USM Polymer Science: Preparing Students for Success

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In the first of an ongoing series, CoatingsTech *looks at the university programs in the U.S. that are recipients of support from the Coatings Industry Education Foundation (CIEF). For more than 25 years, this non-profit foundation has fostered the evolution of a nationwide network of top-flight undergraduate and graduate programs focused on polymers and coatings. These programs are engaged in training students in the newest technologies and practical applications that will help prepare them for careers in this challenging field. In this issue,* CoatingsTech *profiles the School of Polymers and High Performance Materials at the University of Southern Mississippi.*

In the current difficult economy and very challenging job market, newly graduated students need every advantage they can find. That is why many people interested in polymer science choose to attend the School of Polymers and High Performance Materials at the University of Southern Mississippi (USM). As one of the leading polymer science programs in the U.S., USM provides students with strong fundamentals and develops their research and communication skills so that they are well prepared to move into the workforce. Undergraduate and graduate students work closely with the highly regarded faculty, industrial partners, and international educational institutions in the exploration of both basic and applied research in coatings, composites, and bio- and other functional materials.

Founded in 1970 by Dr. Shelby Thames, the USM School of Polymers and High Performance Materials offers undergraduate and graduate programs leading to Bachelor of Science, Master of Science, and Doctor of Philosophy degrees in Polymer Science and Engineering and Sports as well as High Performance Materials. The principal goal of the program, according to director Robert Y. Lochhead, is to educate incoming students in the fundamental theory and state-of-the-art practice of polymer science and engineering. This is achieved through a multidisciplinary curriculum covering chemistry, physics, mathematics, engineering, and biochemistry taught by an expanding faculty with ever-broadening areas of expertise. “While initially the program focused on coating science, today, research on polymers for coating applications is just one component. Functional polymers of all types, such as those for targeted drug delivery and the production of better matrices for more durable composites, for example, are being developed and evaluated,” Lochhead observes.

Close ties with industry and strong community involvement are also hallmarks of the USM polymer science program. About half of the faculty previously held positions in industry, and over half of the research is funded by industrial sponsors. “Our close connections with some of the top companies in the world—Boeing, GE, Procter & Gamble, BASF, GlaxoSmithKline—are very beneficial to our students, because once they grasp the fundamentals of polymer science, they have the opportunity to learn about designing effective research projects and pursuing research

that ultimately may have real-world applications," says Lochhead. National Science Foundation programs actually make it possible for undergraduate and graduate students to report the results of their work directly to industrial research teams via teleconferencing. Through the USM Accelerator technology transfer initiative, the school is working to find ways to quicken the successful commercialization of new technology developments. This new venture, established in 2010, provides space, technology, and professional advice for start-up companies.

Educating the community is also a priority at USM, and the polymer science program is very involved with groups of all ages. "We need to build the human infrastructure in order to have a strong position in new materials development in the future. At USM, we are working toward that goal by introducing polymer science to people of all ages, from elementary to high school, and throughout the general workforce," explains Lochhead. "Several high schools in the area have even implemented polymer science programs, and the USM faculty and graduate students help with those programs. We have a GK-12 program called Molecules to Muscles that introduces students to the wonders of materials science and engineering, even from the time of their earliest experience in formal education."

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Global outreach is also important to a successful science program, according to Lochhead. "Research takes place on a global scale today, and understanding cultural differences is critical for the success of such ventures. Therefore, students need to have experience working in a cross-cultural setting," Lochhead states. To that end, USM sends both undergraduates and graduate students to work on joint research projects at the Indian Institute of Technology (IIT), and researchers from IIT come to work at USM. Other exchanges are being developed with England and Japan, and Lochhead hopes the program continues to expand.

The graduate students taking advantage of the USM polymer science program come from varied backgrounds. While most enter directly from an undergraduate program, some have spent time in the workforce before returning to school. They have majored in chemistry, polymer science, material science and engineering, biology, and other areas. All are attracted by the breadth of research opportunities and strong reputation that the school has earned.

Regardless of their backgrounds, most students like the program organization, with classes held in the first year, and the remainder spent focused on research. Many find the first year of classes to be very challenging. "The coverage of polymer synthesis, characterization, physics, etc., is extensive and provides students with the skills they need to be successful as research scientists," notes Jeremy Moskowitz, a second-year student working with Dr. Jeff Wiggins on engineered carbon fibers for composite applications. Adds recently graduated Joshua Hanna, "The first-year class work is very intensive and difficult, but the faculty make sure that students learn the fundamentals of polymer science. As a result, once that year is completed, it is possible to begin contributing to a research project immediately." As a student in Dr. James Rawlins' group, Hanna defended his work on polymers containing fluorescent probes as corrosion indicators, and will soon start a job with Huntsman Advanced Materials.The supportive atmosphere at the school is another big factor in the success of the program, according to many of the students. "The atmosphere in the USM polymer science school is really positive, and everybody works together—faculty and students. There is a real willingness to help each other and to share knowledge," says Kevin Harman, a second-year student in the Rawlins group that is continuing the work on polymeric corrosion indicators containing fluorescent probes. A sixth-year student with Dr. Robson Storey, Lauren Kucera is working to develop new thermoplastic elastomers based on polyisobutylene for use in running shoes, and expects to defend in the spring of 2013. Kucera feels that the school is like a family, with the graduate students all fairly close to one another and the professors easy to approach. "It is definitely a supportive and collaborative environment, and while it is hard work, it is also fun," she comments. Many students remain in close contact with the faculty and other students from the program even after they graduate.

The collaborative environment, combined with all of the types of projects underway within the school, also mean that students get exposed to many different aspects of polymer science. In addition, weekly seminars led by different students make it possible to learn about other aspects of polymer science, which is an important part of the program for many.

Students also have a lot of choices when it comes to selecting a research topic. "I like polymer science because it touches upon many different disciplines, and in particular I am interested in the combination of polymer and biological sciences. When I toured USM and met with the professors, I was really impressed with the breadth of the research projects, and knew that I would not have any difficulty finding a research project that would allow me to pursue those interests," observes sixth-year student Lea Paslay, who is completing his research on surface modification with hydrophobin proteins and the development of synthetic antimicrobial peptide mimcs with Dr. Sarah Morgan. Greg Curtzwiler, a second-year student with Dr. Rawlins, also notes that the faculty supports the interests of students, even if they involve completely new materials or chemistries. He

is looking at the addition of carbon nanotubes as a way to increase the conductivity of epoxy coatings, mainly for electrostatic discharge (ESD) applications. "Dr. Rawlins had not studied carbon nanotubes before, but he encouraged me to follow my passion."

Encouragement is also provided as students look to move on from the school, and this support is invaluable. Sixth-year student Heather Pearson, who is investigating the modification of antimicrobial and anticoagulant properties of surfaces for biomedical implants under the direction of Dr. Marek Urban, is interested in finding a position in industry where she can apply polymer science to solve biological issues. She greatly appreciates all of the job postings made available to students, and feels that the connections between faculty and industry are very beneficial. All of the students in the process of looking for a job also take advantage of the onsite interviews that companies hold. In recent months alone, industry leaders Eastman, PPG Industries, and DuPont visited USM. Hanna adds that the professors are very understanding with respect to the time it takes to conduct a job search and participate in interviews.

Brandon Achord, a 2011 graduate who studied conductive block copolymers for use in flexible organic photovoltaics with James Rawlins and now works in the Formulation Additive Division at BASF, adds that the reputation of the USM polymer science program is a real advantage for graduating students looking to earn a position in industry. That reputation originates from the fact that the graduates of the program do very well when they enter the workforce. "I believe that, with the combination of class work, independent research projects, participation in conferences, and even the opportunities to take part in community outreach efforts, I am very prepared for employment," asserts Olivia McNair, a fifth-year student under the supervision of Dr. Daniel Savin. Achord adds that access to advanced technologies and hands-on use of state-of-the-art equipment help students prepare for the transition to the workforce.

"From beginning to end, the level of teaching and the challenging classes in the first year, the ability to design and pursue a research project, the weekly seminars and exposure to so many different aspects of polymer science, the interactions with all of the faculty and other students, the community outreach activities—the entire program is geared toward preparing graduate students for a successful career in polymer science, whether in industry or academia. When I start my new job as a polymer research engineer with Remington Arms, which is a job I am thrilled to have, I am confident that, with the education and experience I have received at USM, I will be able to contribute significantly to the new product development and technical support efforts at the company," concludes Ryan Hensarling, a recently graduated student of Dr. Derek Patton who prepared polymer brushes and studied their surface modification using various biological molecules.

USM School of Polymer Science: Student Highlights

BRANDON ACHORD

Undergrad:	Polymer science from USM
Year:	Graduated in 2011
Professor:	James Rawlins
Research Project:	Synthesis and characterization of conductive block copolymers of polythiophene and buckminsterfullerene for use in flexible organic photovoltaics.
Comments:	Currently employed at BASF; as an undergrad, liked the hands-on learning and the positive atmosphere

OLIVIA MCNAIR

Undergrad:	Chemistry from USM
Year:	Fifth year
Professor:	Daniel Savin
Research Project:	Using combination radical step growth polymerization for the preparation of highly uniform thiolene networks that can withstand significant shocks and absorb energy, but have improved toughness and impact properties
Comments:	Has an MA in education and taught high school chemistry for four years before attending graduate school. Close to finishing and beginning her job search. Really believes strongly in the educational outreach activities of the school and the positive impact they have, especially when engaging the interest of young children in science.

GREG CURTZWILER

Undergrad:	Biochemistry from California Polytechnic Institute, San Louis Obispo (Cal Poly)
Year:	Second year
Professor:	James Rawlins
Research Project:	Addition of functionalized carbon nanotubes as a means to increase the conductivity of epoxy coatings for electrostatic discharge applications. The nanotubes are functionalized and incorporated into the epoxy polymers via radical grafting with the goal of controlling their location in the polymer network for reduced percolation thresholds.
Comments:	Worked two years as a teacher between undergraduate and graduate school. Considering post doctoral opportunities and teaching at Cal Poly once graduated.

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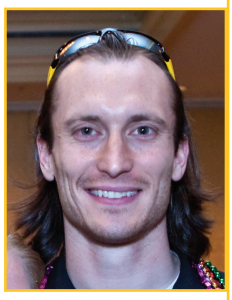


JOSHUA HANNA

Undergrad:	Chemistry from Milsaps College
Year:	Recently graduated
Professor:	James Rawlins
Research Project:	Tethered a fluorescent tag that fluoresces at high pH onto a phenoxy resin as an indicator of corrosion before rust forms on steel; works 240 times faster than visual methods.
Comments:	Appreciates the diversity of research at USM and the ability to pursue interdisciplinary projects.

KEVIN HARMAN

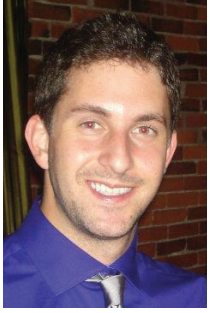
Undergrad:	Chemical physics from Centre College
Year:	Second year
Professor:	James Rawlins
Research Project:	Continuing the research on coatings for corrosion prevention, using a fluorescent probe that responds to the presence of ions rather than changes in pH, which will enable formulation of water-based systems.
Comments:	Very interested in sports.

RYAN HENSARLING

Undergrad:	Polymer science from USM
Year:	Recently graduated
Professor:	Derek Patton
Research Project:	Polymeric surface modifications via thiol-click chemistry: robust polymer brush formation and modification of surface properties to manipulate the surface functionality—hydrophobicity or hydrophilicity.
Comments:	Has taken the position of polymer research engineer with Remington Arms.

LAUREN KUCERA

Undergrad:	Chemistry from Hope College
Year:	Sixth year
Professor:	Robson Storey
Research Project:	Synthesis, characterization, and mechanical testing of polyisobutylene-block-polyamide copolymers as alternatives to currently produced polyether polyamide block copolymers (Pebax from Arkema) for use in running shoes. The use of polyisobutylene is anticipated to increase the durability (resistance to degradation).
Comments:	Participated in the GK12 program and taught in a local high school; currently looking for a job in the sports industry, but if that is not possible, will consider teaching at a small college.



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JEREMY MOSKOWITZ

Undergrad:	Material science and engineering from Cornell University
Year:	Second year
Professor:	Jeff Wiggins
Research Project:	Investigation of polyacrylontrile polymers prepared via reversible addition-fragmentation chain transfer (RAFT) polymerization as precursors to carbon fibers to gain a better understanding of how carbon fibers develop.
Comments:	Very interested in sports and hopes to get a job in a sports-related field when he graduates.

LEA PASLAY

Undergrad:	Biological science with a minor in chemistry from William Carey University
Year:	Sixth year
Professor:	Sarah Morgan
Research Projects:	Surface modification with biological materials: investigation of the self-assembly of a particular hydrophobin protein at an interfaces; development of synthetic polymers that mimic the action of antimicrobial peptides, which selectively kill pathogens and leave plant and animal cells unharmed.
Comments:	Recipient of a Department of Education GAANN fellowship that allowed the pursuit of education and communication training and an NSF IRES grant that funded a three-month international research experience in India. Will be graduating soon and is currently looking for a job in industry.

HEATHER PEARSON

Undergrad:	Chemistry & biological science from William Carey University
Year:	Sixth year
Professor:	Marek Urban
Research Projects:	Surface modification of ultra-high molecular weight polyethylene and polytetrafluoroethylene (PTFE) in order to impart various functionalities that affect antimicrobial and anticoagulant properties of biomedical implants.
Comments:	In her final year of the program and looking for a job that will allow her to continue to work in both the polymer and biological science fields.