PolyRMC celebrates its 10th anniversary this year. It is gratifying to reflect back on the past decade and the many activities, participants, and achievements at the Center. These sort out into scientific and technical milestones, the education, experience and advancement of the people involved, and service to Tulane and other universities, and to the community.

Some of the scientific and technical milestones of which we are proudest include the first time fully automatic control of molecular weight, conversion, and composition in free radical copolymerization via the ACOMP/Control Interface platform, development of a second generation of ACOMP for monitoring the onset and evolution of stimuli responsive behavior in 'smart polymers', discovery of supramicellar assemblies and their properties, developing methodologies for rapidly establishing complex phase behavior in solutions, and establishing new approaches and instrumentation for monitoring and understanding the kinetics of protein aggregation.

PolyRMC has provided a wide variety of educational and training experiences, including support for many Postdoctoral Fellows, graduate students, visiting professors on sabbatical, undergraduate research and honors thesis direction, funded Research Experiences for Undergraduates, internships in both summer and during the academic year, hands on training of industrial personnel, and, of course, the semi-annual three day intensive workshop in polymer characterization with an emphasis on GPC.

Service has likely had several dimensions, including instrumentation and characterization support for faculty and students at Tulane and other universities, support of student conferences, and full time employment opportunities both for Tulane graduates and those from other backgrounds. Our relationship with the International Symposium on Polymer Analysis and Characterization has been an especially strong link to the wider polymer community. We are especially proud of our spin off company, Fluence Analytics (previously Advanced Polymer Monitoring Technologies, Inc.) and its bold mission to impact the vast chemical and biotechnology industries. While service to the community is often viewed as volunteer and philanthropic work, we consider that founding a young, dynamic company, which provides well paid local jobs and attempts to raise the intellectual and high tech profile of our region, is also a significant service to our community and beyond.

Numbers are also an interesting index for gauging the past decade; over two hundred participants at PolyRMC, including the training courses, over $6M in funding directly to PolyRMC, and $16M in collaborative funding, sixteen patents issued or pending, and dozens of publications and presentations at conferences.

2017 has been another productive year, with some highlights on the following pages. As we take stock of the past decade’s highlights we look forward to continuing intense activities.

Sincerely,
Wayne F. Reed
Murchison Mallory Professor of Physics
PolyRMC Overview

PolyRMC is a non-profit center within the Tulane University School of Science and Engineering that has developed unique instrumentation and methods for comprehensive monitoring of polymerization reactions, allowing process optimization, accelerating R&D of new polymeric materials, and potentially allowing fullscale reactor control. This work is complemented by our advances in the area of macromolecular characterization.

Mission statement:
To be the world’s premier center for R&D in polymerization reaction monitoring and control.

Motto:
Value and impact based on scientific and technical excellence, integrity, and relevance.

PolyRMC Team

Founding Director
Prof. Wayne F. Reed

Associate Director for Instrumentation
Mr. Michael F. Drenski

Assoc. Director for Operations & Strategy
Mr. Alex W. Reed

Research Scientist
Dr. Curt Jarand

Graduate students
Daniel Rees, Julia Siqueria

Faculty Affiliate
Prof. Scott Grayson, Tulane Chemistry Dept.
Prof. José Romagnoli, LSU, Chem Eng

Postdoctoral Fellows
Dr. Aide Wu, Dr. Terry McAfee

Research Technician
Thomas Zekoski

Visiting Research Professor
Prof. Nurettin Sahiner (Çanakkale, Turkey)

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Update on Dept. of Energy consortium project with LSU (Prof. Romagnoli) and Fluence Analytics (formerly APMT, Inc.)

The DoE project ended in June 2017 with a list of first time achievements in free radical polymerization:

• Automatic control of conversion and molecular weight
• Simultaneous, automatic control of composition and molecular weight in copolymers; ‘no longer enslaved to reactivity ratios’
• First time coupling of NMR to ACOMP and first terpolymerization control
• Extension to emulsion polymerization control
• First non-linear model-based control of polymerization

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Features in Scientific and Technology Progress

Advances

- Application of the 2nd generation ACOMP to stimuli responsive copolymers, in collaboration with Phillip Pickett of Prof. McCormick’s group at USM in Hattiesburg, MS
- PolyRMC/Fluence make polymer history: first automatic active, simultaneous control of composition and molecular weight in free radical polymerization, using continuous realtime reaction and polymer characteristics
- NMR was coupled to ACOMP for the first time and was used to control terpolymerization composition
- Differentiation of protein aggregation mechanisms was found with MALS
- Trimodal composition copolymers were produced with the Tulane/APMT controller
- The LSU group successfully implemented a non-linear model-based controller with Kalman filter on the Tulane ACOMP/CI

Patents

There have been both provisional and non-provisional patent applications this past year, some owned by Tulane, some co-owned by Tulane/Fluence, and others owned by Fluence. In the ACOMP area there were three non-provisionals submitted concerning monitoring and control of polymerization reactions, and two patents issued for monitoring onset and evolution of polymer stimuli responsiveness, and means for realtime assessment of formulas. In SMSLS one new patent issued on diversifying its use, including new means of applying and quantifying effects of stressors on protein solutions and approaches to quantifying particulates in such solutions. A non-provisional was filed (Fluence) on application of SMSLS to non-linear aggregation signatures. A provisional was filed concerning a new concept for online, continuous, non-extractive monitoring for manufacturing therapeutic proteins

Summary of Research Activities

Ongoing efforts include:

- Further development of monitoring and analysis of stimuli responsive polymers (with NSF/EPSCOR SMATDAP).
- Further means of controlling polymerization reactions
- Interpretation of non-linear light scattering signatures in protein aggregation and relation to aggregate concentration
- Development of means to characterize stability and loading capacity of surfactants and nanoparticle/polymer oil dispersant agents (With Prof. Scott Grayson via the GoMRI/BP foundation).
Dr. Nurettin Sahiner, a Full Professor of Chemistry in Canakkale Onsekiz Mart University, Turkey, is currently on sabbatical at PolyRMC. Dr. Sahiner has published over 200 peer-reviewed articles and book chapters, holds several international patents, and is active at numerous international conferences. His research focuses on design and synthesis of polymeric materials with unique properties for applications in catalysis, sensors, energy, environment, and biomedical fields. His research interest covers wide range of synthetic and natural polymeric smart material preparation such as hydrogels, cryogel microgel, nanogels and polymeric particles and conductive polymers. The development and application of new and versatile materials using polymeric composites, polymeric ionic liquid (PIL), and engineering materials with tunable surface properties, porosity, interfaces and hydrophilic/hydrophobic balance are also other aspect of Dr Sahiner’s research. He is also interested in the development of polymeric composites using clays, silicates, Carbon Nano Tubes (CNT), Graphene Oxide (GO), Covalent Organic Framework (COF), Metal Organic Framework (MOF), Metal Nano Particle (MNP), carbon particles and carbon dots, and aerogels for energy, storage, gas sensor, separation and device applications.

At PolyRMC he is using ACOMP, SMSLS and other methods to explore many different polymeric and nanoparticle systems.

$6M SMATDAP Consortium Uniting Louisiana and Mississippi Heads into Final Year

The consortium project includes a host of university partners, including: Tulane University (lead), LSU, Xavier University, UNO, Mississippi State University, University of Southern Mississippi, Jackson State University.

You can visit the NSF press release on all consortium awards.

Latest updated and enhanced version of the SM-ACOMP system:
Aide Wu and Michael Drenski
Typical industry projects include:

- Fundamental and quantitative understanding of polymer science and engineering systems; thermodynamics, reaction kinetics, complex interactions.
- Methodology development for polymer characterization (GPC or other).
- R&D projects for online reaction monitoring (ACOMP), process optimization, formulation/product stability testing (SMSLS, GPC, DLS), quality control, etc.
- New polymer product development R&D in collaboration with materials scientists.
- ACOMP feasibility and method development in preparation for implementation at the manufacturing reactor or in the R&D laboratory.

- Polymer characterization and analysis services.
- Expert polymer characterization and analysis services for IP cases.

PolyRMC strongly values industrial collaborations and we thank our sponsors for ongoing support.

Interaction with industry is a vital link between the very active fundamental research activities and breakthroughs happening at PolyRMC in order to translate this valuable work into societal impact.

Additionally, through better understanding of industrial challenges, PolyRMC has been able to improve its training of undergraduate, graduate and postdoctoral students, better preparing them for their careers.

Fluence Analytics Releases Third-Generation ACOMP

Improvements to the third-generation ACOMP include enhanced software user interface and analytics functionality, an upgraded detector train and new smart sensors. The newest generation ACOMP also has a higher temperature throughput which allows it to process a broader range of polymer applications.

Fluence Analytics installed its first two generations at an industrial facility where ACOMP achieved more than 98% on-stream availability and enabled a global specialty chemical company to optimize batch cycle time by an average of 17%.

Visit www.fluenceanalytics.com for news, product info and more!
Affiliate Spotlight - Dr. Scott Grayson, Chemistry

An ongoing collaboration between graduate student Farihah Haque and Fabienne Barroso-Bujans (Donostia Int'l Physics Center, Spain) has explored the architectural impurities generated during the zwitterionic ring-expansion polymerization of glycidyl ethers and their effect on bulk physical properties. (Macromolecules 2017, 50, 5129-5138.)

A Gulf of Mexico Research Initiative grant has been awarded to Dan Savin (U. Florida), in collaboration with the Grayson and Reed research groups, to study the effectiveness and biocompatibility of nanoparticle-based oil dispersants.

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- Dr. Hyuk Yu – Eastman Kodak Professor Emeritus of Chemistry at the University of Wisconsin-Madison

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