronto, Toronto, CANADA, W. Dougherty, C. Mateer, A. Pape, W. Wittig, Sartomer Company, Exton, PA

Durability of Wood Flour-Recycled Thermoplastics Composites Under Accelerated Environmental Conditions, K. Adhikary, S. Pang, M. Staiger, University of Canterbury, NEW ZEALAND

Melt Processing and Characteristics of Cellulose-Polypropylene Composites, N. Ucar, M. Ucar, L. Wang, K. Jacob, Y. Wang, Georgia Institute of Technology, Atlanta, GA

Wheat Straw Flour Filled Recycled Thermoplastic Composites: Thermal Degradation, Mechanical Properties and Morphology, F. Mengeloglu, K. Karakus, A. Kabakci, University of Kahramanmaras Sutcu Imam, TURKEY

Bio-Composite Rigid PVC: Natural Fiber Reinforcement, Improving Cost and Performance for "Greener" Building Products, E. Schut, CreaFill Fibers, Chestertown, MD

10:15 -10:30 am Coffee Break

2:30 – 5:00 pm Session VII. Conventional and Hybrid Structural Wood Composites

Plenary Speaker: Ed Pilpel, Polystrand, Montrose, CO, *New Advances in Thermoplastic Composites Advances in Structural Composite Lumber, B.J. Yeh,* APA – The Engineered Wood Association, Tacoma, WA

Introducing FRP Glulam into the Code Approval Process, T. Williamson, APA – The Engineered Wood Association, Tacoma, WA

Transverse FRP Composite Reinforcements for Improving Shear Performance and Ply Engagement of Glued-Laminated Timbers, R. Gentry, S. Hensey, C. Chang, Georgia Institute of Technology, Atlanta, GA.

Measurement of Interlaminar Stresses of a Novel Engineered Wood Product with Densified Surface Laminate Using Embedded Fiber-Optic Sensors, L. Li , M. Gong, Wood Science and Technology Center, Fredericton, New Brunswick, CANADA, K. Li, University of New Brunswick, CANADA, Y. Chui, Wood Science and Technology Center, Fredericton, New Brunswick, CANADA

Thursday, July 10, 2008

9:00 – 9:30 am Continental Breakfast. AEWC Center Conference Room, University of Maine, Orono, ME

9:30 – noon Tours of AEWC Laboratories

Sponsored by Colortronic North America and Instron Tour The AEWC Center's 10 integrated laboratories with a special demonstration of the Pallmann "Paltruder" wood plastic agglomeration system for preparing wood plastic composite feedstocks.

Tour the AEWC Center's Laboratories

Established by the National Science Foundation to lead the U.S. in the development of next generation engineered wood composites, the AEWC Center at the University of Maine is an ISO 17025 accredited 48,000ft^2 state of the art "one stop shop" for integrated composite materials research, development and testing. Currently, over 100 AEWC employees (including academic researchers, engineers and scientists, as well as both undergraduate and graduate students) are engaged in R&D projects including the development of wood plastic composite materials for transportation infrastructure, development and testing of a composite patrol craft for the US Navy, and the development of ballistic panels, inflatable composite structures, and blast-resistant structures for the US Army. AEWC's Modular Ballistic Protection System - ballistic panels for Army tent protection in combat zones recently received two of the composites industry's highest awards — the ACMA's Best of Show and People's Choice awards for superiority in composites innovation. Tours of the AEWC during the week of the 14th can be made by appointment with Prof. Gardner.

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

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.

We are indeed happy to announce that this the 6th symposium in the series will be organized in collaboration with Prof. Douglas Gardner in the Advanced Engineered Wood Composites Center at the University of Maine, Orono, Maine. Prof. Gardner is well acquainted with problems of wettability and adhesion having published on the Dynamic Wettability of Wood and also serving on the editorial board of the Journal of Adhesion Science and Technology which is edited by the Conference Director Dr. Mittal.

This symposium is also being held in tandem with the **4th International Conference on Advanced Engineered Wood and Hybrid Composites** being held the week before since the topics of wettability and adhesion are of critical interest to both meetings. Details of the wood composites symposium are available at: www.aewc.umaine.edu/conference . Due to the commonality of interest we expect significant overlap in participation between the two gatherings.

The CONTACT ANGLE 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, papers, 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. 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. Below is a partial listing of papers to be presented

MOLECULAR FUNDAMENTALS OF WETTABILITY AND ADHESION

David W. Dwight, Gordon K.-S. Tseng and **David L. Allara**; Departments of Chemistry and Materials Science & Engineering, Pennsylvania State University, University Park, PA 16802; **The Reciprocal Relationship Between Donor-Acceptor and Dispersion Forces**

Edward Bormashenko; The Ariel University Center of Samaria, 40700, Ariel, ISRAEL;**Contact Angle Hysteresis on the Polymer Substrates: Experimental Techniques and Calculation of CAH Energy**

Athanassia Athanassiou; NNL-National Nanotechnology Laboratory, INFM-CNR, Via Arnesano, 73100, Lecce, ITALY; **Reversible Transition from Hydrophobicity to Hydrophilicity of Photon Responsive Surfaces: From Photochromic Molecules to Nanocrystals**

Kash Mittal and **Frank M. Etzler**; Boehringer-Ingelheim Pharmaceuticals, 900 Ridgebury Road, Ridgefield, CT 06877; **Is the World Basic? Lessons from Surface Science**

Alexander Y. Fadeev; Department of Chemistry and Biochemistry, Seton Hall University, South Orange, NJ 07079; **Wetting of Hydrophobic Surfaces: Macroscopic and Microscopic Pictures**

Seong H. Kim; Department of Chemical Engineering, The Pennsylvania State University, University Park, PA 16802; **Effects of Water and Alcohol Adsorption on Silicon Oxide Nano-asperity Adhesion**

Dayanand Saini, Yu Zheng, Leela M. Gullapalli and Dandina N. Rao; Craft & Hawkins Department of Petroleum Engineering, 3516, Patrick F. Taylor Hall, Louisiana State University, Baton Rouge, LA, 70803; **Effect of Line Tension on the Work of Adhesion for Rock-oil-brine Systems**

M. E. R. Shanahan and K.Sefiane; Université Bordeaux 1, Laboratoire de Mécanique Physique, CNRS UMR 5469, 351 Cours de la Libération, 33405 Talence Cedex, FRANCE; **Kinetics of Triple Line Motion during Evaporation**

W. H. Zhong; School of Mechanical and Materials Engineering, Washington State University, Pullman, WA 99164; **Wettability and Adhesion of Nano-Epoxies to UHMWPE Fibers**

EXPERIMENTAL METHODS

Edward Bormashenko; The Ariel University Center of Samaria, 40700, Ariel, ISRAEL; **Study of the Cassie-Wenzel Wetting Transition Using Vibrated Drops**

Miguel A. Rodríguez-Valverde, Pedro M. Gea-Jódar, Helmut Kamusewitz, Francisco J. Montes Ruiz-Cabello and **Miguel A. Cabrerizo-Vílchez**; **Model For Estimation of The Young Contact Angle From Contact Angle Hysteresis Measurements**

T. S. Horozov; Surfactant & Colloid Group, Department of Chemistry, University of Hull, Hull, HU6 7RX, UNITED KINGDOM; **Contact Angles of Colloidal Particles Measured by a Novel "Film Calliper" Method**

Patricia McGuiggan; Johns Hopkins University, Department of Materials Science and Engineering, 3400 N Charles Street, Baltimore, MD 21218; **Wetting of Microspheres and Nanotubes Using the AFM**

Vladimir V. Dobrokhotov, Mehdi M. Yazdanapanah, Mahdi Hosseini, Santosh Pabba, Scott M. Berry, Abdelilah Safir, Robert S. Keynton and Robert W. Cohn; University of Louisville, Louisville, KY 40292; **Liquid Property Measurements Using Constant Diameter Nanoneedle-Tipped AFM Probes**

Joung-Man Park, Pyung-Gee Kim, Jung-Hoon Jang, Zuojia Wang, Woo-Il Lee, Jong-Kyoo Park, K. Lawrence DeVries; Gyeongsang National University, Jinju 660-701, KOREA; **Interfacial Adhesion Evaluation and Self-Sensing of Single Carbon Fiber/Carbon Nanotube-Epoxy Composites Using Electro-Micromechanical Technique and Dynamic Contact Angle Measurement**

Toshiya Watanabe and Naoya Yoshida; The University of Tokyo, 4-6-1,Komaba, Meguro-ku, Tokyo, 153-8505 JAPAN; **Surface Wettability Control by Photocatalysis for Self-Cleaning**

SUPERHYDROPHOBIC/OLEOPHOBIC BEHAVIOR

Peilin Chen; Institute of Applied Science and Engg. Research, Academia Sinica, 128, Section 2, Academia Road, Nankang, Taipei 115, TAIWAN; **Novel Applications of Switchable Superhydrophobic Surfaces**

Wonjae Choi, Anish Tuteja, Robert E. Cohen, and Gareth H. McKinley; Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Massachusetts; **Exploring Contact Angle Hysteresis and the Validity of the Cassie-Baxter Equation Using Super-oleophobic Surfaces**

Michele Ferrari, Libero Liggieri, Francesca Ravera; CNR-Istituto per l'Energetica e le Interfasi, via De Marini 6, 16149 Genova, ITALY; **Adsorption of Surfactants at Superhydrophobic Surfaces in Air/Water and Oil/Water Systems**

Chih-Feng Huang and Feng-Chih Chang; Department of Applied Chemistry, National Chiao Tung University, Hsinchu 300 TAIWAN; **Fabrication of Super-Amphiphobic Surfaces and New Type of Mold-Release Agent for Nanoimprint via Polybenzoxazine**

Minglin Ma and Gregory C. Rutledge; Chemical Engineering, Institute for Soldier Nanotechnologies, Massachusetts Institute of Technology, Cambridge, MA; **Superhydrophobic Electrospun Nonwovens**

Avi Marmur; Chemical Engineering Department, Technion - Israel Institute of Technology, Haifa, 32000 ISRAEL; **Super-hydrophobicity: Water in Air, and Air in Water**

W. Ming, B. Leng and G. de With; Nanostructured Polymers Research Center, Materials Science Program, University of New Hampshire, Durham, NH 03824; **Superoleophobic Surfaces**

A. R. Phani, P. De Marco, and S. Santucci; CASTI, CNR-INFM Regional Laboratory, Department of Physics, University of L'Aquila, via Vetoio, 67010 Coppito- L'Aquila - ITALY; **Super Hydrophobic Films Based on Organic-inorganic Hybrid Coatings - Potential Application in Aeronautic, Automotive and Biomedical Applications**

D. K. Sarkar and M. Farzaneh; Université du Québec à Chicoutimi, QUÉBEC; **Superhydrophobic Binary Structures: Preparation, Characterization and Ice Adhesion**

Mireille Turmine; Laboratoire d'Electrochimie et Chimie Analytique (UMR7575), Université Pierre et Marie Curie, 4 place Jussieu, 75252 PARIS Cedex 05, FRANCE; **Grafted ZnO Surface (Superhydrophobic Surface)**

Jian Xu; State Key Laboratory, Polymer Physics & Chemistry, Institute of Chemistry, Chinese Academy of Sciences, Beijing 100080, P.R. CHINA; **A Novel Ultra-Hydrophobic Surface: Statically Non-Wetting but Dynamically Non-Sliding**

M. Thieme, C. Blank, A. Pereira de Oliveira, H. Worch, R. Frenzel, S. Höhne, F. Simon, H. Pryce Lewis, and A. J. White ; Technische Universität Dresden (TUD), Institut für Werkstoffwissenschaft, Dresden, GERMANY; **Superhydrophobic Aluminum Surfaces: Preparation Routes, Properties and Artificial Weathering Impact**

STRUCTURED SURFACES

Chuck Extrand; Entegris Research Group, Entegris, Inc., 3500 Lyman Blvd., Chaska, MN 55318; **Super Wetting of Structure Surfaces**

Akira Fujishima; Kanagawa Academy of Science and Technology, KSP Building West 614, 3-2-1 Sakado, Takatsu-ku, Kawasaki, Kanagawa 213-0012, JAPAN; **TiO2 Photocatalysis - Fundamentals and Applications**

Dr. Rikard Lingström; Division of Fibre Technology, School of Chemical Science & Engg., Royal Institute of Technology, (KTH), SE-10044 Stockholm, SWEDEN; **Fibre Surface Engineering and the Link Between Fibre Wettability and Wet Adhesion**

S. T. Picraux , Dongqing Yang , S. Choi, P. Aella , Antonio A. Garcia; Center for Integrated Nanotechnologies, Los Alamos National Laboratory, Los Alamos, New Mexico 87545; **Design of Surfaces with Photo-induced Superhydrophilic to Superhydrophobic Switching**

Hiroshi Yabu, Miki Kojima, Yuji Hirai, Masatsugu Shimomura; Institure of Multidisciplinary Research for Advanced Materials, Tohoku University, 2-1-1, Katahira, Aoba-ku, Sendai, 980-8577, JAPAN; **Honeycomb Films; Their Unique Structures and Surface Properties**

Haoshen Zhou; (AIST), Umezono 1-1-1, Tsukuba, 305-8568, JAPAN; **Wettability Properties Controlled by the Nanostructured Surface Fabrication**

BIOLOGICAL SURFACES

Laurence Boulangé, F. Crozet, F. Charlon and F. Desmaris; BD Medical - Pharmaceutical Systems, 11 Rue Aristide Bergès, 38800 Le Pont de Claix, FRANCE; **Effect of the Surface Solid Heterogeneity on Protein Stabilization**

E. Fadeeva, A.Y. Vorobyev, S. Schlie, J. Koch, C. Guo, and B. N. Chichkov; Laser Zentrum Hannover e.V., Hollerithallee 8, 30419 Hannover, GERMANY; **Wettability Properties of Femtosecond Laser-induced Surface Micro- and Nanostructures and Their Influence on Fibroblast Cell Proliferation**

Xian Jia; Department of Science and Technology, University of Science and Technology Beijing, Beijing 100083, CHINA; **Research Progress of Hydrophobic Biomaterial Surfaces and Biomimetic Hydrophobicity Surfaces**

Mika M. Kohonen; Surfactant & Colloid Group, Department of Physical Sciences, University of Hull, Kingston upon Hull, HU6 7RX, United Kingdom; **Observations on Insect Adhesion and Friction**

Lei Jiang; Center of Molecular Sciences, Institute of Chemistry, Chinese Academy of Sciences, Beijing 100080, CHINA; **Design and Creation of Bioinspired Surfaces with Special Wettability**

Carel Jan van Oss; School of Medicine and Biomedical Sciences, SUNY Buffalo, Buffalo, NY 14214-3078; **Energetics and Kinetics of Specific Ligand-Receptor (Including Antigen-Antibody) Interactions**

WOOD TECHNOLOGY

Balamurali Balu, Victor Breedveld, and **Dennis W. Hess**; **Superhydrophobic Paper/Cellulose Surfaces Formed by Plasma Processing**

Gloria S. Oporto and Douglas J. Gardner; Advanced Engineered Wood Composite (AEWC) Center, University of Maine, Orono, ME 04469; **Adhesion Properties of Wood Plastic Composites Surfaces (WPC) Using Atomic Force Microscopy**

Marko Petric, Borut Kricej, Andreja Kutnar, Matjaz Pavlic, Philippe Gerardin, Mathieu Petrissans and Milan Sernek; University of Ljubljana, Biotechnical Faculty, Dept. of Wood Science & Technology, Jamnikarjeva 101, SI 1000, Ljubljana, SLOVENIA; **Wettability of Various Wood Based Materials and Their Surface Free Energies**

B. Riedl, V. Blanchard, P. Blanchet, R. Gilbert and P. Evans; Département des Sciences du Bois, Université Laval, Québec, CANADA; **Plasma Treatment for Enhanced Adhesion of Coatings to Wood.**

THEORETICAL STUDIES

Dan Lewis; Rensselear Polytechnic Institute, Materials Research Center, Room 110, 110 8th Street, Troy, NY 12180; **Computational Method for Understanding Balance of Surface Tension Forces Against External Constraints of Varying Complexity**

Mark Robbins; Dept. of Physics and Astronomy, Johns Hopkins University, Baltimore, MD 21218; **Moving Contact Lines: Can the Interfacial Width Remove the Stress Singularity?**

Mireille Turmine; Laboratoire d'Electrochimie et Chimie Analytique (UMR7575), Université Pierre et Marie Curie, 4 place Jussieu, 75252 PARIS Cedex 05, FRANCE; **Nonextensive Approach of Thermodynamics to Wettability**

Mireille Turmine; Laboratoire d'Electrochimie et Chimie Analytique (UMR7575), Université Pierre et Marie Curie, 4 place Jussieu, 75252 PARIS Cedex 05, FRANCE; **Wettability Behavior of Acid-Base Surface**

F.J. Montes Ruiz-Cabello, Halim Kusumaatmaja, **M.A. Rodríguez-Valverde**, J.M. Yeomans and M. Cabrerizo-Vilchez; Biocolloid and Fluid Physics Group, Department of Applied Physics, University of Granada, Campus de Fuentenueva; E-18071 Granada, SPAIN; **Study of Contact Angle Multiplicity of Cylindrical Drops Using Lattice-Boltzmann Model**

Edmund B. Webb III; Computational Materials Science & Engineering, Sandia National Laboratories; **High Temperature Capillarity in Metal Systems: Insights from Atomic Modeling**

SURFACE TREATMENT STUDIES

Thomas Bahners, Gerald Hoffmann, Jürgen Nagel, Eckhard Schollmeyer and Arne Voigt; Deutsches Textilforschungszentrum Nord-West e. V., Adlerstr. 1, 47798 Krefeld, GERMANY; **The Effect of a Plasma Pre-treatment on the Quality of Flock Coatings on Polymer Substrates**

Tokuzo Kawase; Department of Chemistry and Materials Technology, Kyoto Institute of Technology, Matsugasaki, Sakyo-ku, Kyoto 606-8585, JAPAN; **A Novel Design of Water- and Oil-Repellent Surface Modifier Having Fluoroalkyl Groups**

Hernando Salapare III; Plasma Physics Laboratory, National Institute of Physics, College of Science, University of the Philippines Diliman, PHILIPPINES; **The Porosity and Wettability Properties of Hydrogen Ion Treated Polytetrafluoroethylene**

Tessa ten Cate, Daniël Turkenburg, Timme Lucassen, Susan Reinders, Lawrence Batenburg and **Mariëlle Wouters**; TNO Science and Industry, Innovative Materials, THE NETHERLANDS; **Using Monolayer Coatings to Tune Surface Wettability**

Akira Nakajima , Shunsuke Suzuki, Munetoshi Sakai, Yoshikazu Kameshima and Kiyoshi Okada; Department of Metallurgy and Ceramics Science, Tokyo Institute of Technology, JAPAN; **Direct Evaluation of the Sliding Motion of Water Droplets on Hydrophobic Silane Coatings**

Torsten Textor, Boris Mahltig, Horst Böttcher and Eckhard Schollmeyer; Deutsches Textilforschungszentrum Nord-West e. V., Adlerstr. 1, 47798 Krefeld, GERMANY; **Durable Nanosol Coatings for Textiles Combining Hydrophobicity and Antistatic Properties**

ELEVENTH INTERNATIONAL SYMPOSIUM ON
PARTICLES ON SURFACES: DETECTION, ADHESION AND REMOVAL
To be held on the campus of the University of Maine, Orono, Maine, USA, July 16-18, 2008

This will be the eleventh event in the series of symposia on particles on surfaces initiated as part of the Fine Particle Society meeting in 1986. Particles are yield detractors in the manufacture of sophisticated and sensitive electronic components and are very undesirable in many other technologies. Contamination of optical surfaces and shorting of microelectronic circuits by conducting particles, among other concerns, underscore the importance of particle detection, adhesion and removal. On the other hand, however, in certain instances particle adhesion to surfaces is necessary. The purpose of this symposium is to address the vast ramifications of particles on solid surfaces by bringing together specialists in many allied fields to discuss their latest findings and to identify areas for further investigation. Various types of substrates and particles --metals, oxides, glass, and polymers-- will be covered. The technical program will comprise both invited and contributed papers ranging from topical overviews to original research and industrial applications. What follows is a partial listing of papers to be presented

SAMPLING OF PAPERS TO BE PRESENTED INCLUDE

Uwe Schlosser, **Thomas Bahners** and Eckhard Schollmeyer; Deutsches Textilforschungszentrum Nord-West e. V., Adlerstr. 1, 47798 Krefeld, GERMANY; **Some Remarks on the Removal of Adhering Particles by Oscillating Air Flows**

Thomas Bahners and Eckhard Schollmeyer; Deutsches Textilforschungszentrum Nord-West e. V., Adlerstr. 1, 47798 Krefeld, GERMANY; **Electrospun Nanofibers – a Way to Improved Wet Filtration Efficiency of Deep-bed Filters**

E. Kesters, M. Claes, Q.T. Le, K. Barthomeuf , M. Lux, G. Vereecke*, **T. Bearda** and J. B. Durkee; IMEC, 75 Kapeldreef, 3001 Leuven, BELGIUM; **Selection of ESH Solvents for Cleaning Applications in Semiconductor Manufacturing**

J. C. J. van der Donck, M.F. Dekker, A.E. Duisterwinkel and B. van Someren, TNO Science and Industry, P.O. box 155, 2600 AD, Delft, THE NETHERLANDS; **On-line Monitoring of Particle Deposition**

John B. Durkee and Anselm Kuhn; POB 847 Hunt, TX 78024; **Measuring Particulate Surface Contamination in an Industrial Setting**

Mathieu Guingo, and Jean-Pierre Minier †; LEMTA - UMR 7563 CNRS, ESSTIN, Université Henri Poincaré-Nancy I, 2, rue Jean Lamour, Vandoeuvre-lès-Nancy, 54519, FRANCE; **A Stochastic Model to Simulate Particle Resuspension in Turbulent Flows**

David Grojo; Steacie Institute for Molecular Sciences, National Research Council Canada, 100 Sussex Drive, Ottawa, ON K1A 0R6, CANADA; **Laser-particle Interactions for Particle Removal and Nanofabrication Applications**

Sandip Halder, Twan Bearda, Karine Kenis, Tom Janssens, Toan-Le Quoc, Kurt Wostyn, Peter Leunissen, and Paul Mertens; IMEC, Kapeldreef 75, B-3001 Leuven BELGIUM; **Particle Removal Efficiency and Damage Analysis of Patterned Wafers in Different Solvents after Megasonic Cleaning**

Hubert Gojżewski [1,2], Arkadiusz Ptak[2] and Michael Kappl [1]; Max Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, GERMANY; **Adhesion on Self-assembled Thiol Monolayers by Means of High-rate Dynamic Force Spectroscopy**

Rajiv Kohli; Washington Group International, NASA Johnson Space Center, P.O. Box 58128, Houston, TX 77258; **Removal of Micro and Nanosize Contaminant Particles from Solid Surfaces**

Luigi Scaccabarozzi; ASML, De Run 6501, 5504 DR Veldhoven, THE NETHERLANDS; **Specifications and Prospects for Cleaning and Inspection of EUV Reticles**

G. Lefèvre[1], M. Fédoroff[1], G. Cote[1], O. Dégardin[1,2], Lj. Čerović[1], S. Delaunay[3], E.-M. Pavageau[3], C. Mansour[3], H. Catalette[3], A. Jaubertie[2], A. Douce[2]; ENSCP - LECA - CNRS UMR 757511, Rue Pierre et Marie Curie, F-75231 Paris Cedex 05 FRANCE; **Studies on the Deposition of Metallic Oxides Particles - Application to Cooling Circuits of Pressurized Water Reactors**

M. K. Mazumder; Department of Applied Science, ETAS 575, College of System Engineering and Information Science, University of Arkansas at Little Rock, 2801 South University Avenue, Little Rock, AR 72204 ; **Dust Hazard Mitigation Methods for Mars and Lunar Missions**

Isabelle Tovena Pecault , GUILLAUME BASSO , François Gensdarmes; CEA/DAM CESTA, DLP/SCAL/LPO, BP 2, 33114 Le Barp, FRANCE; **Qualification of Particle Surface Probe**

F. Wali , D. M. Knotter , J.J. Kelly , F. Michel , and M van Straten ; University of Twente; **Preparation of mono-disperse silica particles with metal-ion tracer**

These symposia are being organized under the direction of Dr. K. L. Mittal, Editor, Journal of Adhesion Science and Technology by MST Conferences, LLC. A proceedings volume is planned for this symposium and further details will be provided in due course. 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 **May 30, 2008** to the conference chairman by any of the following methods:

E-mail: rhlacombe@compuserve.com
FAX: 212-656-1016
Regular mail:
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Conference Chairman
3 Hammer Drive
Hopewell Junction, NY 12533

Contact by phone:
845-897-1654
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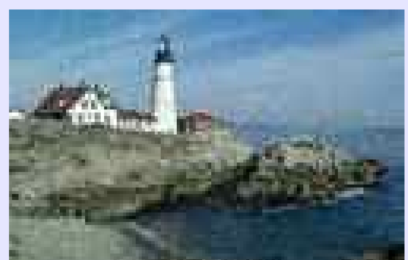
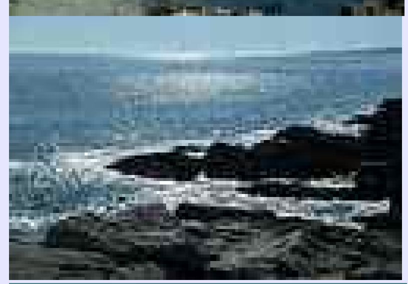
Full conference details and registration via the Internet will be maintained on our web site:

For the CONTACT ANGLE symposium go to: http://www.mstconf.com/contact6.htm

For the PARTICLE symposium go to: **http://mstconf.com/particle11.htm**

Maine is considered to be a vacation land by many in the continental US and the month of July is close to the height of the season with a number of pleasant attraction including the Acadia National seashore pictured below:





REGISTRATION INFORMATION

DATES:

JULY 14-16, 2008: SIXTH INTERNATIONAL SYMPOSIUM ON CONTACT ANGLE, WETTABILITY AND ADHESION

JULY 16-18, 2008: **ELEVENTH INTERNATIONAL SYMPOSIUM ON PARTICLES ON SURFACES: DETECTION ADHESION AND REMOVAL**

LOCATION:

University of Maine, Orono, Maine

http://www.umaine.edu/

HOTEL TRAVEL

These area hotels are offering special conference room rates for the nights of July 13 – 18, 2008 on a first come first serve basis.

Additional nights may be available. Continental breakfast and wireless access are included at each hotel. Rooms in July go fast. Call now to book your room.

To receive these rates, you must mention the MST Conference.

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$87.00 per night/single occupants
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http://universitymotorinn.com/

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Tel: (207) 866-7120

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The following are hotels that offer free shuttles to and from the airport.

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Ramada Inn	(207) 947-6961
Super 8 Motel – Bangor	(207) 945-5681

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Please see the comprehensive listing on the website:

Http://www.flybangor.com/

Taxis are available at the exit doors on a 24 hour basis.

REGISTRATION:

Speaker/student $395 each; regular attendee $595 each. A 20% discount applies if you are attending both symposia. An additional 10% discount applies if more than 1 person are participating from the same organization.

ON CAMPUS HOUSING

Housing on campus is also available at a location conveniently nearby the conference meeting room. Full details on reserving accommodations are given in the form at the end of this document. Registrants are asked to fill in the form and FAX it to the number listed on the form. Questions should be directed to Debra Wright at the University of Maine. Her telephone number and E-mail address are listed at the bottom of the form.

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SHORT COURSE ON APPLIED ADHESION MEASUREMENT METHODS

JULY 13 and 19, 2008: Associated with these symposia MST gives a short course on adhesion measurement methods. Since nearly all of the MST symposia have some relation to adhesion phenomena, the ability to quantify the adhesion of one material layer to another is clearly one of the unifying themes. This course is designed to mesh with the topical symposia by presenting an overview of the most useful adhesion measurement techniques which are being used to evaluate the **PRACTICAL ADHESION** of coatings. Emphasis will be 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 coatings. The effects of material elastic properties and residual stress are considered as well as other external influences which affect coating adhesion.

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

Level: Beginner to Intermediate

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

Duration: 1 day

Registration fee: $595: Includes course notes, handouts and a copy of the newly published handbook and reference volume: **ADHESION MEASUREMENT METHODS: THEORY AND PRACTICE** (CRC Press, 2006).

How You Will Benefit From This Course:

- Understand advantages and disadvantages of a range of adhesion measurement techniques.
- Gain insight into mechanics of adhesion testing and the role of intrinsic stress and material properties
- Learn optimal methods for setting adhesion strength requirements for coating applications.
- Learn how to select the best measurement technique for a given application.
- Gain perspective from detailed discussion of actual case studies of product manufacturing and development problems.

A complete course syllabus may be found at www.mstconf.com/AdhesionShortCourse.pdf

CANCELLATIONS: Registration fees are refundable, subject to a 15% service charge, if cancellation is made by June 20, 2008. **NO** refunds will be given after that date. All cancellations must be in writing. Substitutions from the same organization may be made at any time without penalty. MST Conferences reserves the right to cancel any of the symposia or the short course if it deems this necessary and will, in such event, make a full refund of the registration fee. No liability is assumed by MST Conferences for changes in program content.

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Short Course on Applied Adhesion Measurement Methods Select Date: ☐ Sunday July 13; ☐ Saturday July 19	$595
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MST Conference July 14 - 18, 2008

Housing Registration Form *Deadline for form return – Friday, June 13, 2008*

Cancellation policy: Through July 1, full payment will be refunded less the $15 processing fee.

Name:______________________________________ Day phone_______________________________

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Lodging on campus will be available on the nights of July 13, 2008 through July 18, 2008

Check in date:_________________ Check out date: _________________

Single room ~ twin bed	$60 per night for ____ nights	__________
Double room ~ twin beds	$40 per person per night for ____ nights	_________
Processing fee	$15.00	15.00
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Lodging will be at Edith Patch Hall in suites with a living area and kitchen facilities (refrigerator, stove, but no coffee maker, cooking vessels, china, or utensils). Suites have between 2 and 4 bedrooms. In suites with two bedrooms, the bedrooms are doubles. In suites with three bedrooms, there are two singles and one double. In suites with four bedrooms, there are four singles. Thus, you may list up to 4 suite mates (being sure that those you list also list you!). If you don't list suite mates, those bedrooms may be assigned to others in your program.

1 …………………………………………….… 3 ……………………………………….

2 …………………………………………….… 4 ……………………………………….

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Questions about housing at the University of Maine: Debra Wright at tel (207) 581-4094
Email: Debra.Wright@umit.maine.edu