Winter 2008 Edition

POLYMER TECHNOLOGY CENTER

PTC Newsletter

Polymer Specialty Certificate Program

TAMU students can apply for this program. Please visit: http://essap.tamu.edu/polymer.htm

MARK YOUR CALENDAR FOR PTC's NEXT CONFERENCES!

April 22-23 - Short Course (Scratch and Wear Behavior of Polymers and Composites)
@ Texas A&M University

April 24th - SCRATCH
@ Texas A&M University

April 25th - PTIC
@ Texas A & M University

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New PTIC and Scratch members

PTC is excited to announce that KRICT (Korea Research Institute of Chemical Technology) has joined the Polymer Technology Industrial Consortium. Please help us in welcoming KRICT as a new PTIC member.

PTC is also excited to announce that Braskem from Brazil has joined the Scratch Behavior in Polymers Consortium (Scratch). Please help us in welcoming Braskem as a new Scratch member.

PTIC and SCRATCH Meetings

PTC held its semi-annual meetings in October. The Scratch Behavior in Polymers Consortium was help in Auburn Hills, MI on October 11. The PTIC Consortium was held at TAMU on October 25-26. The companies in attendance are as follows:

Scratch Behavior in Polymers Consortium

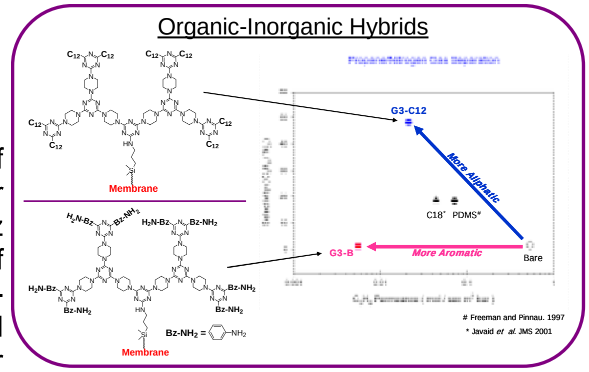
- **Advanced Composites, Inc.**
- AXEL Plastics
- Cadillac Products Packaging Company
- Ciba Specialty Chemical Ins.
- Daimler Chrysler
- Dow Chemical Company
- GM
- Honda
- Kraton Polymers
- Japan Polypropylene Corporation
- MyTex Polymers Corporation
- Nissan-USA
- Phillips Sumika Polypropylene Corp.
- Rio Tinto Minerals
- Solvay Engineered Polymers
- Sumitomo Chemical
- Visteon

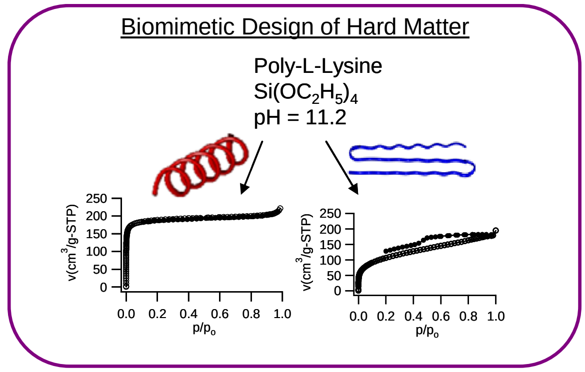
Polymer Technology Industrial Consortium (PTIC)

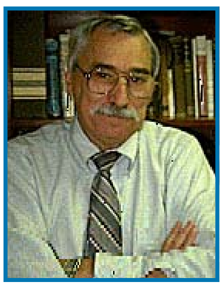
- Ashburn Technologies
- BASF - The Chemical Company
- Dow Chemical Company
- INEOS Olefins & Polymers
- Kaneka Texas Corporation
- Kraton Polymers
- KRICT (Korea Research Institute of Chemical Technology)
- Kyoto Institute of Technology-Japan
- MTS Systems
- MyTex Polymers Corporation
- National Chung-Hsing University-Taiwan
- The Research Valley Partnership, Inc.
- South Texas Section of the SPE
- Sunoco Inc.
- Tokai Rubber-Japan
- Total Petrochemicals
- Toyo Ink International Inc.
- Sumitomo Chemical Amercia, Inc.

PTC Faculty Research-Dr. Daniel Shantz, Dept. of Chemical Engineering

Dan Shantz has been with Texas A&M University since 2001 when he started as an Assistant Professor in the Department of Chemical Engineering, where he is now an Associate Professor and the Associate Head for Graduate Programs. The Shantz lab, from a global perspective, is involved in the development of new materials with relevance to engineering applications. On one hand, the research has a strong scientific foundation that involves both material synthesis and characterization to develop robust structure-property relationships. On the other hand, the lab is involved in testing these materials for applications such as catalysis and separations. This testing is the essential engineering component that allows us to understand how the fundamental knowledge gained in the synthesis and characterization work can be brought to bear, in a meaningful way, on societally relevant problems via new/improved materials. The figure illustrates two parts of the Shantz research program involving polymeric materials, the first being supported dendrimers for novel membranes (collaboration with Eric Simanek), and the second being biomineralization of hard matter with biomimetic polymers.







PTC Faculty Research-Dr. Abraham Clearfield-Chemistry Department

Clearfield Group - Layered Materials, Porous Pillared Organic - Inorganic Hybrids

Abe Clearfield joined the faculty at Texas A&M in 1976. He was recently promoted to the rank of Distinguished Professor and also has won a teaching award when at Ohio University. He was awarded an honorary Ph. D. (Honoris Causa) from the University of Oviedo, Spain. He is an internationally recognized chemist for his work on layered phosphates and phosphonates, but also is engaged in problems of nuclear waste remediation.

We have synthesized several families of group 4 phosphates and phosphonates that have layered structures. Group 4 phosphates are isostructural to α-zirconium phosphate, $M(O_3POH)_2$ have a clay-like structure in which the metal is 6-coordinate and forms a layer bonded above and below two phosphate tetrahedra. The ^{-}OH groups point into the interlayer space and the proton can be ion exchanged with other cations. The layers intercalate a host of compounds and are easily exfoliated. We have used this property to form polymer clay composites in which the layers are well dispersed within the polymer. Substitution of a monophosphonate group for the phosphate groups leads to compounds of the type $M(O_3PR)_2$ where the R can be almost any organic group bonded to the phosphonate phosphorous. Functionalization of the R-group leads to a family of reactive materials. Diphosphonic acids of the type 4,4'-biphenyldiphosphonic acid with M^{4+} also form layers, but the layers are cross-linked into 3D-structures. By simple procedures these compounds can be made highly porous with interlayer pores in the 10-20Å range. Functionalization of the aromatic rings imparts a variety of catalytic and chemical properties to these materials.

A. B.

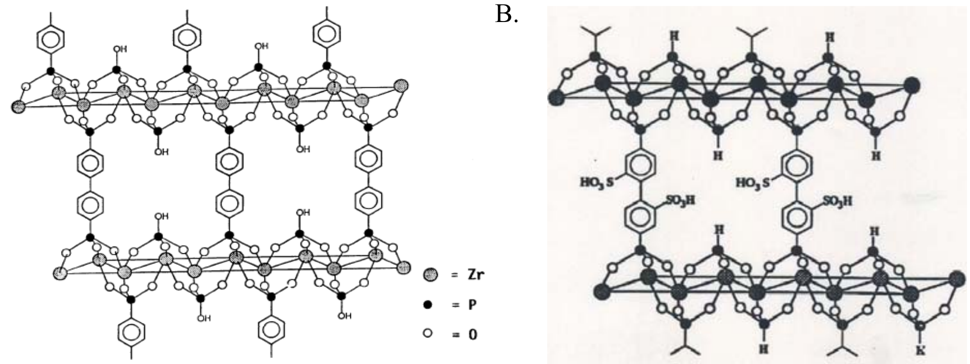


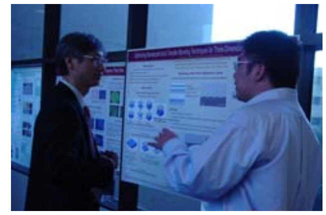
Fig. 1. Idealized representation of α-zirconium phosphonate type layers pillared by biphenyl groups with phosphate spacers to impart (A) ion exchange behavior and (B) bronsted acidity.

Fig. 2. TEM of zirconium phosphate-epoxy polymer nanocomposite showing the dispersion of layers in the polymer.

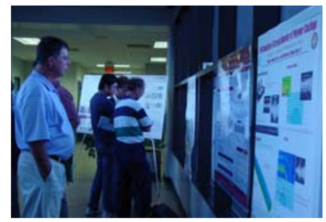
Poster Session at PTIC

The PTC poster session proved to be the best that we have had. The polymer industry, students and faculty were all sharing research ideas, etc.

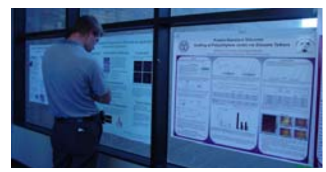
- Mechanical Properties of Energetic Materials
  Oscar Ojeda, **Tahir Cagin**
- Effect of Nanoimprint on Crystallization in Polymer Thin Film
  Hyunsoo Park and Huifeng Li, **Xing Cheng**
- Optimizing Nanoimprint and Transfer-Bonding Techniques for Three-Dimensional Polymer Structures
  Hyunsoo Park, Huifeng Li and **Xing Cheng**



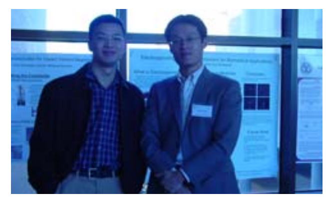
- Clay Assisted Dispersion of Carbon Nanotubes in Conductive Epoxy Nanocomposites
  Lei Liu, **Jaime C. Grunlan**
- Layer by Layer Assembly of PEDOT
  Thomas Dawidczyk, Matthew Walton, Woo-Sik Jang, and **Jaime C. Grunlan**
- Layer by Layer Foil Replacement
  Woo-Sik Jang, Ian M. Rawson, **Jaime C. Grunlan**



- Inorganic-Organic Hydrogel Scaffolds based on Poly(dimethylsiloxane) and Poly(ethylene oxide)
  Yaping Hou, Katherine R. Regan, Cody A Schoener, Mariah S. Hahn and **Melissa A. Grunlan**
- Protein-Resistant Silicones: Grafting of Poly(ethylene oxide) via Siloxane Tethers
  Ranjini Murthy, **Melissa A. Grunlan**
- Development of Reinforced BioPolymers for Orthopedics
  Douglas E. Rodriguez, H.J. Sue, Khalid Lafdi, Mariah Hahn, **Ozden O. Ochoa**

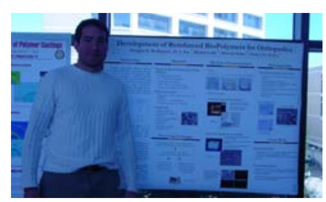


- Electric Field-Tailoring of Single Wall Carbon Nanotube Polymer Composites
  Sumanth Banda and **Zoubeida Ounaies**
- Electrospinning of Continuous Piezoelectric Yarns For Composite Application
  Natasha Lagoudas, **Zoubeida Ounaies**
- Multi-Scale Reinforced Carbon Fiber Nanocomposites
  Ainsley VanRooyen, Sumanth Banda, and **Zoubeida Ounaies**

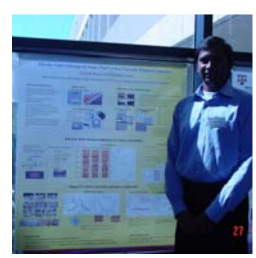


- Polymer Nanocomposites as Electrostrictive and Piezoelectric materials
  Sujay Deshmukh, **Zoubeida Ounaies**
- Single Walled Carbon Nanotube Reinforced High Density Polyethylene Composites by Solution Casting
  Jessica Dowden, Sanjay Kalidindi, **Zoubeida Ounaies**
- Electrospinning Functional for Biomedical Applications
  Chris Call, **Cris Schwartz**

- WHMWPE/PDMS Nanocomposites for Impact Tolerant Bearings
  Kevin Plumlee, **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**
- FEM Simulation of Scratch Behavior of Polymer Coatings
  Han Jiang, R.L. Browning, J.D. Whitcomb and **H.-J. Sue**



- Influence of Additives on the Scratch Behavior of Polymers
  Bobby Browning, G.T. Lim, A. Moyse, L.Y. Sun, and **H.-J. Sue**
- 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 Caoting Scratch Resistance: Effect of Coating Thickness
  Bobby L. Browning, G.-T. Lim, A. Mose, and **H.-J. Sue**
- Scratch Behavior of Anisotropic Polypropylene Surfaces
  Bobby L. Browning, Allan Moyse and **Hung-Jue Sue**



- Synthetic Nanoplatelet Reinforced Polymer Nanocomposites
  J. (Daniel) Liu, Woong Jae Boo, Abraham Clearfield and **Hung-Jue Sue**

PTC Seminars

Strategy and Future for Micro- and Nano-Molding Process

Hiroshi Ito, Dr. Eng.,
Polymer Engineering and Precise Processing Lab
Dept. of Polymer Science and Engineering
Graduate School of Science and Engineering
Yamagata University

Abstract:

Polymer processing, especially injection molding process, is an ideal process for mass-production. For that reason, it is widely used in various industrial situations in the automobile, electrical, and food packaging industries. In recent years, quality improvement and higher performance of molded products are keenly required, especially for precise and micro-scale products such as optical devices, medical applications, information and communication applications, and others. These micro electro mechanical systems (MEMS) will have a far-reaching influence on device manufacture in the near future. During the last two decades, numerous studies have addressed the research and development of MEMS. An intense research interest has prevailed in micro-scale polymer processing because of the growing emphasis on MEMS. In micro-scale polymer processing, e.g. micromolding, micro-scale molded products were placed in three categories; there are molded products with micro-structured surfaces, molded products with milligram less than one pellet weight, and micro-scale thin-walled products. However, micromolding is still in a trial-and-error stage. Moreover, it is difficult to achieve an optimum product design. Most studies have limited their scope to issues of processability and surface observation, and the higher-order structure and properties of the molded products have not been deeply discussed. Molding conditions have a marked effect on structural development and final properties of molded products. Therefore, precise investigation of relationships between molding conditions and structure and physical properties is indispensable. Recently, we have performed micromolding, and have thoroughly analyzed the higher-order structure and final properties of microscale thin- wall molded products. In this time, I would like to talk and discuss about the micro-and nano-molding process/higher-order structure/properties relationship in these processes, and also introduce the future in these moldings in the world.

Canadian National Biofibres Initiative

Sean McKay
Composites Innovation Centre Manitoba Inc.

Dr. Ozden Ochoa, TAMU Professor left and Mr. Sean McKay

Abstract:

Supported by the expansive agricultural base in Manitoba, the Composites Innovation Centre (CIC) has made the development and commercialization of naturally occurring materials in composite structures a priority. This has resulted in the establishment of a pilot biofibre processing capability at the CIC featuring pilot-scale equipment such as a 450-ton hydraulic press, a hammer mill, a fibre separator and a resin applicator. Further, the CIC has composite design and analysis capabilities and laboratory facilities that provide a capacity to develop, process, and test composite materials and prototype products.

In September 2006, Agriculture and Agri-Food Canada (AAFC) provided financial support to the CIC to coordinate a national biofibres research and commercialization project under its Agricultural Policy Framework (APF), Science, and Technology Broker Program. The project's main aim is to develop and commercialize biofibre mats from flax and hemp feed stock as a replacement for fiberglass reinforcements in composite parts. This is combined with the identification and development of markets for the plant's waste stream or co-products generated during removal of the fibres. Specifically, activities that are being undertaken include the following:

- Investigating alternate harvesting techniques
- Developing new decortication facilities and processes
- Performing a fibre grading program that includes test protocols and developing fibre property data bases
- Preparing and assessing natural fibre mat forms to replace fiberglass random oriented chopped strand fibre mats
- Identifying and assessing compatible thermoset resin systems used for resin infusion moulding
- Manufacturing and testing nature fibre reinforced test laminates and products and comparing their properties with similar fiberglass components
- Preparing business cases assessing the profitability of natural fibre and co-product markets
- Developing and commercializing co-products

This seminar will provide a brief overview of the Composites Innovation Centre and describe the current status of the projects being conducted under the Canadian National Biofibres Initiative.

Surface-Challenged Polymer

Janet Wong
Department of Materials Science
Univ. Illinois - Urbana Champaign

Abstract:

Friction and tribology-related problems are costly to our society, and any way to reduce such cost will be beneficial. By understanding how molecules move at interfaces, we gain insight about how energy is dissipated and thus the origin of friction in these systems. This talk describes the first measurements to elucidate polymer surface diffusion. A rich and unexpected dependence is found on molecular weight and surface roughness.

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Short Course: Scratch and Wear Behavior of Polymers and Composites
Date: April 22-23, 2008
Where: Texas A&M University, College Station, Texas
Presented by: Professor Klaus Friedrich, University of Kaiserslautern; Professors Hung-Jue Sue, & Cris Schwartz, Texas A&M University, PTC

Basic Fundamentals
-Fundamental Mechanical Behavior of Polymers
-Fundamental of Friction and Wear of Polymers & Composites
-Fundamentals of Scratch and Mars of Polymers & Composites
-Text and Evaluation Methodology

Applications
-Aerospace Examples
-Automotive Examples
-Design Principles
-Laboratory Practices

PTC Visiting Scholar from Japan

Howdy! My name is Naoya AOKI, and I'm a first-year master's degree student at KIT (Kyoto Institute of Technology). My specialized field is material science, especially forming and mechanical evaluation of polymers. I have studied structure and interfacial adhesion of PP/PBS sandwich injection moldings. I am here for about three months to learn the details of scratch testing as a part of my graduate research. My main challenge is to acquire evaluation techniques for surface damage of polymers. I really appreciate Dr. Sue for providing me such a great opportunity to study in excellent research facilities and to exchange views with researchers from all over the world. I'm sure this experience will become the cornerstone for my life as a researcher.

New Officers appointed for the SPE Student Chapter

The new SPE student officers appointed at Texas A&M University for the 2008-2009 year are:

- President: Bob Browning
  Dept. of Mechanical Engineering
  b_squared02@yahoo.com

- Treasurer: Adriana Moncada
  Dept. of Chemistry
  amoncada@mail.chem.tamu.edu

- Secretary: Yongxin Huang
  Dept. of Aerospace Engineering
  iamhyx@gmail.com

Bob Browning, President:

Thank You

PTC would like to thank and acknowledge Solvay Engineered Polymers for hosting the Scratch Behavior in Polymers Consortium meeting that was held in Auburn Hills, MI on October 11. PTC would especially like to acknowledge the following Solvay employees for their hard work and dedication on this project: Mr. Edmund Lau, Ms. Edie Wier, and Ms. Lesley Signorello

Solvay Engineered Polymers

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Edited by: Neil Everett, Graham Warren & Jonathan O'Reilly