2024

Fourth Quarter

PTC Newsletter

# Polymer Technology Consortia

## UPCOMING EVENTS

## Mark Your Calendars for the PTC meetings!

**Scratch Behavior of Polymers Consortium-SCRATCH**

SCRATCH SPRING meeting — TBD

**Polymer Technology Industrial Consortium-PTIC**

PTIC SPRING meeting — April 10th—11th, 2025
PTIC FALL meeting—October 16th-17th, 2025
at Texas A&M University-College Station, TX

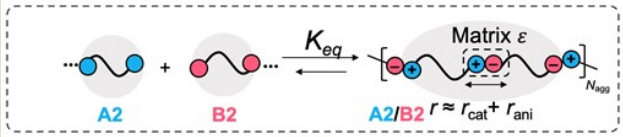
## Inside the Newsletter



### Structure and dynamics of telechelic ionic associating polymers
### Shuyi Xie, Chemical Engineering

Dr. Shuyi Xie is an Assistant Professor in the Chemical Engineering Department. His research group focuses on the fundamental polymer physics of ion-containing systems, block copolymers, polymer blends, and sustainable polymeric materials. One of their current research areas involves designing, synthesizing, and characterizing ionic polymers formed by linking oligomers via pure ionic bonds. Compared to conventional polymers linked by covalent bonds (bond energy ~350 kJ/mol), supramolecular polymers, such as hydrogen-bonding systems, are more dynamic and easier to reprocess and recycle. However, due to their low bond energy (< 40 kJ/mol), hydrogen bonds exchange too quickly, resulting in polymers with ineffective chain entanglements and low viscosity. In this fundamental work, the group leverages ionic interactions (tunable bond energy > 60 kJ/mol) to construct ionic polymers that exhibit superior mechanical properties compared to hydrogen-bonding systems, and better recyclability compared to covalent systems.

Doctoral student Jie Xu selected poly(ethylene glycol) (PEG) (3 kDa) as a model system and functionalized it into two charge-neutral telechelic polymer precursors (A2 and B2). Blending these precursors forms associating polymers without counterion formation (**Fig. 1**), thereby maximizing intermolecular ionic attractions. Compared to hydrogen-bonding systems, the significantly higher ionic bond energy results in a three orders of magnitude




$$\langle N_{agg} \rangle_n = \frac{2K_{eq}[\,\oplus\!\!\sim\!\!\ominus\,]}{(1+4K_{eq}[\,\oplus\!\!\sim\!\!\ominus\,])^{1/2}-1} \qquad K_{eq} = \exp(-\Delta G/RT) \quad \Delta H \approx e^2/(4\pi\varepsilon r)$$

| | Hydrogen-bonding[1] | Ionic (predicted) |
|---|---|---|
| $\Delta H$ (kJ/mol) | −40 | −60 |
| $K_{eq}$ (L/mol) | 1000 | $4\times10^6$ |
| $\langle N_{agg} \rangle_n$ | ~25 | ~2000 |
| $\eta$ | $\eta \sim \eta_0 \langle N_{agg} \rangle_n$ | $\eta \sim \eta_0 \langle N_{agg} \rangle_n^3$ |

[1] *Macromolecules* **2015,** *48*, 8933-8946 and *Phys. Rev. Lett.* **2016,** *117*, 147802.

**Figure 1**. Binding thermodynamics controls the dynamics of the A2/B2 associating polymers. Chains are much longer than hydrogen-bonding systems, resulting in higher viscosity.

Continues on Page 2

Continues from page 1—Structure and dynamics of telechelic ionic associating polymers
Dr. Shuyi Xie, CHEN

increase in the equilibrium constant ($K_{eq}$) for association, and consequently, a larger effective chain length ($N_{agg}$). This enhancement in association thermodynamics leads to distinct chain dynamics: as ionic bonds exchange more slowly, the A2/B2 polymers become effectively entangled, exhibiting significantly higher viscosity.

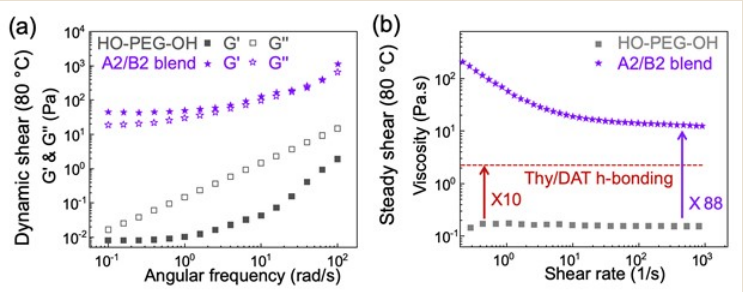
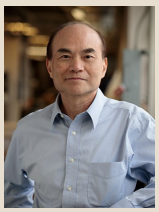



**Figure 2**. Rheology measurements for HO-PEG-OH and A2/B2 blend: (a) dynamic shear and (b) steady shear ($T$ = 353K). The red dash line indicates a triple hydrogen-bonding PEG system. Data from *Macromolecules* **2015,** *48*, 8933-8946.

Small amplitude oscillatory shear (SAOS) rheology indicates that the ionic associating polymer is more solid-like ($G' > G''$), suggesting the existence of transient crosslinking (**Fig. 2a**), while steady shear experiments reveal an almost 100 fold increase in viscosity compared to the HO-PEG-OH precursor (**Fig. 2b**). Notably, this significant increase in viscosity occurred rapidly after melt-blending A2 and B2 without the need for solvent processing, and the resulting viscosity was already much higher than that of the triple hydrogen bonding system.

Our system demonstrates the potential to construct robust, entangled supramolecular polymers that can be assembled and disassembled on demand. This ongoing project will further explore the relationship between nanostructure and rheological properties, setting a benchmark for developing polymers with enhanced recyclability and reprocessability.

## "Capstone project: mechanical characterization of PHA biopolymers using 3D printing"



Hung-Jue Sue
Department of Materials Science & Engineering

Departmental Capstone projects are opportunities for small teams of undergraduate students to spend a year to perform research related to solving problems of industrial and societal significance. Although these projects are generally sponsored by industry, Prof. H. -J. Sue has initiated a new project to investigate the use of 3D printing technology to produce test samples that can be used for mechanical characterization of 10 g of poly(hydroxyalkanoate) (PHA). An additional goal of the project is to use 3D printing to produce a specific biodegradable product that matches the properties of PHA with market needs. Ultimately the team hopes that their research will not only lead to new applications for PHA, but also reduce the effort required for producing test specimens for small quantities of new polymers and formulations.

Kaneka Corporation has generously agreed to supply PHA strand and samples that the team needs for fabrication and testing. For more information about sponsorship of Capstone within the Material Science Department, contact Prof. B. Mansoor or Prof. K. C. Atli, or visit the website at: https://engineering.tamu.edu/materials/academics/capstone/index.html


Team members: Minhchau Du, Luis Ramos, Beth Gleason, Hudson Legendre, and Andrew Phong

## Zih-Yu Shih (Greta)
## Visiting Scholar from Taiwan

Being a visiting scholar from Taiwan offered me the opportunity to immerse myself in a vibrant, multicultural, and multidisciplinary academic environment over these two years. Engaging deeply in research discussions with Professor Sue and my lab mates has allowed me to integrate fundamental polymer knowledge in physics, chemistry, and technology in a more scientific and efficient manner. The adventure of exploring both research and American life has profoundly enriched my perspective. I will be returning to Taiwan and continue to work with Formosa Plastics where I will be using this new knowledge learned.

## Texas A&M Only University In Texas Among Newsweek's 'America's Greatest Workplaces'

Texas A&M University is one of the best places to work in America, according to *Newsweek,* and the only university in Texas on its list of "America's Greatest Workplaces."

Texas A&M finds itself in top company as the other universities on the list are some of the nation's most prestigious, including Harvard, Georgetown, Johns Hopkins and Vanderbilt. A total of 134 companies headquartered in Texas are on the list, including Texas Instruments, USAA, James Avery Craftsman, Memorial Hermann Healthcare System, Methodist Health System, NRG Energy and Schlumberger.

"What makes Texas A&M special is our people; they are the foundation of this university's success. From our world-class faculty to our exceptionally talented staff, our employees are passionate about this university and what it stands for – things like pride, patriotism, service, family, loyalty and respect," said General (Ret.) Mark A. Welsh III, president of Texas A&M. "These ideals are embraced by the Aggie Family and contribute to the supportive and dynamic environment that makes me and thousands of others proud to call Aggieland home."

Full story: **rb.gy/fouzmk**


## Texas A&M No. 1 Public University In The Nation For Number Of Fortune 500 CEOs


A remarkable number of Texas A&M University graduates are leaders in America's biggest companies, according to new findings showing a preeminence of Aggie CEOS in the Fortune 500.

### Aggie CEOS In The Fortune 500

Bruce D. Broussard '84, Mays Business School, Humana
David M. Cordani '88, Mays Business School, The Cigna Group
Kimberly A. Dang '92, Mays Business School, Kinder Morgan
Robert E. Jordan '85, '86, College of Engineering, Mays Business School, Southwest Airlines,
Travis D. Stice '84, College of Engineering, Diamondback Energy
Noel R. Wallace '87, Mays Business School, Colgate-Palmolive
Darren W. Woods '87, College of Engineering, Exxon Mobil

Full story: **https://shorturl.at/qBChC**


## Texas A&M ranks in the top 10 public universities nationwide for undergraduate engineering

"Our consistent ranking in the top 10 public engineering schools is attributed to excellence in delivering a high-quality education at scale while preparing the next generation of engineers to lead in a rapidly changing world," said Dr. Robert H. Bishop, vice chancellor and dean of engineering and director of the Texas A&M Engineering Experiment Station. "These rankings underscore the dedication of our faculty, staff and students in advancing engineering education and research."

Full story: **https://u.tamu.edu/nzN-NZzz**

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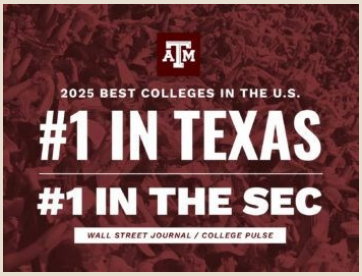
## Wall Street Journal Names Texas A&M The Best University In Texas




For the second consecutive year, Texas A&M University is the best university in Texas, according to rankings from *The Wall Street Journal,* which rate the top 500 universities in the country.

In the 2025 edition of the prestigious "Best Colleges in the U.S.," *Journal* editors, along with College Pulse/Statista, place Texas A&M at No. 1 in the Lone Star State, No. 11 among the nation's public institutions, and No. 28 overall.

The overall national number is a remarkable 10-place rise from last year. Additionally, the rankings place A&M No. 1 among Southeastern Conference (SEC) schools.

Full story: **https://rb.gy/k3p7ck**

## SPE STUDENT CHAPTER officers for 2023-24

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## Polymer Specialty Certificate Updates

| | |
|---|---|
| Students who have applied for the Polymer Specialty Certificate | 87 |
| Students who have received the Polymer Specialty Certificate | 75 |

**For more information, please visit: http://ptc.tamu.edu/polymer-specialty-certificate/**

### Have Questions?


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