Newsletter Summer 2011 Edition

Polymer Technology Center

MARK YOUR CALENDAR FOR PTC'S UPCOMING CONFERENCES!

- **October 5th—SCRATCH**
  @ Detroit, Michigan
- **October 27th-28th—PTIC**
  @ Texas A & M University
- **November 3rd—APPEAL**
  @ Texas A & M University

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PTC held its semi-annual conference meetings for the Scratch Behavior of Polymers Consortium (Scratch) on April 7th, 2011 and the Polymer Technology Industrial Consortium (PTIC) Meeting on April 7th-8th, 2011 with the following companies in attendance:

Scratch Behavior of Polymers Consortium

- *Advanced Composites, Inc.*
- *ARKEMA*
- *BRASKEM*
- *Cadillac Products Packaging Company*
- *Flint Hills Resources, LP*
- *KANEKA*
- *MyTex Polymers*
- *Phillips Sumika Polypropylene Company*
- *Rio Tinto Minerals*
- *South Texas Section of the SPE*
- *Space Food Systems Laboratories*

Polymer Technology Industrial Consortium

- *Advanced Composites, Inc.*
- *Advanced Technology Diversified Products*
- *BRASKEM*
- *Cadillac Products Packaging Company*
- *Dow Chemical*
- *Flint Hills Resources, LP*
- *KANEKA*
- *MyTex Polymers*
- *SBC Polymers Consulting*
- *South Texas Section of the SPE*
- *Space Food System Laboratories*
- *The Research Valley Partnership, Inc.*
- *Total American Services Inc.*

FLINT HILLS resources®

PTIC Newest Member

PTC is pleased to announce Flint Hills Resources as the newest Polymer Technology Industrial Consortium (PTIC) Member.

Dr. Daniel Shantz, Chemical Engineering

Living in a Material World

Considering a human hair is about 100,000 nanometers wide, a five-nanometer-wide hole doesn't seem very big, but it provides all the room Daniel Shantz needs to work his magic.

That "magic" is the science of organic chemistry being performed inside each of the microscopic pores of a sponge-like membrane Shantz is working to develop – a membrane with the potential to help alleviate the nation's dependence on foreign oil.

Shantz, an associate professor in the Artie McFerrin Department of Chemical Engineering at Texas A&M University, works in the area of materials development, with a particular focus on energy. His latest project, a National Science Foundation-funded effort, is aimed at developing materials that can selectively remove valuable components, such as sugars, from the complex mixtures produced from biomass conversion. These compounds can then be blended with conventional fuels or used as alternative fuels after additional processing.

Much like crude oil, current approaches to biomass conversion result in a crude mixture containing many compounds. Many of these compounds (for example, water and acids) must be removed before the mixture can be rendered usable, Shantz explains. But unlike crude oil, for which refineries exist to achieve this process, separation technology is relatively nonexistent for bio-oils and cellulose hydrolysis mixtures, Shantz says.

"The chemical nature of these mixtures is very different from those primarily found in current refineries and can't really be used 'as is'," Shantz says. "Current approaches to biomass conversion - such as cellulose hydrolysis or biomass pyrolysis – result in very complex mixtures. The question then becomes how do I get the valuable compounds out in an efficient way and leave the undesirable stuff behind. If there is twenty percent of something of value, can I separate it out effectively so that I can blend it into existing fuel pools?"

"Fueled" by that question, Shantz is developing a novel membrane that can function as a filter of sorts for these biomass mixtures. Typical filters do their job based on size, similar to how a strainer drains water from spaghetti while retaining the pasta, but Shantz's nanoscale filter relies on chemistry to achieve the desired separations.

Utilizing a ceramic membrane that contains numerous pores – each five nanometers wide – Shantz is inserting branched layers of organic molecules within each microscopic hole. These organic molecules, known as dendrimers, are grown off the surface of the membrane and covalently attached within each pore by chemical bonds, Shantz explains. It is this "nano-stubble" that goes to work, absorbing or binding the molecules Shantz wants to separate.

"Think of these membranes as tiny sponges," Shantz says. Within each of the holes in these sponges, we're growing molecule trees, and we can grow different types of trees depending on what we want them to separate.

"So instead of sieving based on size, we are looking at achieving a solubility-based separation. Think of the old adage – like attracts like. In other words, I have a molecule that is much more soluble in this pore. What that effectively does is partition it across the membrane. These molecules absorb in and then the pores become full of them. These desired elements go into the membrane much more readily and will then move through."

It's an innovative approach to what Shantz calls a "horrendous separation problem" faced by the petrochemical industry as they search for ways to make renewables a larger percentage of their feedstocks and do so by using their existing facilities.

"We are trying to design structure and chemistry on short-length scales," Shantz says. "By changing things very deliberately on the nanometer scale with some organic chemistry, we believe we can make membranes that will sort out a group of molecules if we do the chemistry one way, another group of molecules if we do the chemistry another way."

That flexibility of the chemistry is something Shantz says adds to the potential attractiveness of this approach. In addition to being less energy-intensive than traditional separation techniques such as distillation, a membrane-based separation technique offers several methods for achieving separation. Employing a solubility-based approach, Shantz can in theory design a dendrimer so that specific molecules of a mixture will react with it more strongly than other molecules, solubilizing and eventually passing through the membrane. In contrast, Shantz is also working to design membranes that can bind up certain components of a mixture, such as in medal sequestration where lead is removed from water.

It's all part of a solution that Shantz views as a viable, intermediate-term answer to shifting the fuel pool away from petroleum. Although scientists' long-term goal is to develop processes that break down biomass into *only* the desired compounds, that has not yet happened, Shantz explains. For now, the ability to glean valuable chemical compounds from these complex mixtures represents a significant step towards a productive transitional period in the nation's adoption of alternative energy, he says.

"What we're doing is that we are using chemistry to engineer structure and function at the nanometer-length scale, and by doing that we hope to do separations that people can't do." Shantz says. "We can make things that have engineering importance."

Daniel Shantz is holder of the Ray Nesbitt Development Professorship III and associate head for undergraduate programs in the Artie McFerrin Department of Chemical Engineering at Texas A&M. In addition, he also is associate director of the university's Materials Characterization Facility/ Microscopy and Imaging Center.

Dr. Shantz installs a membrane that will be tested for separating carbon dioxide and nitrogen as part of a Dow Chemical supported project.

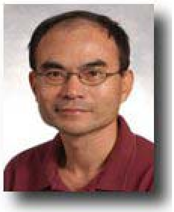
Prof. Hung-Jue Sue
Dept. of Mechanical Engineering

Development and Testing of Advanced Polymer Systems at Texas A&M

The use of polymer composites is rapidly expanding with their acceptance in applications historically relegated to conventional engineering materials, and novel applications made possible by their unique properties, such as thin film electronics. However, the development of these materials is hindered by the challenge in establishing clear understanding between the molecular and bulk response. Professor Hung-Jue Sue's research is focused on three primary areas: the incorporation of model nanoparticles into polymer matrices for novel applications, the fundamental characterization of scratch behavior in polymers, and toughening of polymers. These research fields fall within a broader objective to understand and fulfill the needs of the polymer community and tailor research aiming to bridge between fundamental understanding of material behavior and the development of commercially viable products.

Polymer nanocomposites are a broad class of materials in which nanometer-scale filler particles with unique properties are incorporated within a continuous polymer matrix. Conventional micron-sized fillers have revolutionized the polymer industry with applications such as carbon fiber reinforced plastics in commercial aircraft, and carbon-black reinforced rubbers in tires. Polymer nanocomposites have potential to significantly enhance these improvements by offering similar properties at much lower concentration due to the increase in surface area. Even more exciting are novel applications which are possible by introducing nanoparticles which interfere with the molecular behavior of the polymer matrix, creating otherwise unattainable unique physical behaviors. In Prof. H.-J. Sue's lab, three types of model nanoparticles with well controlled size and shape have been synthesized and well characterized in both individual state and when incorporated in polymer composites. Zinc oxide (ZnO) quantum dots with diameter of about 5 nm have been synthesized and individually dispersed in a number of polymer matrices. When incorporated in poly(methyl methacrylate) (PMMA), a widely used transparent thermoplastic, there is a substantial increase in thermal stability without loss in transparency. Two-dimensional zirconium-phosphate (ZrP) and clay nanoplatelets have been individually exfoliated and incorporated into epoxies to provide significantly enhanced elastic modulus, tensile strength, and barrier properties without embrittlement, significant weight gain, or loss in transparency. Very recently, individual 1-dimensional nanoparticles of carbon, known as carbon nanotubes (CNTs) were exfoliated using ZrP nanoplatelets to yield a highly flexible, conductive clay film with excellent environmental stability. The role of particle interaction between these model NPs has also been studied. Rheology is currently being used as a means of relating nanoscale structure with mesoscale network formation to better understand physical response of these materials.

Extensive fundamental research has been conducted on the scratch behavior of polymers. As part of the Polymer Scratch Behavior Consortium (SCRATCH), the first standardized testing and analysis methodology for scratch behavior was developed (ASTM D7027/ISO 19252). This approach has allowed for a unified, extensive fundamental understanding of the polymer scratch behavior. Over a decade of research has been performed from both mechanistic and aesthetic perspectives. The mechanistic approach has attempted to correlate numerical simulation with experimental findings. Numerical approaches, with focus on finite element analysis (FEA), have been used extensively to study the underlying mechanics involved with scratch deformation. The primary aesthetic metric of interest has been the resistance to scratch visibility, which was carried out using digital image analysis based on human optical physiology. The combined use of image analysis and ASTM/ISO scratch test standards have enabled quantitative analysis of visibility and allowed the development of better scratch-resistant polymeric systems.



The toughening and strengthening of polymers, composites, and films is the third focus of Dr. H.-J. Sue's research group. Premature fracture of engineering materials is a significant limitation for many polymeric materials. Toughening is generally approached with the addition of a second phase toughening particle which is able to improve impact resistance and damage tolerance. The identification of fracture mechanisms in engineering polymers is a unique strength of the research group. A wide variety of plastics (polypropylene, polyethylene, polyketone, polystyrene, ABS, nylon, polycarbonate, biodegradable plastics, and thermosetting resins) have been used to study how different toughening particles (core-shell particles, ethylene-propylene rubbers, styrene-ethylene-propylene rubbers, calcium carbonate, talc, silicon dioxide, clay, zirconium phosphate nanoplatelets, and nano-sized block copolymer micelles) influence the fracture process. This insight has been useful for the development of toughened plastics for the aerospace, automotive, and packaging industries.

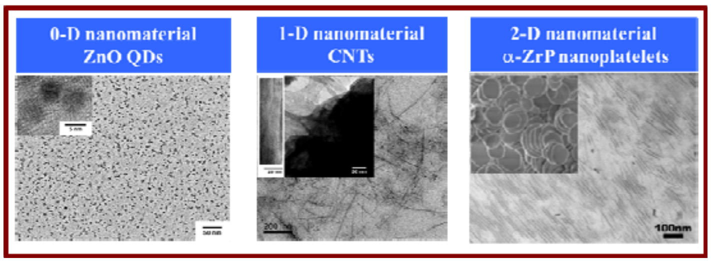


Figure 1. Overview of nanomaterial research with Prof. H.-J. Sue's research group at Texas A&M University. In order to relate structure and property, model nanocomposites have been developed with individual exfoliation and homogeneous dispersion. The nanoparticles have been successfully dispersed in various polymer matrices for substantial property enhancement.

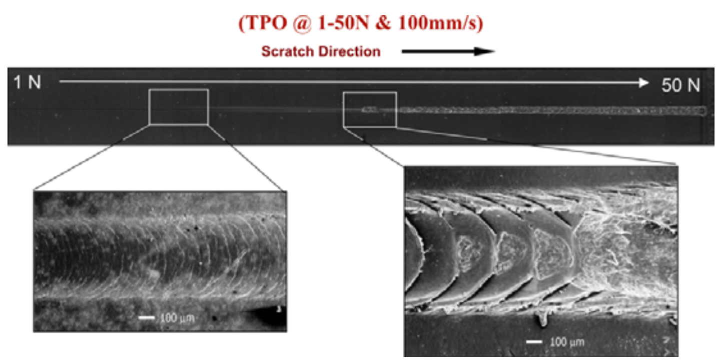


Figure 2. ASTM and ISO standardized scratch test applies linearly increasing load along surface, allowing the individual scratch mechanisms to be studied.

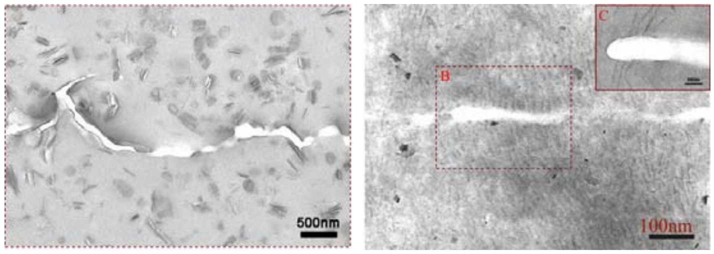
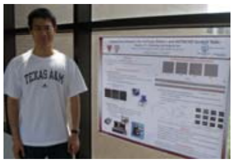
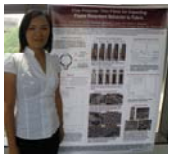
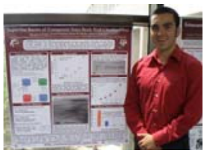


Figure 3. Crack propagation in ZrP-reinforced epoxy. On left, ZrP are partially exfoliated and crack propagates through rupture of clay tactoids. On right, individual ZrP do not interfere with the crack propagation and therefore do not affect fracture toughness of composite.







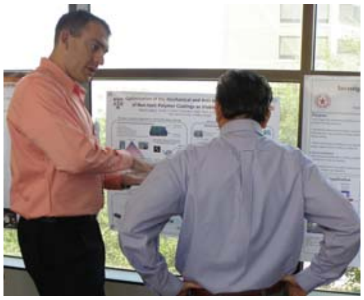
PTIC Student Poster Session was a huge success. The award recipients were:

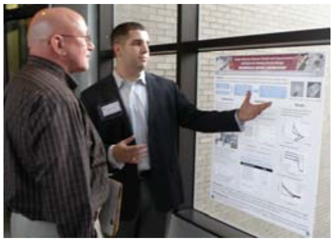
- 1st place, Peng Liu, MEEN
- 2nd place, Yu-Chin Li, MSEN
- 3rd place, Morgan Priolo, MEEN

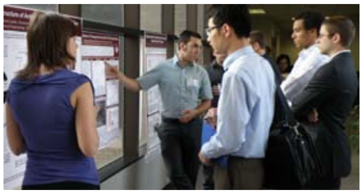
PTC would like to congratulate these students. PTC would like to let everyone know that there will be more opportunities for you to compete in the Student Poster Session as they are held twice a year, once in the Spring and once in the Fall. Again, congratulations to these students and thanks to all that participated in this event.

Participants of the PTIC Student Poster Session
April 7-8th, 2011

Students Name	POSTER TITLES
Alejandro Camou	"Investigating the Potential of Using Thermoelectric Devices to Harvest Frictional Heat in Polymer Bearings"
Brian Hare	"Evaluation of Packaging Film Integrity Using Standardized Scratch Test"
Mohammad Hossain	"FEM Parametric Study on Scratch Behavior of Polymers"
Hsiu-Chin Huang	"Transparent and Flexible Free-Standing of Polyelectrolyte Multilayers Assembled with Self-Healing Ionomer"
Xiayun Huang	"The Wettability Modulation of Polyelectrolyte Multilayer Film"
Phil Imbesi	"Optimization of the Mechanical and Anti-Biofouling Properties of Non-Toxic Polymer Coatings as Viable Ship Hull Paints"
Galina Laufer	"Growth and Microstructure of Antimicrobial Layer-by-Layer Thin Films"
Yu-Chin Li	"Clay-Polymer Thin Films for Imparting Flame Retardant Behavior to Fabric"
Peng Liu	"Comparison Between the Erichsen Delta-L and ASTM/ISO Scratch Test"
Gregory Moriarty	"Enhancement of Thermoelectric Properties of Segregated-Network Polymer-CNTs Composites"
Jacqueline Pope	"Characterization of PEEK (Polyetheretherketone) Polymers by Solid-State NMR Spectroscopy"
Morgan Priolo	"Super Gas Barrier of Transparent Nano Brick Wall Ultrathin Films"
Brent Volk	"Shape Memory Polymer Models with Experimental Validation for Medical Device Design"
Kevin White	"Hierarchical Strength Enhancement of Carbon Fiber Reinforced Epoxy Nanocomposites"
Minhao Wong	"A Highly Stable Dispersion of Nanoparticle-Nanocomposite Obtained Via Free Radical Copolymerization"
Paul Zeits	"Cp*Ir Cationic π–Adducts of Poly(Phenylene–Vinylene)"







TAMU NEWS

Thank You & Farewell
Former TAMU President Dr. Robert Gates

In 2006, Aggieland said "farewell" to Dr. Robert Gates, the 22nd President of Texas A&M University, as he accepted the nomination for United States Secretary of Defense.

Former TAMU president Dr. Robert M. Gates retired on June 30, 2011 from his post as Secretary of Defense.

President Obama awarded Dr. Gates with the Presidential Medal of Freedom, the highest award a civilian can be bestowed in the US. President Obama said that Gates had earned the right to retire after serving seven presidents. When Gates agreed to President Obama's request to continue to as Secretary of Defense, the President stated it was because Dr. Gates is a "humble American patriot, a man of common sense and decency: quite simply one of our nation's finest public servants."

You've made Aggieland proud!

Texas A&M Baseball Team Goes to the College World Series

The TAMU baseball team made it to the College World Series after defeating a tough Florida State team.

Texas A&M baseball team faced South Carolina at the College World Series Sunday, June 19, at 6 p.m. Unfortunately for the Aggies, they lost 5-4. Despite the loss, TAMU fans had an awesome Father's Day game at Omaha , Nebraska.

Time Capsule Found

Dr. R. Bowen Loftin, TAMU President said "Little did we know when we started renovating and expanding the historic YMCA Building that we'd find something left behind for us -- a time capsule containing a 1911-1912 annual catalog, a 1912 student handbook, a Battalion article on the building's groundbreaking and other artifacts. You can view the items at the Cushing Memorial Library and Archives." for more information, visit: http://library.tamu.edu/news/visit-1912-time-capsule-display-at-cushing-library/

PTC NEWS

PTC's Post Doc Dr. Lin Jin

Hello. My name is Lin Jin. I am currently working as a postdoc in Prof. Sue's group at the Polymer Technology Center. My research focus is on PAEK and their composites. The challenge is to correlate dimensional stability of PAEK and other high performance polymer materials with their molecular nature and processing variables, so as to minimize residual stress and warpage of the materials.

I grew up in Shanghai, China, and moved to Cleveland, OH where I received my PhD degree in Macromolecular Science and Engineering from Case Western Reserve University.

I would like to thank Dr. Sue and Dr. Bremner for providing me with such a great opportunity to work in this excellent research environment .

Dr. Chien-Chia Chu, Post-Doctoral Returns to Taiwan

Dr. Chien-Chia Chu received his Ph.D degree in Chemical Engineering from National Chung Hsing University of Taiwan in 2008 and has been working with Professor H.-J. Sue as a post-doctoral research fellow at Polymer Technology Center since 2009. With years of experience in a nanomaterial dispersion, his work focuses on the dispersion of nanomaterial in polymers and to analyze the property improvement involving thermal, electrical and mechanical behaviors.

Dr. Chien-Chia Chu will wrap up his research at Texas A&M University and will join a nanotechnology company in Taiwan as a researcher this summer. He will continue to work on nanomaterial dispersion and related research. He is open to the collaboration opportunities in the field of material and polymer science. He can be reached at: adrian0524@yahoo.com.tw

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UPCOMING PTC SEMINAR ANNOUNCEMENT

Polymer Nanohybrid from Imogolite Nanofiber
August 26, 2011 @ MEOB Room 301 @ 10:30-11:30am

By: Atsushi Takahara
Institute for Materials Chemistry and Engineering, Kyushu University, Fukuoka, JAPAN

An overview on recent development of imogolite reinforced nano-composites, including fundamental structure, synthesis/purification of imogolite, physicochemical properties of nanocomposites and its potential application in industry is presented. The naturally derived nanotubular material of imogolite represents a distinctive class of nanofiller for industrially significant polymer. The incompatibility between the surface properties of the inorganic nanofiller and organic matrix has prompted the need to surface modify the imogolite. Early problems in increasing the binding properties of surface modifier to imogolite has been overcome by using a phosphonic acid group. Different approaches have been used to gain better control over the dispersibility of nanofiller and further to improve the physicochemical properties of nanocomposites. Among these, polymer grafting, *in situ* synthesis of imogolite in polymer matrix, and spin-assembly are some of the profound method that will be presented herein.

Congratulations to the TAMU/SPE Student Chapter Officers for 2011-2012

President: Kevin White
Vice President: Casie Hilliard
Secretary: Jacqueline Pope
Treasurer: Kevin Laux
Webmaster: Tiffany Pinder
Publicity Coordinator: Danielle Policarpio
Activities Coordinator: Peng Liu
Chemistry Rep.: Melissa Clough
Chem. Eng. Reps.: Andres Mejia (graduate)
Krsteen Abdelsayed (undergraduate)
Aero. Eng. Rep.: Timothy Omoniyi
Mech. Eng. Rep.: Spencer Hawkins
Biomedical Eng. Rep.: Melissa Giese
Materials Science Eng. Rep.: Julibeth Martinez

3rd Place 2011 Challenge Grant Contest Winner

The Polymer Modifiers & Additives Division of the Society of Plastics Engineers presented Mr. Minhao Wong the third place award for participating in the 2011 Challenge Grant contest.
Congratulations Minhao Wong

Polymer Specialty Certificate Updates

Students that have applied for Certificate	**25**
Students that have received the Polymer Specialty Certificate	**16**

For more information:

http://ptc.tamu.edu/certificate.html

Kevin White, SPE Student Chapter President

TAMU/SPE Student Chapter

To find out more about the TAMU/SPE Student Chapter please contact Kevin White at: whitek@tamu.edu

Visit the SPE Student Chapter website at:

http://plastics.tamu.edu/

PTC Newsletter prepared by: Isabel Cantu
Edited by: Garrett Nowak & Kevin White