Second Quarter 2016 Newsletter

Polymer Technology Center

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SPE Student Chapter News

Mark Your Calendars!

Scratch Consortium	PTIC Consortium	APPEAL Consortium
October 5th, 2016	October 20th — 21st	To Be Announced
at Michigan	Texas A&M University	Contact Isabel for
Immediately after the TPO Conference	College Station	information

Have Questions?

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Precise Synthesis and Solution Processing of Rigid Macromolecules

Dr. Lei Fang

Department of Chemistry,

Department of Material Science and Engineering

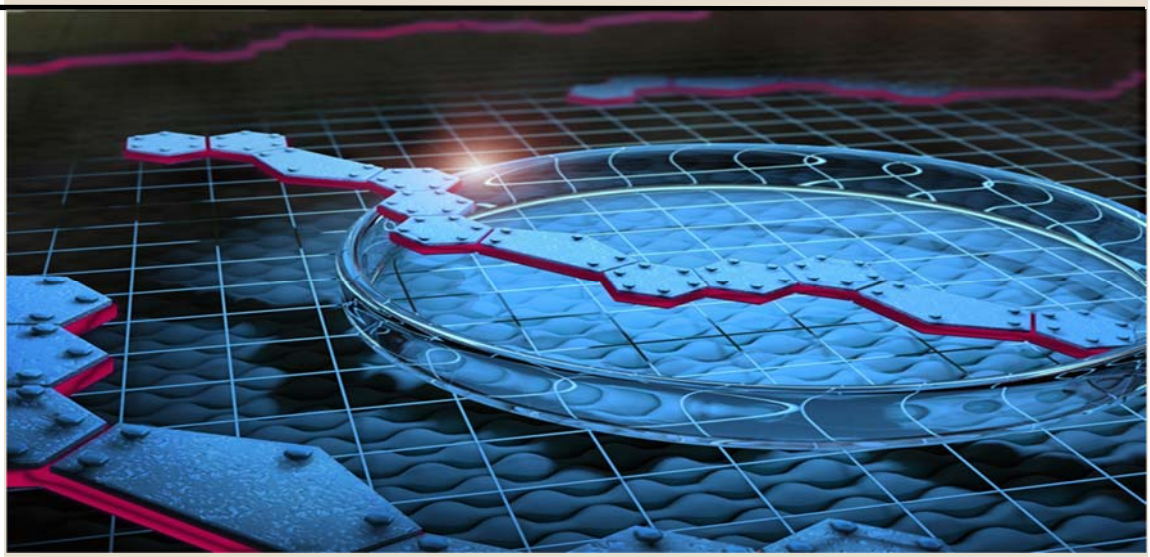

Figure 1. An artistic representation of the rigid ladder polymer

Read about Dr. Fang's rigid ladder type polymers

Dr. Lei Fang leads a multidisciplinary research group studying functional organic materials with electronic, thermal or photo-activities. His current research goal is to gain insights into design principles and structure-property relationships of functional organic materials at both the molecular and the macroscopic scales by employing the toolboxes of synthetic chemistry and process engineering. In particular, the Fang research group focuses on the bottom-up synthesis and processing of ladder polymers and microporous polymer networks for applications associated with electronics and energy conversion/storage. For example, Dr. Fang's group has recently demonstrated a highly efficient synthesis of rigid ladder type polymers using a thermodynamic controlled olefin metathesis reaction (Figure 1). This method affords a polymer backbone free of defect that allows its high performance in electronic applications. Using molecular engineering approach, Dr. Fang's group also works on solution processing of rigid conjugated polymer materials. Recently, the group has developed an electronically solvent resistant polymer thin film by incorporating labile t-butyloxycarbonyl protecting groups into a conjugated polymer (Figure 2). Thanks to the strong intermolecular hydrogen bonds, field effect transistor devices of the polymer thin film retained the performance after soaking in organic solvents. This technique opens the door to multi-layer processing of polymer thin films from solution.

Figure 2 — Electronically Solvent Resistant Polymer thin film.

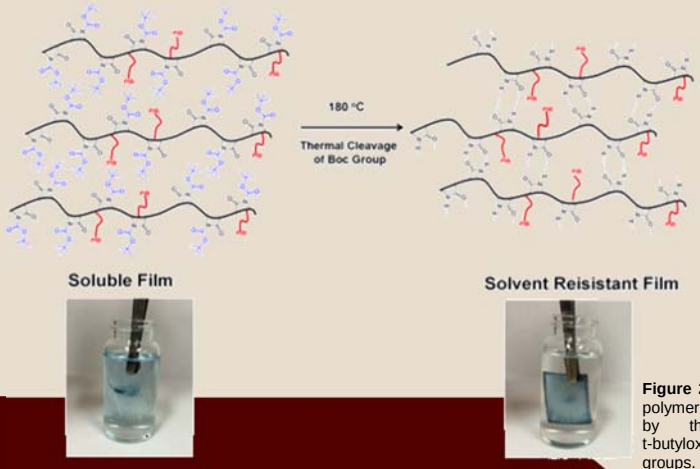

Figure 2. Solvent resistant polymer thin film developed by the cleavage of t-butyloxycarbonyl protecting groups.

Impact of Dissipation on Ultrasounds for the Inspection of Epoxy—Coated Pipes

Dr. C. Steve Suh, Department of Mechanical Engineering

Viscoelastic coating materials and their application as protective layers to tubulars have a substantial impact on the propagation and attenuation of ultrasounds generated for inspection. Coating materials such as bitumen and epoxy to improve pipeline reliability; however, they also dampen and dissipate ultrasounds. Little knowledge is available with regard to the characteristics of ultrasounds propagating in pipes treated with multi-layers of protective coatings. The following study presented explores propagating longitudinal and shear waves in both the axial and circumferential directions that are physically admissible in a pipe so as to establish their dissipation (i.e., dispersion and attenuation) characteristics in response to the presence of perfectly bonded, multi-layered viscoelastic coatings.

A Schedule 40 elastic steel pipe with viscoelastic coatings is considered. The radius and thickness of the pipe are 2.25" and 0.1185", respectively. The thickness of the viscoelastic material, which is a type of E&C Epoxy, is 0.02". The properties of the elastic tubular and the viscoelastic material can be found in ASME/ANSI B36.10/19. The steel tubular has a density of 7.8 g/cm^3, and the longitudinal and shear wave velocities it supports are 5.9 km/sec and 3.19 km/sec, respectively. It is noted that the corresponding viscoelastic material constants are complex and frequency dependent, thus the underlying mechanism for dissipation. Figure 1 to the side shows the phase velocity and attenuation dispersion curves of the *axial longitudinal wave* propagated in the pipe with a single layer (top) and 2 layers (bottom) of epoxy coatings. Two additional modes are seen in the bottom figures, in which the 3rd, 4th, and 5th modes are seen fast approaching the non-dispersive asymptotic phase velocity with poor resolution in differentiating them at frequency higher than 1.0MHz. Of all the admissible modes, the 3rd mode demonstrates the least attenuation between 0.2 and 1.0MHz, making it a potential candidate for charactering tubing with 2 epoxy coatings. Attenuation of the first 2 modes is seen to be worse than the single coating case.

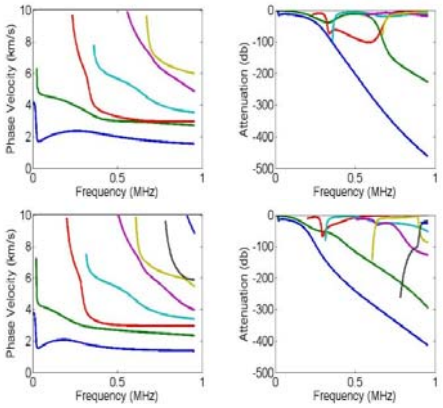

Fig 1

The phase velocity and attenuation dispersion curves of the *circumferential shear* wave in the pipe with 1 (top) and 2 (bottom) layers of epoxy coatings are given in Fig. 2. Several observations can be made regarding the phase velocity dispersion for the single coating layer tubing: 1) there is an additional higher order mode; 2) the highest 5 modes rapidly converge to an asymptotic phase velocity at approximately 3.5km/sec; 3) the differentiation of the highest 5 modes at frequency higher than 1.6MHz becomes demanding; 4) the 1st mode has a cutoff frequency at about 0.52MHz; and 5) the 2nd mode demonstrates fast attenuation. Except for the 3rd mode which displays relatively low attenuation between 0.5-1.0MHz, all the higher order modes see significant attenuations at high frequency. All admissible modes suffer from significant attenuation, with the exception of the 2nd mode which demonstrates relatively low attenuation between 0.2 and 0.6MHz.

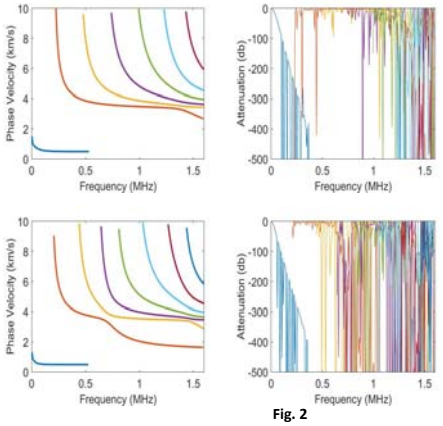

Fig. 2

As opposed to Fig. 2, the 1st mode of the circumferential longitudinal wave in tubing coated with 1 (top) and 2 (bottom) layers of epoxy coatings (Fig. 3) does not demonstrate a cutoff frequency. However, the particular mode along with the 2nd mode do not converge to the non-dispersive phase velocity but rather quickly dissipate with increasing frequency. The 2nd mode in the 2-layer case is the only mode that displays low attenuation among all the admissible modes when the excitation/propagation frequency is lower than 0.18MHz. The most interesting feature in the 1-layer case is the overlapping of the two highest order modes. The two modes cannot be differentiated in the 0.71-to-0.74MHz frequency range. In addition, their corresponding high attenuations also suggest fast dissipation and, therefore, short life span.

A brief summary is made in this section which should provide significant knowledge relevant to the proper application of ultrasounds for pipe inspection. The dispersion of phase velocity and ultrasonic attenuation for the coated pipe were explored to establish the propagation characteristics of guided shear and longitudinal waves moving along both the axial and circumferential directions. All the wave motions considered in the study share the following observations that 1) the number of modes increased with increasing number of viscoelastic layers, 2) while more admissible modes could be excited, the corresponding phase velocity dispersion could not provide the resolution needed to differentiate them from one another, and 3) higher order modes attenuated significantly less at high frequencies than the lower order modes at low frequency. In addition, at the frequency range considered, all the circumferential propagating modes, be they shear or longitudinal, are much more attenuative and therefore dissipating than their axial propagating mode counterparts. Regardless of the number of epoxy coating layers, the 1st modes of the shear waves all have a cut-off frequency at approximately 0.55MHz. The presence of viscoelastic coatings, on the other hand, does not suppress the generation of the 1st mode of the longitudinal waves. Nonetheless, the epoxy layers do impact the 1st mode by reducing the phase velocity at frequencies greater than 0.2MHz. Wave attenuations are profound enough for all the first few lower order modes to suggest limited applicability of the circumferential running waves.

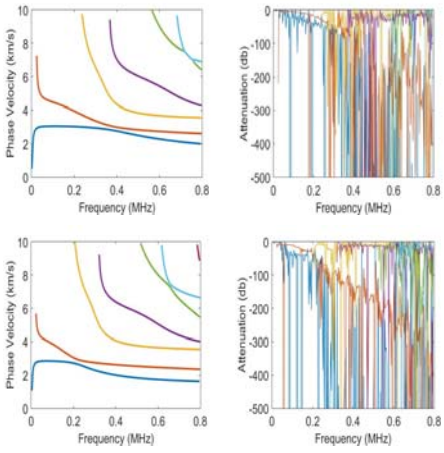

Fig. 3

Conjugated Organic Radical Polymers for Electrochemical Energy Storage

Dr. Jodie Lutkenhaus &

Dr. Fei Li

Artie McFerrin Department of Chemical Engineering

Department of Material Science and Engineering

Batteries play an important role in our daily life from cell phones to electric vehicles. Current batteries are faced with long charging times, limited power and short lifetime. Organic radical polymer batteries (ORB) are a promising candidate to current inorganic batteries due to their fast charge transfer kinetics, high power and long durability features. One demonstrated ORB is from a nitroxide radical polymer called PTMA (poly (2, 2, 6, 6-tetramethylpiperidinyloxymethacrylate)) with a reported maximum cathode capacity of 110 mAh/g. The PTMA polymer suffers from insulating backbone and thus requires conductive additives to promote the electrode conductivity. One way to address this low intrinsic conductivity issue is to design PTMA analogs bearing conductive backbones. Dr. Lutkenhaus' group recently reported a facile way to access a series of polythiophenes carrying pendant 2, 2, 6, 6-tetramethylpiperidinyl-1-oxyl (TEMPO) radicals (PTATs) via electropolymerization. The spacing between the TEMPO radical and the polythiophene backbone was varied by an alkyl spacer (n = 4, 6, 8), and the electronic and electrochemical properties of such thin film electrodes were examined. We discovered that this polymer class generally appears to have the color of a polythiophene and the electrochemistry of an organic radical. By studying the charge transfer mechanisms in PTAT electrodes, we believe that they could provide some mechanistic insight on the reported inferior capacity and cycling stability of conjugated radical polymer batteries as compared with the performance of PTMA electrode. This fundamental knowledge will guide us to design high-performance hybrid electrodes.

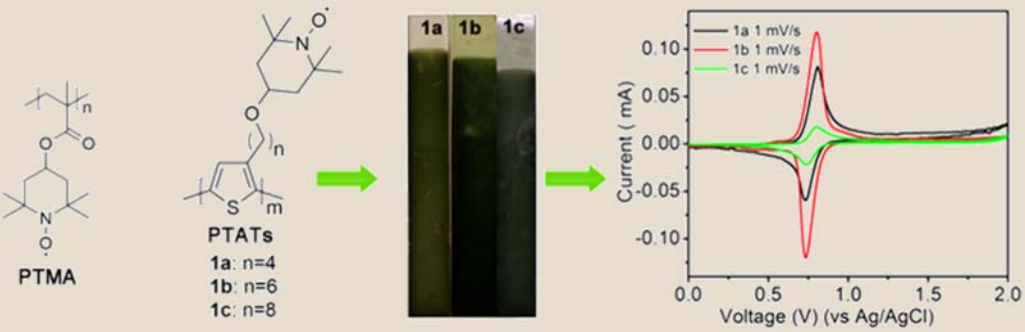

Figure. Polythionphenes with nitroxide radical pendant groups were electropolymerized. Depending on the spacer length *n*, the polymers show varying electrochemical activity.

Have Questions about our Newsletter?

Contact Our Office!

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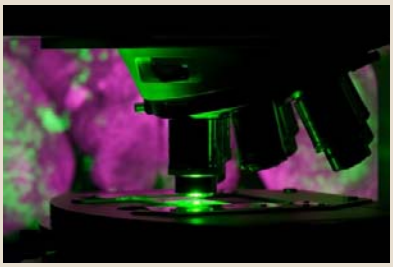
Texas A&M Fares Well In U.S. News Rankings

The School of Law, which Texas A&M acquired two years ago, moved up 38 places in the new rankings, now ranking 111th overall and among the top 60 law schools operated by public institutions. Also, it ranks 28th for best part-time law school programs and 14th in the intellectual property category.

Full story: http://goo.gl/AQ1Y4f



Despite Flat National Market For Funding, Research At Texas A&M Grew To $866 Million In FY15

Texas A&M University posted $866.678 million in annual research expenditures for fiscal year 2015, a 1.44-percent increase of $12.464 million from fiscal year 2014, the University announced today. The University accomplished this despite a relatively flat market for research funding across the United States.

Full story: http://goo.gl/sVMFRV

Goal To Reduce World Temps Will Fail, Researchers Say

GALVESTON – Last December, officials representing more than 190 countries met in Paris to participate in the United Nations Climate Change Conference. The historic outcome from that conference was the "Paris Agreement" in which each country agreed to reduce greenhouse gas emissions in order to limit global warming to less than 2 degrees Celsius (3.6 degrees Fahrenheit) above temperatures seen near the start of the Industrial Revolution in the 1850s. Such a level was considered acceptable, or "safe," by all participating countries, but the goal is unrealistic and almost impossible to achieve, according to a new study by two Texas A&M University at Galveston researchers.

Full story:
http://goo.gl/e4eGFe

Sukhishvili receives NSF grant to study functional polymer coatings

Dr. Svetlana Sukhishvili, professor in the Department of Materials Science and Engineering, has received a $424,000 grant from the National Science Foundation (NSF) to conduct fundamental research on controlling the structure of functional polymer coatings for biomedical and optical applications.

Full story: https://goo.gl/RNxvpc

Dr. Peng Li
Former PTC Student

Our congratulations to Dr. Peng Li, who has recently accepted a Product Development Engineer position at Formosa Plastics Corporation in Texas. He has also been awarded the "2015 Chinese Government Award for Outstanding Self-financed Student Abroad". Sponsored by the Chinese Ministry of Education, the award recognizes the academic excellence of self-financed Chinese students studying overseas and is granted across all fields of study in 29 countries.

With his Master degree in Polymer Science & Engineering from ZheJiang University in China, Peng Li passed his Ph.D Final Exam in Materials Science & Engineering from Texas A&M University in March 2016. He joined Professor H-J Sue's group in 2011 as a Graduate Research Assistant. His doctoral research focuses on a fundamental understanding of nanoplatelet self-assembly behavior, and to efficiently control nanoplatelet mesophases in solvents and polymers via a simple and scalable manner. These highly aligned nanocomposites exhibit exceptional physical properties, which include outstanding oxygen barrier properties, low viscosity under shear, superb mechanical rigidity and strength, excellent fire retardation and corrosion resistance properties.

Michela Puopolo
Visiting Scholar from Rome, Italy

Howdy!

My name is Michela, and I started my TAMU experience in October 2015 as Visiting Scholar. I worked in Dr. Sue's group just for six months but it was enough to understand that the group operates at a high scientific level.

My research was about the mechanisms of dispersion of nanofillers and their usage to improve some properties of polymeric materials. I was focused on a double filler system, which due to the electrostatic interaction avoided the presence of agglomerates that are commonly a problem in nanofillers. The last goal of my work was to use the high dispersion degree of the fillers to increase the barrier property of an acrylic polymer against gas while improving its mechanical properties.

During my TAMU experience I have collaborated with people with high scientific skills, and I have learned several things about the dispersion mechanisms of nano-metric fillers and their characterization.

Furthermore I lived a beautiful human experience, knowing other cultures and lifestyles. I would like to thank Dr. Sue and all his research group for their support and their help during this extraordinary experience.

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SPE South Texas section

2016 SPE INTERNATIONAL POLYOLEFIN CONFERENCE

The SPE International Polyolefin Conference was held in Houston, TX on Feb. 21-24, where Texas A&M/SPE chapter students assisted with conference details.

Jeniree Flores was the 1st place recipient in the student poster contest, and Spencer Hawkins was awarded the International Polyolefins Conference Polymer Modifiers and Additives Scholarship.

From left to right: Jeniree Flores, TAMU graduate student; Dr. Hung-Jue Sue, Professor & PTC Director; and Spencer Hawkins, TAMU graduate student

CONGRATULATIONS

From left to right on top row: Jennifer Summerhill Zigmond, Chih-Gang Chao, Mary Layne Harrell, Dr. Hung-Jue Sue, Spencer Hawkins, James Chrisman, bottom row: Xun He, Dr. Michael Mullins, Jeniree Flores, and Fan Lei

Polymer Specialty Certificate Updates

Students that have applied for the Polymer Specialty Certificate	45
Students that have received the Polymer Specialty Certificate	31

For more information, please visit: http://ptc.tamu.edu/certificate.html

Q-2 2016

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