POLYMER TECHNOLOGY CENTER

Summer 2007 Edition

PTC Newsletter

Undergraduate Polymer Specialty Certificate Program

TAMU students can now take advantage of this opportunity. To apply for this program please visit: http://essap.tamu.edu/polymer.htm

MARK YOUR CALENDAR FOR PTC's NEXT CONFERENCES!

October 11 - SCRATCH
@ Detroit, Michigan
October 26 - PTIC
@ Texas A & M University

Polymer Technology Center
Texas A&M University
MS 3123
College Station, TX 77843-3123

Hung-Jue Sue, Director
(979) 845-5024
hjsue@tamu.edu

Isabel Cantu
Program Coordinator
(979) 458-0918
icantu@tamu.edu or
ptctamu@gmail.com
Website: http://ptc.tamu.edu

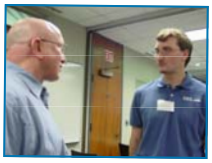
New PTIC member

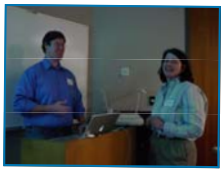
PTC is excited to announce that Tokai Rubber Industries, Ltd. from Japan has decided to join the Polymer Technology Industrial Consortium. Please help us in welcoming Tokai Rubber Industries, Ltd as a new PTIC member.

On April 26th and 27th, PTC held its semi-annual Consortium conferences. The conference attendees are as follows:

Scratch Behavior in Polymers Consortium

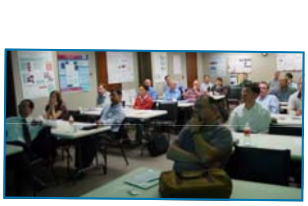
- Advanced Composites, Inc.
- AXEL Plastics
- BASF - The Chemical Company
- Cadillac Products Packaging Co.
- Dow Chemical Company
- Japan Polypropylene Corp.
- Kraton Polymers
- Phillips Sumika Polypropylene Co.
- Rio Tinto Minerals
- Solvay Engineered Polymers
- South Texas Section of the SPE
- Sumitomo Chemical
- Surface Machines Systems
- Visteon



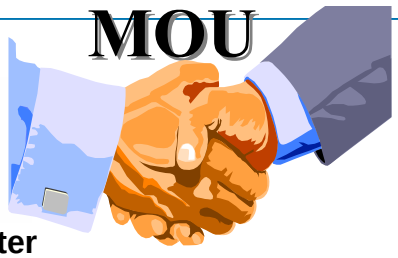



Polymer Technology Industrial Consortium (PTIC)

- AXEL Plastics
- BASF - The Chemical Company
- Cadillac Products Packaging Co.
- Dow Chemical Company
- Goodyear Tire & Rubber Co.
- Halliburton
- Japan Polypropylene Corp.
- Metabolix
- National Chung Hsing University
- Rio Tinto Minerals
- ShawCor Ltd
- Schlumberger
- South Texas Section of the SPE
- Sumitomo Chemical
- Sunoco
- TA Instruments - Waters LLC
- Total Petrochemicals




KRICT
Reliability Assessment Center



PTC

1. Researcher Exchange Program
   (1) Training
   (2) Invited Lecture

2. Collaboration Scope
   - Improvement of Reliability & Durability of Polymeric Materials
   - Plastic Failure Analysis and Degradation Prevention
   - Development of New Accelarated Life-Time Prediction Techniques
   - Characterization of Scratch Behavior of Plastics

Neil Everett

Evanescent Wave and Video Microscopy Methods for Directly Measuring Interactions between Surface-immobilized Biomolecules

The primary aim of this dissertation work was to measure weak interactions between a class of calcium-dependent cell-cell adhesion molecules known as cadherins (Fig. 1). In biology, cadherins (i) play a crucial role in embryonic development, (ii) help regulate controlled cell death (apoptosis) and cell proliferation, and (iii) have been implicated in controlling the infiltration of cancerous cells into healthy tissue. Recent studies have elucidated a wealth of information pertaining to the mechanisms of how cadherins bind and what the strength of these bonds are under loading (non-equilibrium conditions), but little is known about the equilibrium binding behavior of these proteins under different physiologically relevant conditions. The aim of this dissertation work was to develop and extend optical methods and create experimental constructs that can be used to directly measure the extremely weak—though extremely important—forces between these proteins or other biomolecules.

The spatial and temporal tracking of passively diffusing functionalized colloids (Brownian particles) continues to be an improving and auspicious approach to measuring weak interactions on the order of thermal energy, *kT*. Here, video microscopy and evanescent wave scattering techniques (Fig. 2) were utilized to monitor the equilibrium three-dimensional trajectories of ensembles of micro-sized particles diffusing in an aqueous environment. Evanescent wave scattering from spherical colloids (Fig. 3) allows for the diffusing particle's instantaneous height above an underlying surface ("wall") to be determined with nanometer resolution. After observing the fluctuations in scattering intensity over a period of time from each particle, a relationship between intensity and instantaneous particle-wall separation is used to generate the equilibrium distribution of heights (histogram of separations) sampled above the wall by each particle. The separation-dependent potential energy profile (PEP) is then found for individual particles using statistical mechanical analyses. From PEPs, one is able to (i) determine attractive and repulsive forces between the two apposing surfaces with a force resolution around 10fN (10^{-14} N), (ii) accurately measure energy wells as low as 0.1*kT*, and (iii) find particle-wall (i.e., protein-protein) association lifetimes; for comparison, atomic force microscopy has a force resolution of approximately 10^{-11} N.

In this research, particle and wall surfaces were modified with cadherins in order to study the biomolecular interactions between these proteins. Supported lipid bilayers (Fig. 4), which are experimental mimics of cell membranes, were used as model interfaces to orient and immobilize cadherins on the particle and wall surfaces. Importantly, these surfaces retain the fluid properties of native cell membranes, allowing proteins to diffuse and interact laterally as they do *in vivo*.

Results from these studies showed that weak interactions between protein-decorated colloids can be measured with a sensitivity unattainable with scanning probe techniques. Furthermore, the experimental construct developed here proved to be a robust and reliable way to immobilize biomolecules and unambiguously probe their interactions.

Neil will be receiving his Ph.D. in August 2007, and he has been co-advised by Drs. H-J Sue and Michael A Bevan. He plans to pursue an academic career in the future, and the PTC wishes him the best of luck in this endeavor.

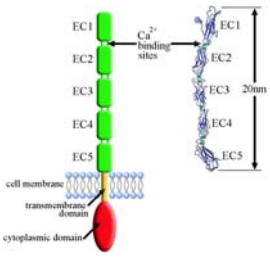


Fig. 1

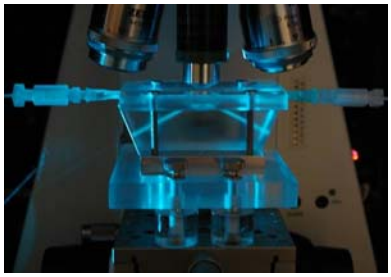


Fig. 2

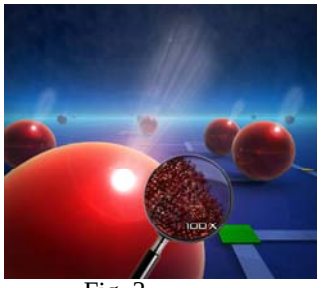


Fig. 3

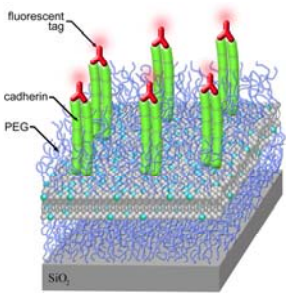


Fig. 4

Student Presentations at ANTEC Cincinnati, Ohio

IMPACT FRACTURE BEHAVIOR OF PP/EPR BLENDS

J. Liu, J.-I. Weon, H.-J. Sue
Polymer Technology Center, Department of Mechanical Engineering,
Texas A&M University, College Station, TX 77843-3123
R.D. Ding, C.P. Cheng, N. O'Reilly
BASF Catalysts LLC, 10001 Chemical Road, Pasadena, TX 77507

Abstract

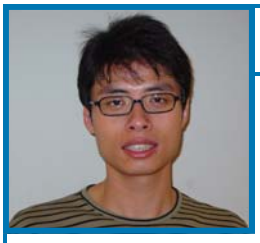
The impact fracture behaviors of two commercial polypropylene/ethylene-propylene rubber (PP/EPR) blends were investigated. The morphology and interfacial characteristics were directly characterized by transmission electron microscopy. The effects of EPR composition on phase morphology, interface and impact fracture behavior were systematically studied. The toughening mechanisms were examined using the double-notch four-point-bending technique. It was found that crazing and shear banding are the two dominant energy dissipation mechanisms in the impact PP/EPR blends investigated. Possible approaches for optimizing the impact strength of PP/EPR blends were also discussed.

Effect of Surface Texture/Roughness on Polymer Scratch Behavior

H. Jiang, R. Browning, A. Moyse and H.-J. Sue
Polymer Technology Center, Department of Mechanical Engineering
Texas A&M University, College Station, Texas 77843-3123

Abstract

Surface texture/roughness is necessary under certain circumstances. Their effects on scratch performance cannot be neglected and have to be examined. The scratch experiment was conducted for two smooth and textured samples (random animal skin and grained surfaces). It turned out that both types of surface texture can delay the onset visibility while the level of improvement depends on texture pattern, material characteristics, etc. To study the effect of surface roughness, the experimental results of the controlled surface roughness samples were compared with the smooth and random animal skin samples. Rougher surfaces exhibit a lower friction coefficient and a better scratch performance. Textured surfaces have better scratch resistance mainly because their surfaces can mask the onset fish-scale transition well and have a lower friction coefficient. It also showed that the effect of roughness on scratch performance depends on the scratch tip size.



PTC Visiting Scholar from Taiwan

Howdy! My name is Chien-Chia Chu and I am a visiting scholar from the National Chung Hsing University in Taiwan. Thanks to Dr. Sue's recommendation letter, it is possible for me to be awarded funding to complete the last year of my PhD program in his group at Texas A&M University. I am so excited that I have the opportunity to study and research in a whole new environment. I also have a good way to enter American culture thanks to my roommate Jonathan. I have only stayed here for two weeks so far, but I have already gotten used to the people, food and life in this area. It's so wonderful that I can be here.

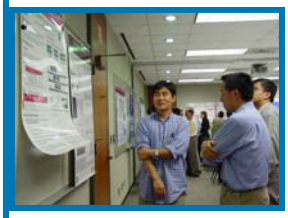
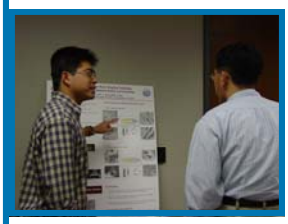
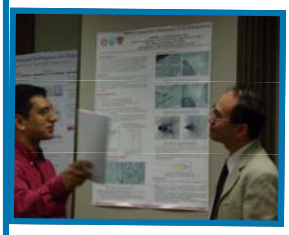
My background is in polymer material science, so I am looking forward to using my experience to generate a lot of new ideas that utilize a new material (α-ZrP). I already know all of the PTC colleagues, and I am making sure that I can work hard and get along with them well. Finally, I want to give great thanks to my professor, Dr. Lin from Taiwan, for his confidence in me that allowed me to come here. I am looking forward to spending the next 1-2 years at Texas A&M University.

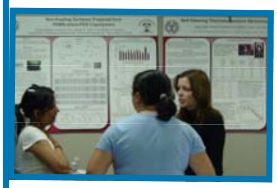
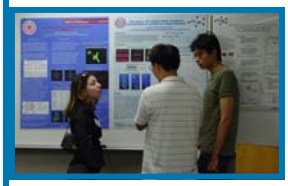
--Chien-Chia Chu

PTIC Poster Session

The poster session was held on Thursday, April 26th in the evening and Friday, April 27th during the lunch hour. PTC would like to thank all the students that took advantage of this opportunity by displaying their research for the Polymer Industry. There was a lot of research information being shared with Industry, students, and faculty. The poster session turned out to be a huge success. The poster titles and authors are listed below.

- Ab-Initio Molecular Modeling of Energetic Materials
  Oscar Ojeda, Mustafa Uludogan, **Tahir Cagin**
- Mechanical and Thermodynamic Properties Calculations of Polymer Clay Nanocompo sites
  Selma Atilhan, **Tahir Cagin**
- Polymer-Carbon nanotube composites
  Arnab Chakrabarty and **Tahir Cagin**
- Polymer Sensor Modeling for Explosive Detection
  Dedri Arman, **Tahir Cagin**
- Structure and Dynamics of Water Within Cyclic Peptide Nanotubes
  Jennifer Andrea Carvajal and **Tahir Cagin**
- Layer-by-Layer Deposition and Pattering of Carbon Black Thin Films
  Jaime C. Grunlan, Matthew Walton, C. Jason Jan, W. Neil Everett, and Ethan P. McConnell
- Layer-by-Layer Foil Replacement
  Woo-Sik Jang, Ian M. Rawson and **Jaime C. Grunlan**
- Tailoring Carbon Nanotube Dispersion and Conductivity with Weak Polyelectrolytes
  Lei Liu and **Jaime C. Grunlan**
- Non-Fouling Surfaces Prepared from PDMS-block-PEO Copolymers
  Ranjini Murthy, Casey D. Cox, Mariah S. Hahn, and **Melissa A. Grunlan**
- Self-Cleaning Thermoresponsive Nanocomposite Hydrogels
  Yaping Hou, Ashley M. Smitherman, Mariah S. Hahn, and **Melissa A. Grunlan**
- Development of Reinforced BioPolymers for Orthopedics
  Douglas E. Rodriguez, H.J. Sue, Khalid Lafdi, **Ozden O. Ochoa**
- Active Nanocomposites: Engery Harvesting and Stress Generation Media for Future Multifunctional Aerospace Structures
  Zoubeida Ounaies, Ramanan Krishnamoorti, Richard Vaia
- Toward Spatial Control af Nanoparticles Distribution in Polymer Composites
  Sumanth Banda and **Zoubeida Ounaies**
- Electrospinning Functional Polymers for Engineering Applications
  Chris Call and **Cris Schwartz**
- UHMWPE / PDMS Nanocomposites for Impact Tolerant Bearings
  Kevin Plumbee, **Cris Schwartz** and Melissa Grunlan
- Double-Notch Four-Point Bending Technique for Toughening Mechanism Studies on Polyolefins
  J. (Daniel) Liu, W.-J. Boo and **H.-J. Sue**
- Impact Fracture Behavior of PP/EPR Blends
  J. (Daniel) Liu, J.-I. Weon and **H.-J. Sue**, & R.D. Ding, C.P. Cheng, N. O'Reilly from BASF Catalysts LLC, 10001 Chemical Road, Pasadena, TX 77507
- Mechanical Behaviors and Toughening Mechanisms of Talc- and CaCO3- Reinforced Polypropylene Composites
  J. (Daniel) Liu, W.-J. Boo, J.-I. Weon and **H.-J. Sue**
- Objective Evaluation of Coating Scratch Resistance: Effect of Coating Thickness
  R.L. Browning, G.-T. Lim, A. Moyse and **Hung-Jue Sue;** H. Chen, J.D. Earls from The Dow Chemical Company
- Transparent PMMA/ZnO Nanocomposites Based on Colloidal ZnO Nanoparticles
  Dazhi Sun, Nobuo Miyatake, and **Hung-Jue Sue**


PTC Faculty

Name	E-mail Address	Office #
Perla Balbuena	Balbuena@tamu.edu	979-845-3375
Dave Bergbreiter	bergbreiter@tamu.edu	979-845-3437
Michael Bevan	mabevan@tamu.edu	979-847-8766
Tahir Cagin	cagin@che.tamu.edu	979-862-1449
Elena Castell-Perez	ecastell@tamu.edu	979-862-7645
Xing Cheng	chengx@ece.tamu.edu	979-845-5130
Abraham Clearfield	aclearfield@tamu.edu	979-845-2936
Terry Creasy	tcreasy@tamu.edu	979-458-0118
Jaime Grunlan	jgrunlan@tamu.edu	979-845-3027
Melissa A. Grunlan	mgrunlan@tamu.edu	979-845-2406
Wayne Hung	hung@tamu.edu	979-845-4989
Helen Liang	hliang@tamu.edu	979-862-2623
Ed Marotta	emarotta@tamu.edu	979-458-3580
Roger Morgan	roger-j-morgan@tamu.edu	979-845-1292
Anastasia Muliana	amuliana@tamu.edu	979-458-3579
Ozden Ochoa	oochoa@tamu.edu	979-845-2022
Zoubeida Ounaies	zounaies@tamu.edu	979-458-1330
K.R. Rajagopal	krajagopal@tamu.edu	979-862-4552
J.N. Reddy	jnreddy@tamu.edu	979-862-2417
Cris Schwartz	cschwartz@tamu.edu	979-845-9591
Dan Shantz	shantz@tamu.edu	979-845-3492
Erik Simanek	simanek@tamu.edu	979-845-4242
Hung-Jue Sue	hjsue@tamu.edu	979-845-5024
Steve Suh	ssuh@tamu.edu	979-845-1417
Jyhwen Wang	jwang@tamu.edu	979-845-4903
John Whitcomb	whit@aero.tamu.edu	979-845-4006

PTC Seminars

"Polymer Research Evolution in Reactive Extrusion and Nano-Modified Polymers"

Professor Charles L. Beatty
Department of Materials Science and Engineering
University of Florida

Compatibilization of mixed composition plastics resulted in a ATP research project for post-consumer plastics with the acquisition of equipment and buildings off - campus for processing and characterization.

Recent research via reactive extrusion has yielded the production of nano elastomeric domains in isotactic polypropylene, (iPP), - thereby allowing bottles to be blow molded with an increase in the empirical drop height from 6 inches to 4.5 feet. This is a new mechanism for impact modification that is related to changes in the intrinsic relaxation time distribution of the iPP that surrounds the elastomeric nanoparticles. Other research involved in other impact modifications are for blast-proof windows for the government, bullet – proof visors, canopies, etc. for the military, as well as for hurricane, tornado, vehicular window accident applications, etc. for companies. In addition, exploratory research on toughening thermosets without loss of modulus, creep resistance and strength characteristics is underway.

Use of "Maxell Demons" generated by reactive extrusion to allow transparent polymeric nanocomposites to be made at high loadings of nanoparticles will be described as well as new surface segregated polymer/polymer alloys. Polymeric nanocomposite coatings for permeability control: as oxygen blocking layers in organic electronics fabrication, food packaging containers, food packaging films (using iPP) and soft drink, beer, and other bottles (using PET) are being investigated.

Nanofiber mats and nanotube mats are being produced with anti-virial and anti-bacterial biomedical applications, as well as for engineering materials (i.e., ceramic and polymeric composites and ductile concrete/cement).

Super-critical carbon dioxide processing is utilized to achieve clean (i.e., green polymer degradation and polymer synthesis reactions, purification and infusion of small molecules into polymeric systems (e.g., compounds to provide protection for wood to fungal and termite attack without discoloration of the wood or use of toxic chemicals and infusion of drugs into a newly invented elastomeric stent to prevent tissue growth).

Very recent research suggests that it may be possible to grow nanoparticles directly from specific reactive groups on polyolefin chains. Dream on!

"Olefin Block Copolymers via Chain Shuttling Polymerization"

Jeffrey Weinhold
The Dow Chemical Company

The mechanical properties of polyethylene products are often tailored through random copolymerization with an alpha-olefin. A drawback to this approach, especially for elastomeric applications, is the reduction in melting temperature that occurs as the comonomer content is increased. Olefin Block Copolymers (OBC) produced by chain shuttling catalysis are able to break this relationship, resulting in both excellent elastic properties and high melting temperatures. The critical role of modeling and high throughput screening in the discovery of fast shuttling catalysts will be presented. Results from analytical techniques will be shown as well as comparisons of OBC elastic properties vs incumbent products.

"New Medical Devices and Technologies for Treating Abdominal Aortic Aneuysm"

Jack Chu
Solace Medical

An aneurysm is a dilation of a blood vessel to greater than 50% of its normal diameter. Aneurysms are most commonly found in the abdominal aorta, thoracic aorta and cerebral arteries. For abdominal aortic aneurysms (AAA), about 5% of the seniors over 65 years old will get it. Nearly all aneurysms eventually rupture if they are left untreated. It is the 13th leading cause of death in the United States. In this presentation, several current treatment options will be discussed. The new, minimally invasive endovascular therapy will be demonstrated. It is inserted into the afflicted artery segment in order to form a new conduit and thereby shielding the weakened aneurysm wall from the pulsatile blood flow. Other than endovascular therapy, several therapies such as local drug therapy, will also be discussed. The dose of drug required to achieve significant suppression of aneurysmal dilatation was at least 100-fold lower with local drug delivery, compared to systemic administration.

THANK YOU

PTC would like to acknowledge and thank TA Instruments for their generous effort to keep up with PTC needs by sponsoring the lunch at the PTIC meeting on April 27th.

PTC Newsletter prepared by: Isabel Cantu
Edited by: Neil Everett & Jonathan O'Reilly