2025

First 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

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PTC, TAMU News & SPE Student Chapter

Developing Cationic Polymers to Fight Bacteria

An Tran (Chemistry) and Quentin Michaudel (Chemistry and Materials Science & Engineering)

Antibiotic resistance is quickly becoming a global crisis that will soon threaten our ability to treat common infections and injuries at the risk of patient death. Health experts are calling for innovative approaches to supplement existing therapies and stay ahead of evolving bacteria. Cationic polymers, or large molecules made of positively charged repeating units, have recently emerged as a promising strategy to combat bacteria. Cationic polymers synthesized by various groups around the world have shown significant antibacterial activity without inducing bacterial resistance due to their specific mechanism of action. These unique molecules interact with negatively charged bacterial membranes via electrostatic forces, insert themselves into the membrane, and disrupt its integrity, resulting in cell death. (**Fig. 1**). Unlike conventional antibiotics that typically target internal bacterial functions, cationic polymers cause physical damage to the lipid bilayer of bacteria. It is currently hypothesized that bacteria cannot evolve resistance to this mode of action without compromising the primary function of their membranes. However, the identification of a cationic polymers with maximized antibacterial activity and minimized toxicity remains a grand challenge. Scientists aim to develop safe and efficient cationic polymers as antibacterial therapeutics through the synthesis and evaluation of numerous structural variants.

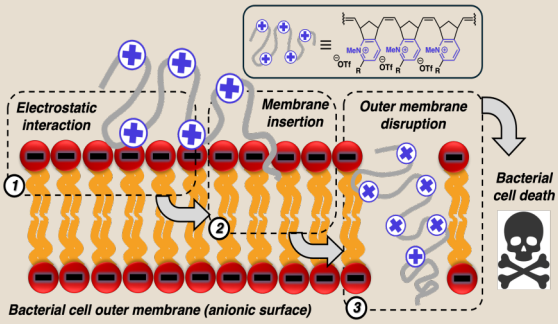

Figure 1. Pyridinium-fused poly(norbornene): a novel type of cationic polymer for antibacterial applications reported in the Proceedings of the National Academy of Science by Michaudel and coworkers: Hancock, S. N. Yuntawattana, N.; Diep, E.; Maity, A.; Tran, A.; Schiffman. J.; Michaudel, Q. *Proc. Natl. Acad. Sci.* **2023**, *120*, e2311396120.

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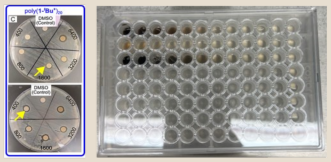
Continues from page 1— Developing Cationic Polymers to Fight Bacteria

To advance this goal, the Michaudel laboratory focuses on designing novel synthetic processes to access cationic polymers with desirable properties. Using an in-house-developed process, the team synthesized two novel pyridinium-fused norbornene monomers in high yields. These monomers were then polymerized through ring-opening metathesis polymerization (ROMP) with AquaMet, a catalyst uniquely suited to the solubility profile of these charged molecules. Careful kinetic analysis revealed that the produced pyridinium-containing materials have living characteristics and, therefore, tunable and uniform chain lengths.

Antibacterial assays showed that the polymers possess high activity against two classes of bacteria: Gram-negative *E. coli* and Gram-positive methicillin-resistant *Staphylococcus aureus* (MRSA). Rapid assessment was first conducted using a disk diffusion assay (**Fig. 2a**). The activity of all polymers was then quantitively measured using a broth dilution assay. The method allowed the determination of the minimum inhibitory concentration (MIC) of the pyridinium polymers, which is defined as the lowest concentration required to inhibit bacterial growth. The measured values of 25 µg/mL for *E. coli* and 50 µg/mL for MRSA are promising stepping stones toward the productions of pyridinium-based cationic polymers for real-life applications. Importantly, the polymer demonstrated low toxicity toward human red blood cells though hemolytic assays, with a measured HC_{50} value of 740 µg/mL for the least toxic polymer (**Fig. 2b**). The HC_{50} corresponds to the concentration of a molecule that causes the lysis (disintegration) of 50% of the red blood cells in the analyzed sample.

(a) MIC calculated through disk diffusion assay (left) and broth dilution assay (right)



Microbe	Disk diffusion assay (µg/mL)	MIC (µg/mL)
E. coli	1600	25
MRSA	400	50

(b) Concentration of cationic polymer inducing 50% lysis of red blood cells (HC_{50})

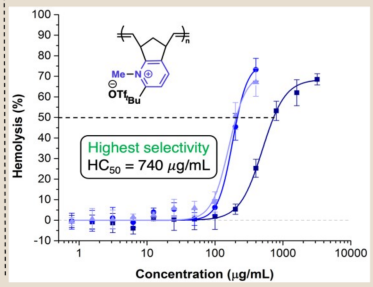


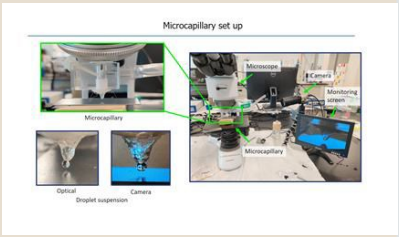
Figure 2. (a) Antibacterial efficiency of one pyridinium-fused poly(norbornene) in inhibiting the growth of *E. coli* and MRSA measured using disk a diffusion assay and a broth dilution assay. (b) Measurement of the hemolytic activity (HC_{50}) of cationic polymers of three different chain lengths. Data from *Proc. Natl. Acad. Sci.* **2023**, *120*, e2311396120. (Copyright, 2023).

This innovative project underscores the importance of interdisciplinary collaboration. The Michaudel Lab partnered with experts across institutions, including Dr. Rachel Letteri's group at the University of Virginia for the characterization of the molar-mass distribution of the polymer samples and Dr. Jessica Schiffman's group at The University of Massachusetts Amherst for the analysis of antibacterial activity. Hemolytic assays were performed at TAMU with the technical help of the Pellois group. The goal of this collaborative project moving forward is to enhance the bioactivity of these cationic polymers while improving their selectivity for bacteria over human cells.

Novel Microcapillary Corrosion Testing Technique Pioneered by NCMRL (National Corrosion and Materials Reliability) Team

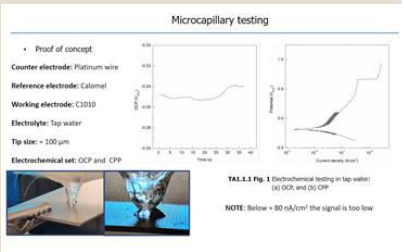
Rebecca Crow, Ulises Martin, H. Castaneda

Inspired by the multiscale corrosion phenomenon, the need for precise tools to observe electrochemical reactions at microscopic levels grows increasingly urgent. Among these constant processes, corrosion—a ubiquitous phenomenon affecting all metals—remains a significant area of study. How, then, can we effectively observe live electrochemical reactions on a micrometer scale, particularly about critical material properties such as grain boundaries or impurities?



Addressing this challenge, researchers from the National Corrosion and Materials Reliability Laboratory (NCMRL) — Brooke Bond, Reece Goldsberry, Ulises Martin Diaz, Ph.D., and Dr. Homero Castaneda-Lopez — , have developed a groundbreaking microcapillary testing setup. This innovative system measures AC and DC electrochemical reactions with remarkable precision, reaching a resolution of square micrometers (µm²) and detecting currents down to the picoampere range.

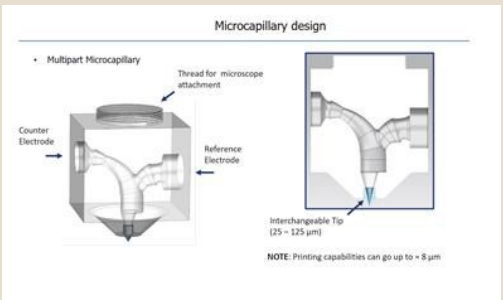
The breakthrough enables detailed observation of electrochemical processes at a previously unattainable level, opening doors to a deeper understanding of corrosion mechanisms and material behaviors under diverse conditions.



For further technical insights, the research team recommends reading their publication, "Applicability of microcapillary electrochemical droplet cell for monitoring microbiologically induced corrosion."

Additionally, a significant application of this microcapillary technology is explored in the article, "Surface passivation on precipitated Ti-containing multi-principal element alloy subject to metal aging."

The NCMRL Lab celebrates this milestone in corrosion science and looks forward to future innovations that will shape the field. Stay tuned for more updates as they continue to push the boundaries of material reliability research.



Dr. Michael J. Mullins
PTC Research Scientist

After working with Prof. H.-J. Sue for 10 years, I've decided to retire effective December 31st, 2024. My roles as a part-time staff member have been working with students, lab safety and training, occasionally teaching, reviewing manuscripts and disclosures, writing grant applications, repairing and building equipment, and others. Prof. Sue and I have worked to transition most of these responsibilities to other members of the group. In addition, I will be available in the foreseeable future for consultation and an occasional visit. I will try to attend upcoming PTIC meetings.

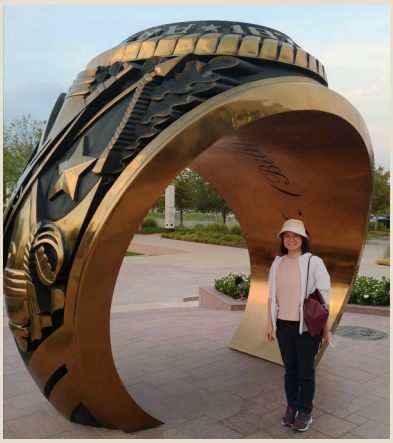
The most memorable and fun part of this position has been watching the students grow in knowledge and skills. It's satisfying and a little sad to see them move on to careers in industry and academia. In addition, helping to solve research problems has exposed me to many new areas of science and technology.

I want to give my sincere thanks to Prof. Sue for giving me the opportunity to work with him.

We would like to express our gratitude to Dr. Michael Mullins for the last 10 years he spent at TAMU-PTC. Dr. Mullins has made an invaluable contribution and impact to both PTC and MSEN at TAMU. We wish him all the best in his retirement. We will all miss him greatly.

Lu-Chen Yeh (Mandy)
Visiting Scholar from Taiwan-Formosa Plastics

I am grateful for the opportunity to be part of the Polymer Technology Center. Joining the Polymer Technology Center has been an incredibly rewarding experience. Through studying the synthesis and properties of polymers and their composites from a materials science perspective, I have broadened my understanding of end-product design and development, while also learning to think beyond conventional with individuals from diverse research fields.

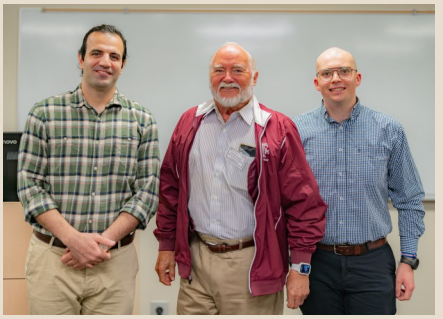


As a result, this journey has been truly unforgettable—not only for the academic knowledge I've gained but also for the broader perspectives it has offered me. Moving forward, I hope to apply what I've learned to product development, turning the end of this journey into the starting point for another phase of innovation.

SPE SCHOLARSHIPS

On October 18th, 2024 the following students were recognized at PTIC meeting for being the SPE scholarship recipients

L-R: Ms. Donna Davis, SPE Liaison and Mr. Nickolas McDaniel, MSEN received the SPE Dale Walker memorial scholarship



L-R: Reza Bahrami, MSEN received the SPE Henry Kahn memorial scholarship; Dr. Dave Hansen, SPE Liaison; and John Hoefler, CHEM received the SPE scholarship

L-R: Sasha George, MSEN; Dr. Hung-Jue Sue, Professor and PTC Director; Maxwell Kimball, CHEM; and Md Saifur Rahman, BMEN

The PTIC poster session was held on October 17th-18th, 2024 with the following students placing in the competition.

Congratulations to all these students!

Polymer Technology Industrial Consortium (PTIC) Student Poster Session			
October 18th, 2024			
	Students Name	MAJOR	Student Poster Titles
1st	Sasha George	MSEN	"Soft polymers for shape changing active textiles"
2nd	Maxwell Kimball	CHEM	"HRMAS NMR for Characterizing Polymers: A New Technique Bridging Solid-State and Solution NMR Spectroscopy"
3rd	Md Saifur Rahman	BMEN	"Engineered Hydrogel-Based Soft, Stretchable, and Biocompatible Electronic Implants for Neuromodulation"

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Congratulations

Md Saifur Rahman Receives Outstanding Engineering Doctoral Graduate Student Award

Md Saifur Rahman, a Ph.D. candidate in biomedical engineering (BMEN) at Texas A&M University, focuses his research on designing innovative materials and devices for implantable and wearable technologies, including sensing, neural stimulation, and health monitoring. He previously earned a prestigious South Korean Government Scholarship to pursue his second M.S. in materials science and engineering at Gwangju Institute of Science and Technology. Saifur has been spearheading several multidisciplinary projects, developing soft electronic implants and shape-morphing composites, which have resulted in a provisional patent and forthcoming peer-reviewed publications. As part of the National Science Foundation-funded Precise Advanced Technologies and Health Systems for Underserved Populations Engineering Research Center, he has also been at the forefront of research developing soft composite-based electronic skin for human vital signs monitoring.

Beyond his research achievements, Saifur is a committed mentor. On October 25th, 2024, he attended the Aggie Engineering Awards banquet where he was recognized for his dedication, receiving the "Outstanding Engineering Doctoral Graduate Student Award", a distinction given to one Ph.D. student per year at Texas A&M University's College of Engineering. His research excellence has garnered numerous accolades, including the Best Oral Presentation award at the BMEN Graduate Student Symposium, recognized honors for an e-poster at the 2024 AAAS Annual Meeting, the PTIC poster award, and several travel grants. In addition to his academic accomplishments, Saifur embodies Texas A&M's core value of selfless service, contributing to the community through outreach initiatives such as judging the Texas Science Olympiad state tournament and the 50th Texas Junior Science and Humanities Symposium.

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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PTC Polymer Technology Consortia
Materials Science & Engineering

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