Spring 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 24th-25th - PTIC
@ Texas A & M University

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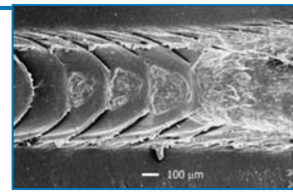
Two New PTIC members

PTC is excited to announce that The Boeing Company and The Research Valley Partnership, Inc. have joined the Polymer Technology Industrial Consortium. Please help us in welcoming The Boeing Company and The Research Valley Partnership, Inc. as new PTIC members.

PTC Short Course: Scratch and Wear Behavior of Polymers and Composites
April 22-23, 2008
Texas A&M University



This short course offers a unique opportunity to learn about fundamentals and applications of polymer and composite wear from presenters respected in the field. This short course, held at Texas A&M University, will expose attendees to cutting-edge research and practice involving polymers and composites. Additionally, it may fulfill your professional development requirements. To learn more about this short course, visit: http://ptc.tamu.edu Register online at: http://engrevent.tamu.edu/event/100366 The registration deadline for this short course is April 11, 2008.

INSTRUCTORS

Klaus Friedrich

Dr. Friedrich received his Ph.D. Degree in Materials Science in 1978. After gaining industrial experience in the construction of machine elements, he held a position with the Center for Composite Materials at the University of Delaware, and he later served as Research Director for Materials Science at the Institute for Composite Materials (IVW) at the University of Kaiserslautern, and as a Professor for Polymers and Composites at the Technical University Hamburg-Harburg. He acts as a Scientific Board Member of various international journals in the fields of materials science, composites and tribology. Dr. Friedrich is editor of five books based on polymer and composite tribology. After retiring from the director position at IVW in March 2006, Dr. Friedrich now acts as a research consultant to various institutes and industrial companies.

H.-J. Sue

Dr. Sue has been a Full Professor in the Department of Mechanical Engineering at Texas A&M University since 1995. He obtained his Ph.D. from the University of Michigan. Before joining TAMU, Dr. Sue was employed by Dow Chemical for about seven years. He focuses most of his research work on the fundamental understanding of structure-property relationships of polymeric materials. His recent research interests include micro- and nano-scratch behavior of polymers and preparation of polymer nanocomposites for nanotechnology applications. Dr. Sue is currently the Director of the Polymer Technology Center at TAMU.

Cris Schwartz

Dr. Schwartz is an Assistant Professor in the Department of Mechanical Engineering at Texas A&M University. His research focuses primarily on polymer tribology and engineering design. He heads the INNOMAT research group at TAMU that investigates phenomena related to the tribological behavior of the human body including artificial joint devices and polymer haptics. Prior to his position at TAMU, Dr. Schwartz served as a senior research engineer at Southwest Research Institute® as a project manager, technical investigator, and systems designer. He is a licensed professional engineer and also a faculty member of the Polymer Technology Center.

PTC Faculty Research: A Generalized Cohesive Zone Model of Peel Test for Pressure Sensitive Adhesives

Dr. Jyhwen Wang. Department of Engineering Technology and Industrial Distribution

Dr. Jyhwen Wang is currently an Associate Professor in the Department of Engineering Technology and Industrial Distribution. Prior to joining Texas A&M, he was a researcher and R&D manager at Weirton Steel Technology Center in Weirton, West Virginia.

One of Dr. Wang's research interests is in deformation of polymer coated sheet metals. In this research, pressure sensitive adhesive (PSA) tape is used for assessing the adhesion of coating films to metallic substrates (as per ASTM D 3359). The pressure sensitive tape is designed so that, by applying a light pressure, the PSA forms a continuous layer to bond the tape to the adherend. The layer has to be soft enough to adhere to the adherend, whereas it has to be hard enough to offer a proper bond resistance. This special behavior requires that PSAs exhibiting a viscoelastic character. The strength of the adhesive bond can be quantified with a peel test. The test is commonly conducted by pulling the backing at a specific rate and angle and measuring the peel force that is applied to rupture the adhesive bond. The peel force depends on such factors as the rate at which the backing is detached, the angle at which the detachment occurs, the nature of the adhesive, and the mechanical and physical properties of the backing and the substrate. The interaction of these factors is the subject of the present study. A cohesive zone model is developed to characterize the mechanics of the peel test. As the adhesive failure is accompanied by a process of cavitation and fibrillation, the cohesive zone is modeled as a continuous fibrillated region (Figure 1). A Maxwell model is employed to characterize the viscoelastic behavior of the adhesive and the governing equation and boundary conditions that describe the mechanics of the peel test are derived. The model predicts the peel force in terms of the peel rate, the peel angle, the nature of the adhesive, and the properties of the backing and the substrate. The traction distribution on the substrate surface is found to depend on various test parameters, as shown in Figure 2.

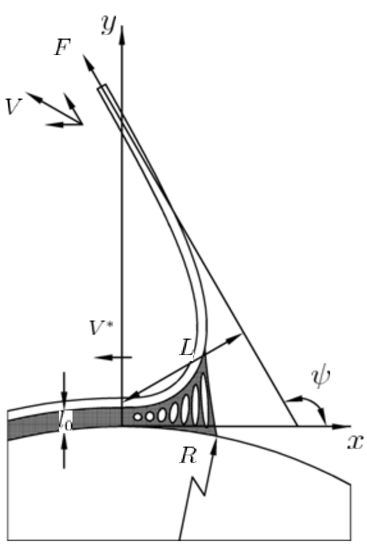


Figure 1. A cohesive zone model of the peel test.

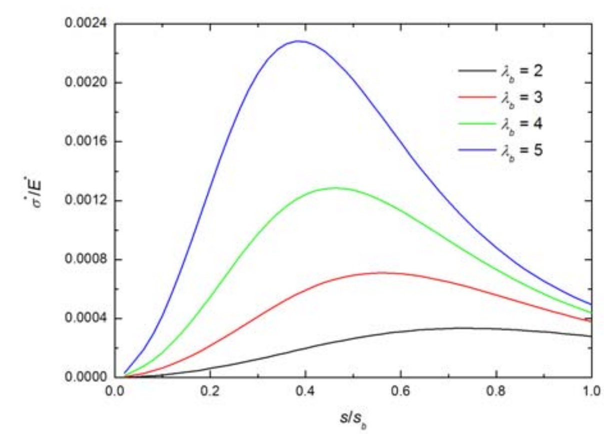


Figure 2. Dimensionless traction distributions for different fibril critical stretch ratios.

PTC Director Research: Nano-Cavitation in Self-Assembled Amphiphilic Block Copolymer-Modified Epoxy

Dr. Hung-Jue Sue, Department of Mechanical Engineering

Jia Liu,[1] H.-J. Sue,[1,*] Z.J. Thompson,[2] F.S. Bates,[2] M. Dettloff,[3] G. Jacob,[3] N. Verghese,[3] and Ha Pham[3]

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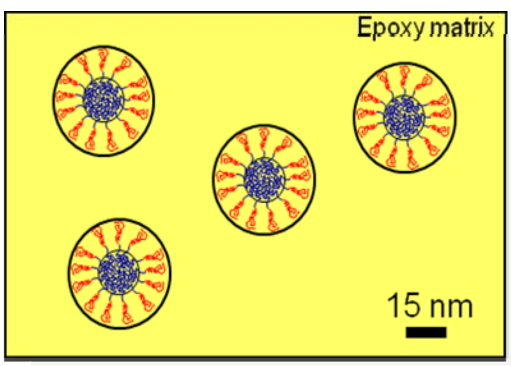
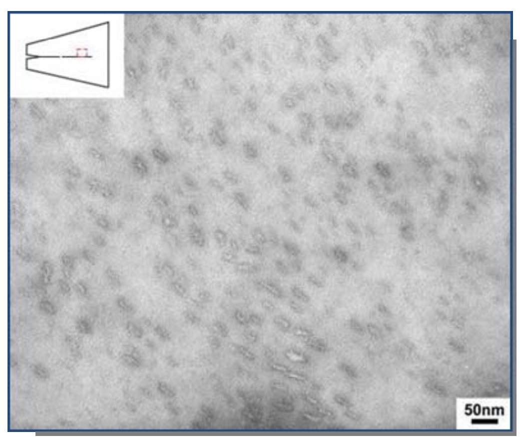
An amphiphilic block copolymer toughener was incorporated into a liquid epoxy resin formulation that self-assembled into well dispersed nanometer scale spherical micelles with a size of about 15 nm. The nano-sized block copolymer at 5wt% loading can significantly improve fracture toughness of cured epoxy thermosets without a reduction in modulus at room temperature and with only a slight drop in T_g. The toughening mechanisms were investigated, and it was found that the 15 nm size block copolymer micelles could cavitate to induce matrix shear banding, which partially accounted for the remarkable toughening effect that was measured. The ***nano-cavitation*** of the block copolymer is believed to be the ***smallest*** size ***ever*** observed in polymer toughening. The existing models are unable to predict the current findings. To account for the observed nano-cavitation phenomenon, contributions from the pre-existence of transient nanovoids and the difference in void expansion between a block copolymer micelle and an ideal rubber particle are discussed. Other mechanisms, such as crack tip blunting, may also play a role in the toughening. Implications of the present finding with regard to designing toughened polymers is discussed.





In addtion to the above research, Dr. Sue continues to carry out research work on scratch behaviors of polymers. His recent focuses include abrasion and mar behavior of thermoplastic olefins and high performance engineering plastics. Significant progresses have been made. Furthermore, many of Dr. Sue's students are conducting research on manipulation and dispersion of nanomaterials in various solvents and polymer matrices for aerospace, microelectronic, and solar cell applications. The nanomaterials of interests include ZnO quantum dots, carbon nanotubes, and nanoclay. New approaches have been developed to exfoliate 0-D, 1-D, and 2-D nanomaterials in polymer matrices.

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SPE Scholarship recipients for 2008-2009

PTC would like to congratulate the following students who received SPE Scholarships for the year 2008-2009.

SPE Scholarships

- **Hui Fu, graduate student majoring in Chemistry, research in: "Smart" Responsive Polymers**
- **Xuele Qi, graduate student majoring in Mechanical Engineering, research in: Optimal Low Cost Insulated Beverage Dispenser Design Using Multinozzle Structural-web Molding Technology"**
- **Brennan Bailey, undergraduate student majoring in Biomedical Engineering**

SPE Scholarship Polyolefin Confence 2008

- **Cody A. Schoener, graduate student majoring in Biomedical Engineering, research in: "Biodegradable Inorganic-organic Hydrogel Scaffolds"**

SPE Henry Kahn Scholarship

- **Piyush R. Thakre, graduate student majoring in Material Science, research in: "Processing and Characterization of polymer matrix multi-functional nanocomposites and multi-scale fiber reinforced polymer composite laminates"**

SPE Dale Walker Memorial Scholarship

- **Alexander Morgan Pankonien, undergraduate student majoring in Aerospace Engineering**

PTC Seminars at Texas A&M University

Left to right: Dr. Hung-Jue Sue, Dr. Sadhan C. Jana, & Dr. K.R. Rajagopal

Sadhan C Jana

Shape Memory Polymer Nanocomposites

March 21, 2008 @ 2:00pm

Abstract:

Shape memory polymers are a class of smart materials that respond to external stimuli, such as heat, solvent, and electrical field, change shape, and recover their original, un-deformed shape. However, their applications are often limited by the low values of shape recovery stress. In this work, small quantities (< 10wt%) of nanoscopic fillers are used for achieving significant improvements in shape fixity and shape recovery force in shape memory polyurethanes. The shape recovery is triggered by both conduction heating and resistive heating. The nanoscopic fillers of various surface characteristics and shapes are used and their influence on hard segment crystallinity, hard segment orientation, and shape memory properties are evaluated. In addition, the study evaluates the effects of cyclic loading and thermal switching behavior on shape memory performance.

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