



## Mark Your Calendars for the PTC meetings!

### Scratch Behavior of Polymers Consortium-SCRATCH

SCRATCH FALL meeting — October 16th, 2025  
at Texas A&M University-College Station, TX

### Polymer Technology Industrial Consortium-PTIC

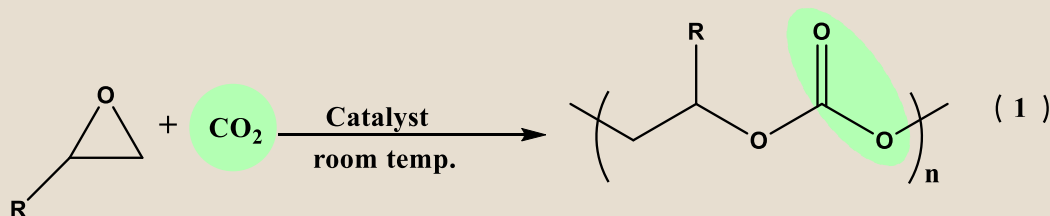
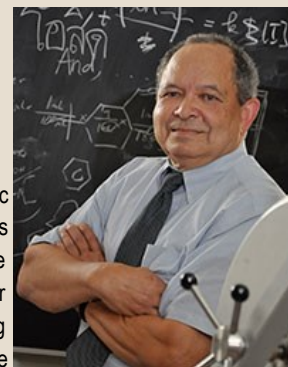
PTIC FALL meeting—October 16th-17th, 2025  
at Texas A&M University-College Station, TX

# UPCOMING EVENTS

### Synthesis of Aliphatic Polycarbonates from Carbon Dioxide and Epoxides Derived from Renewable Resources.

Dr. Donald J. Darensbourg, Distinguished Professor  
Department of Chemistry

Currently, chemists worldwide are seeking methods for producing sustainable polymeric materials using monomers derived from natural products. The need for such useful polymers stems from the adverse accumulation of nonbiodegradable petroleum-based polymers in the ecosystem, as well as the long-time goal of depletions of nonrenewable resources. Our approach to this issue is the development of catalytic, low-energy pathways for synthesizing aliphatic polycarbonates from epoxide monomers derived from natural sources and waste carbon dioxide (equation 1).



In our studies we have recently employed epoxide monomers derived from eugenol or furfural derivatives in coupling reactions with CO<sub>2</sub> to afford polycarbonates. Eugenol is an inexpensive phenolic low viscosity liquid obtained from various sources, such as clove oil. Two eugenol-based epoxides readily synthesized in multigram quantities are shown in **Scheme 1**. It is noteworthy that epichlorohydrin is synthesized industrially from glycerol, a byproduct of biodiesel production, known as *Epicerol* process.

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## Inside the Newsletter

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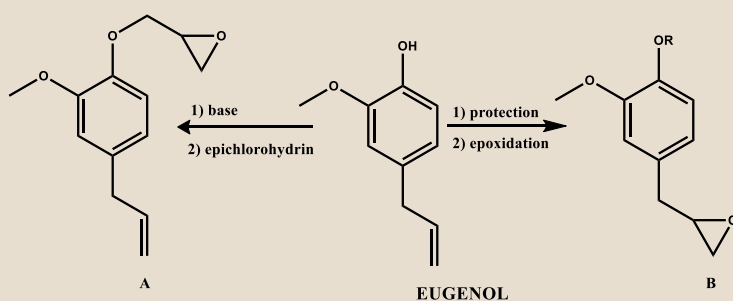
PTC Faculty Research  
Highlights

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TAMU news

Continues from page 1—Synthesis of Aliphatic Polycarbonates from Carbon Dioxide and Epoxides Derived from Renewable Resources. Donald J. Darensbourg, CHEM

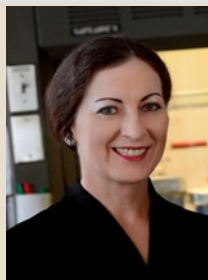
Scheme 1.



Collaborative efforts with Professors Pentzer and Wooley in chemistry, along with Dr. Wei in the Soft Matter Facility at TAMU, have shown the polymer derived from monomer **A** and CO<sub>2</sub> with plant-based crosslinks and hydroxyapatite fillers represents an ideal polymer matrix for use in bone tissue engineering. This polymeric material provides a sustainable scaffold with functionally engineered mechanical properties, excellent thermal stability, and low creep deformation. The polymer is compatible with UV-assisted direct ink writing technique, enabling the fabrication of precise 3D structures with tailable hydrophilicity. In addition, assisted by researchers Lim and Smolen in the Laboratory for Synthetic-Biologic Interactions, *in vitro* cytocompatibility studies using MC3T3C1 preosteoblasts have shown excellent cell viability of greater than 91%, strongly supporting the potential use of these polymers for biomedical applications. Hence, these sustainable polymeric materials are superior to conventional 3D-printed scaffolds that are based on petrochemicals feedstocks.

Alternatively, we have recently reported the sustainable synthesis of an epoxide monomer derived exclusively from the renewables eugenol and furoic acid, epoxide **B**, where OR = furoate. Copolymerization of **B** with CO<sub>2</sub> and its sulfur congener carbonyl sulfide in the presence of metal catalysts have selectively afforded polycarbonates or polymonothiocarbonates in very good yields with excellent regioselectivity. TGA and DSC measurements have revealed these polymers to be stable up to 240°C with relatively high glass-transition temperatures of 95°C. That is, these polymers exhibit thermal properties very similar to those produced from petrochemical-based chemicals, such as PMMA and PS. The polycarbonate was demonstrated to fully degrade under basic conditions within one hour quantitatively to the diol, which is readily converted to the epoxide, making the copolymerization/depolymerization partially circular. In contrast, the closely related polymonothiocarbonate is stable to degradation under identical conditions.

Our long-term research goal is to continue the development of catalytic pathways to provide (bio)degradable polymeric materials incorporating waste CO<sub>2</sub> for use in a wide variety of important applications. This can only be achieved in an environment where strong intra- and inter-departmental collaborative efforts, along with the availability of good core facilities, are possible.



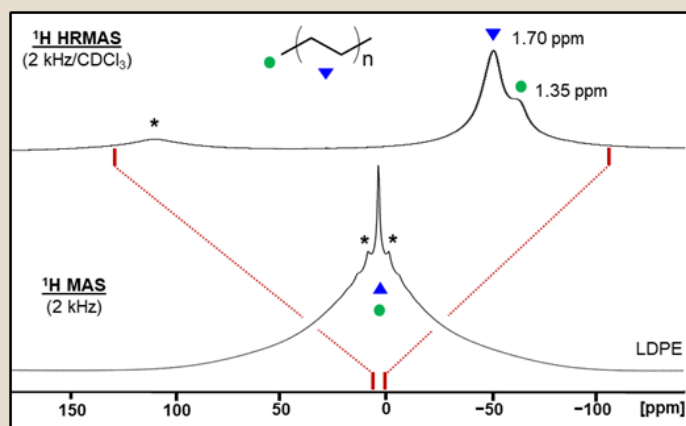
## Solid-State NMR Spectroscopy: New Tricks for Polymers

Dr. Janet Bluemel  
Department of Chemistry

The Bluemel group uses solid-state NMR spectroscopy for characterizing diverse inorganic and organic materials, including polymers. The classic solid-state NMR techniques for dry samples allowed us, for example, to explore the degradation of poly(arylether)ketones (PAEK).<sup>1,2</sup> Furthermore, the selective uptake of D<sub>2</sub>O and lithium salts could be probed by <sup>2</sup>H and <sup>7</sup>Li solid-state NMR.<sup>1,2</sup>

For investigating polymers that can incorporate solvents, we recently implemented a new powerful technique to improve the spectral resolution.<sup>3</sup> HRMAS NMR (High-Resolution Magic Angle Spinning) spectroscopy affords <sup>1</sup>H and <sup>13</sup>C NMR spectra with superior resolution. For acquiring HRMAS spectra, the polymer is first swollen (not dissolved!) in favorable organic solvents. Then the samples are measured with a conventional solid-state NMR spectrometer at the low spinning speed of 2 kHz. Anisotropic interactions like CSA (Chemical Shift Anisotropy) and dipolar interactions are reduced due to the additional mobility of the polymer chains in the presence of the solvent within the polymer network. The combined effect of this mobility and MAS leads to signals with substantially reduced halfwidths as compared to classic MAS of the dry polymer. With HRMAS, in most cases all signals of the polymer become visible. This line-narrowing effect is illustrated in the following, using three examples, A-C.

**A. Structure and Functional Groups.** The immediate advantage of HRMAS is demonstrated in the Figure below. The bottom spectrum shows the classic <sup>1</sup>H MAS spectrum of low-density polyethylene (LDPE).<sup>3</sup> The signal is dominated by large <sup>1</sup>H-<sup>1</sup>H dipolar interactions and is extremely broad, spanning a range from +100 to -100 ppm. Swollen in CDCl<sub>3</sub>, the signals with a chemical shift difference of less than 0.4 ppm can be resolved (top spectrum). The polymer is just mobilized, not dissolved: rotational sidebands, denoted by asterisks, are still present.



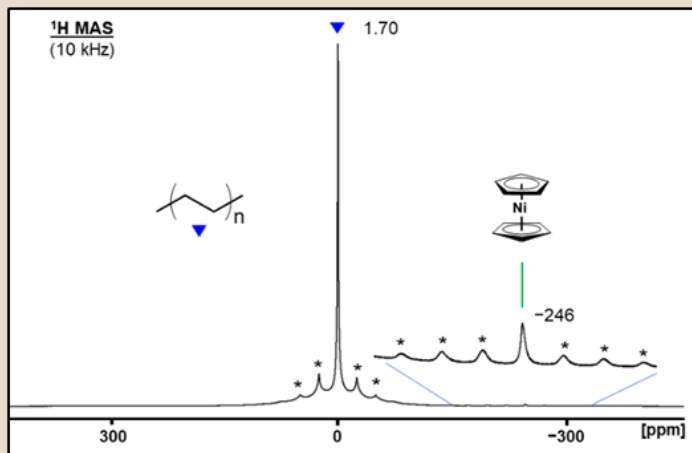
In general, being able to characterize polymers on the molecular level, and identifying the solvents that penetrate the polymer network best, enables post-synthesis modifications of polymers.

**B. Metal Complexes in Polymers.** We could demonstrate by paramagnetic HRMAS that the metallocene nickelocene (Cp<sub>2</sub>Ni) penetrates the LDPE network along with the solvent and is homogeneously dispersed within the polymer. The impact of the paramagnetic Cp<sub>2</sub>Ni on the <sup>1</sup>H NMR signal half-

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**Solid-State NMR Spectroscopy: New Tricks for Polymers—Dr. Janet Bluemel, CHEM**  
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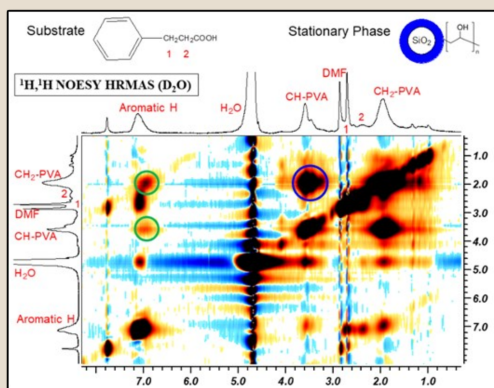
width and  $T_1$  relaxation time of LDPE has been studied. Naturally, paramagnetic complexes facilitate such investigations because their signals lie far outside of the diamagnetic region, as the Figure below shows.



In general, HRMAS allows a quick assessment of metal complexes regarding their ability to penetrate the LDPE network and therefore supports future studies of matrix-stabilized single atom catalysts and catalytic polymer degradation.

**C. Spatial Correlations within Polymers.** The spectral resolution obtainable with the HRMAS method is often sufficient for two-dimensional correlation spectra. The Figure below shows an example from chromatography. The stationary phase is polyvinyl alcohol (PVA)-coated silica, the substrate 3-phenylpropionic acid. For a rapid test of the interactions between substrate and stationary phase, which are indispensable for chromatographic separation, a  $^1\text{H}, ^1\text{H}$ -NOESY HRMAS spectrum was recorded. NOESY (Nuclear Overhauser Effect Spectroscopy) probes the proximity of protons through space. For example, the blue circle in the spectrum shows the intensive cross-peak for the neighboring  $\text{CH}$ - and  $\text{CH}_2$ -PVA protons. Importantly, the green circles indicate the spatial proximity between the aromatic protons of the substrate and the  $\text{CH}$ - and  $\text{CH}_2$ -PVA protons. Therefore, the substrate interacts with the stationary phase, and a promising match for a chromatographic separation is identified.

In general, probing stationary phases for interactions with substrate mixtures using NOESY HRMAS and optimizing the conditions prior to a chromatographic separation attempt saves time and effort. Recording the displayed HRMAS spectrum took about 30 minutes, while performing the actual chromatography takes hours.



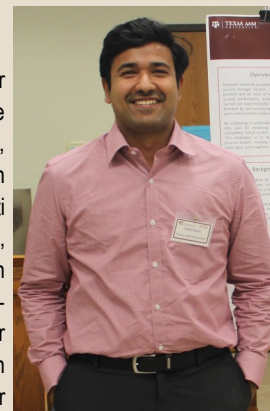
Besides polymer chemistry the Bluemel group pursues research with catalysts immobilized on silica, peroxides, as well as metallocenes and phosphines adsorbed on diverse solid surfaces.

<https://www.chem.tamu.edu/rgroup/bluemel/publications.html>

1. Pope, J. C.; Sue, H.-J.; Bremner, T.; Blümel, J. *Polymer* **2014**, *55*, 4577-4585.
2. Pope, J. C.; Sue, H.-J.; Bremner, T.; Blümel, J. *J. Appl. Polym. Sci.* **2015**, *132*, 1804-1816.
3. Hoefler, J. C.; Kimball, M. R.; Blümel, J. *Magn. Reson. Chem.* **2025**, *63*, 110-121.

### Sumit Khatri, Ph.D. Graduate

During my time as a PhD student at the Polymer Technology Center (PTC) at Texas A&M, I had the opportunity to integrate simulation, experimentation, and industry collaboration to advance research in polymer scratch mechanics. Working on complex multi-physics problems using finite element analysis, machine learning, and experimental validation significantly enhanced my technical depth. Participating in the biannual scratch consortium and PTC poster competitions allowed me to translate research concepts into industry-relevant solutions and foster meaningful connections with industrial mentors and collaborators. Receiving the SPE scholarship and mentoring students in Polymer lab courses further enriched my Ph.D. journey, making it a well-rounded experience defined by continuous learning, impactful research, and professional growth.



### Hengxi Chen, Ph.D. Graduate

My five years as a PhD student in the Department of Materials Science and Engineering at Texas A&M University have been profoundly impactful, thanks to the opportunity to join the Polymer Technology Center (PTC). This experience has been incredibly rewarding, allowing me to delve deep into the synthesis and characterization of polymer materials and composites. Beyond the hands-on technical skills, I've also learned how to establish useful structure-property relationships for polymer materials, significantly honing my critical thinking and research capabilities.

I want to express my sincere gratitude to Professor Sue for providing me with this invaluable opportunity to work with him. The knowledge and skills I have gained at the PTC are truly priceless, and I am eager to apply everything I have learned here to future research and development activities, contributing meaningfully to the field.



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## Texas A&M Awarded More Than 13,000 Diplomas At Spring Commencements

Texas A&M University awarded approximately 13,016 degrees to spring graduates at the Spring commencement ceremonies. Commencements were held at Reed Arena on May 8, 9 and 10 for undergraduate, master's and doctoral students.



Full story: <https://rb.gy/ektvee>



## Texas A&M University Named No. 2 Most Recognized Public University in US

Texas A&M University has surged to the No. 2 spot for most visible public universities and No. 8 among all U.S. institutions, according to **American Caldwell's 2025-2026 Global University Visibility (GUV) rankings**. This marks a dramatic climb from sixth place last year among U.S. public universities, leapfrogging UCLA, Arizona State, Michigan and UC Berkeley this year. Texas A&M also jumped from No. 21 to No. 13 worldwide, the largest leap among the Top 15.

Texas A&M remains the most visible university in Texas, as well as the SEC, and now stands firmly among the world's most talked about, searched and followed institutions of higher learning.

Full story: [rb.gy/c79be6](https://rb.gy/c79be6)

## SPE STUDENT CHAPTER officers for 2024-25

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