

FALL 2010

# CLEMSON<sup>®</sup>

## CHEMICAL AND BIOMOLECULAR ENGINEERING

### *Message from the Chair:*



Dear Alumni and Friends of the Department:

Greetings from Clemson and I hope you are doing well! We have had additional faculty and student achievements recognized since the summer. For example, Prof. Scott Husson received the FRI/John F. Kunesh Award from AIChE's Separations Division.

This award recognizes "outstanding contributions to the academic, scientific, technological, industrial, or service areas involving separations technologies for individuals under the age of 40." Congratulations to Scott and certainly well-deserved, and congratulations to all of our faculty and students highlighted in this newsletter.

This past semester we've had another increase in undergraduate enrollment, now totaling 155 students in the sophomore through senior years and representing a 75% increase over the last five years. Of those, 50% participated in our cooperative education program and many others had summer internships and research experiences. This past year we had 35 B.S. degrees awarded and we project 50 this coming year.

The Departmental research expenditures totaled \$2.2 million for FY10 and we graduated 5 Ph.D. students. We had another productive year in securing research funding. As examples, research awards this past year came from the Army Research Labs, Air Force Research Labs, National Science Foundation, and industry for the development of ultrahigh performance carbon and polymeric fibers; the National Institute of General Medical Sciences to develop advanced membranes for chromatography-based protein purifications; and the Department of Energy through the multi-university Center for Atomic-Level Catalyst Design, headquartered at LSU, focused on the development of new catalysts for the production of clean fuels and chemicals from renewable sources.

We have seen changes in our faculty. This semester Dr. Graham Harrison accepted a permanent position in the Office of International Science and Engineering at the National Science Foundation. Graham contributed enormously to the Department and we wish him all the best in his new position. At the same time, we are pleased to welcome Dr. Mark Roberts to our faculty. Mark received his Ph.D. from Stanford and completed a two-year postdoc at Sandia National Labs. His research interests are in the areas of conducting polymers, energy storage, and chemical sensors. His teaching and research interests make him a great addition to our Department.

Best regards,  
Douglas Hirt, Professor and Chair

### New Faculty Member Dr. Mark Roberts

The Chemical and Biomolecular Engineering Department is pleased to announce the addition of a new faculty member: Dr. Mark E. Roberts, Assistant Professor. Dr. Roberts received his B.S. degree from Montana State University and his Masters and Ph.D. degrees from Stanford University, followed by a post doc at Sandia National Labs.



Dr. Roberts' research interests are in the areas of conducting polymers, energy storage, and chemical sensors. His research group will focus on understanding the assembly of conducting polymers into three-



dimensional films with defined nanostructures and exploiting their properties for applications in electrical energy storage and chemical or biological sensors. Polymer film assembly is guided by molecular variations, incorporation of template-assisted methods and precise control of chemical and electrochemical polymerization conditions. Formulation of structure-property relationships is paramount in developing and optimizing material systems for target applications.

Current research involves a broad range of activities, from material design and organic synthesis to film deposition, characterization, and device fabrication. Insight into conducting polymer assembly, combined with novel polymeric materials, is used to fabricate and evaluate electrically conductive polymer films with chemistry-structure combinations applicable to emerging energy storage and sensor systems. Mechanistic details associated with polymerization and device operation are obtained from electrical, optical, and structural characterization techniques.



# DEPARTMENT OVERVIEW

## FAST FACTS 2009-2010

- Number of tenured/tenure track faculty: 10
- Undergraduate/graduate enrollments: 155 (UG), 29 (Ph.D); 1 (M.S.)
- Number of graduates: 35 B.S.; 1 M.S.; 5 Ph.D. AY2009-10.
- Research expenditures: \$2.2 Million
- Research thrusts/hot button issues:
  - Advanced Materials
  - Kinetics and Catalysis
  - Energy
  - Chemical & Biomolecular Separations
  - Molecular Modeling and Simulation
  - Biosensors and Biochips



# FACULTY HIGHLIGHTS



**Prof. David Bruce and Mark Thies** have been working with TECHFISH LLC, a start-up company in Charleston, SC, to develop a process for the recovery and purification of lignin, which can then be used as a fuel source. The project addresses the opportunity of increasing biomass feed to electricity-generating power furnaces with the goal of reducing greenhouse gases. The team has recently been awarded a Phase II SBIR grant from the Department of Energy totaling \$1 million.



**Esin Gulari**, Dean of the College of Engineering and Science and Professor of Chemical and Biomolecular Engineering, has been elected vice chairman of the National Science Board (NSB), the nation's top science policy organization. "This is a significant achievement for Esin and a proud moment for Clemson," said Clemson President Jim Barker. "Her elected leadership within this body is a reflection of the regard with which her peers hold her. This is a distinguished mark in a distinguished career." The National Science Board is an independent body of advisers to both the president and Congress on national policy issues related to science and engineering. Drawn from both industry and universities from various scientific disciplines, the members are appointed by the president and confirmed by the Senate.



**Prof. Anthony Guiseppi-Elie**, Dow Chemical Professor, has been named to the Editorial Advisory Board of Applied Biochemistry and Biotechnology (ABAB).

**Prof. Douglas Hirt** was recently appointed to the position of permanent **Chair of the Department of Chemical and Biomolecular Engineering**. The Faculty and Staff would like to acknowledge and congratulate Dr. Hirt on this recent promotion. His experience as a professor and researcher, as well as his vision for the future of our department, will be a great asset. Congratulations, Dr. Hirt!



**Prof. Scott Husson** was the recipient of the **2010 FRI/John G. Kunesh Award from the AIChE Separations Division**. This award, sponsored by Fractionation Research Inc., FRI, recognizes outstanding contributions to the academic, scientific, technological, industrial, or service areas involving separations technologies for individuals under the age of 40. Prof. Husson was recognized for the development of bioseparation membranes with improved performance arising from the use of surface initiated atom transfer radical polymerization for the creation of nano-layers.



Prof. Scott Husson also received a grant from the **National Institute of General Medical Sciences** to develop high-performance membranes for chromatography based protein purifications. The rapidly growing public demand for protein therapeutic products requires new, higher productivity, higher resolution methods for their recovery and purification. Development of these materials is essential to the production of lower cost therapeutic products for improved public health. Professor Husson's group has demonstrated in earlier work that membrane chromatography fulfills these requirements.

They have developed strategies to overcome historically low binding protein binding capacities by grafting high-capacity polymer nanolayers from base membrane supports. A goal of the NIH work is to understand the roles of nanolayer structure, membrane pore structure, and novel polymer chemistry on protein binding, with the major objective to accelerate the use of membrane chromatography in initial protein capture steps.

**Prof. Amod Ogale** was an invited speaker at the International Symposium on Advanced Fibers (ISAF 2010) in Fukui, Japan, held November 15-17, 2010. He delivered a research lecture on the future application of advanced carbon fibers in next-generation energy production. Prof. Ogale was officially hosted by the Research Center for Fiber and Textiles and the Graduate School of Engineering at University of Fukui.



# STUDENT HIGHLIGHTS



Jose Orellana received the Award for Outstanding Research Presentation at the 2010 SACNAS National Conference.

Several of our Ph.D. students were awarded travel grants to present their research at the SACNAS National Conference in Anaheim on September 30 to October 03, 2010. The award recipients and their presentation titles were: **Milagro Marroquin** “Development of inverted colloidal crystal membrane adsorbers” (Prof. Scott Husson, advisor); **David Esquerra** “Molecular design of carbonaceous oligomers for thermal management applications” (Prof. Mark Thies, advisor); and **Jose Orellana** “Polylactic acid-cellulose nanocrystal composite films” (Prof. Chris Kitchens, advisor). SACNAS is a society of scientists dedicated to fostering the success of Hispanic/Chicano and Native American scientists—from college students to professionals—in attaining advanced degrees, careers, and positions of leadership.

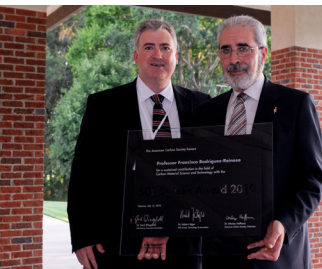


Milagro Marroquin is shown here working on her membrane research.



David Esquerra is shown here working on carbon applications.

## CARBON CONFERENCE 2010



Professors Mark Thies and Amod Ogale co-chaired **CARBON 2010, the World Conference on Carbon, July 11-16, 2010 at the Madren Center**. The international conference is held once every three years in the US; the other two years it is held in Asia and Europe. About 400 delegates from over 40 countries presented over 550 papers. The international conference was organized by the Center for Advanced Engineering Fibers and Films (CAEFF) and was co-sponsored by the American Carbon Society, College of Engineering and Science, and thirteen companies.



Prof. Thies, Mira Ogale, Evanne Thies, Diana Stamey, and Prof. Ogale were honored for all the hard work they put into making this Carbon Conference a huge success.



# WORDS FROM AN ALUMNUS

Words from an Alumnus to Prof. Scott Husson:

*"I felt the need to tell you of a project I have been working on....*

*Our refinery requested an evaluation to determine whether one of their MEA reclaimers could be operated in a different configuration which would give some steam savings. There is no commercial modeling tool available because the thing is not steady state, and it is an ugly combination of chemicals.... non-ideal liquids, ions, and absorbed H<sub>2</sub>S and CO<sub>2</sub>, and most importantly, it is not a "money making" unit so no one has created a commercial model. Anyway, I was asked to create a model.*

*It amused me. After all, I recall sitting in your class thinking, "Uh huh yeah right. Sure I'm going to use this stuff. They invented ASPEN for a reason." I did not foresee having to create my own simulation. Anyway, I pulled a lot of binary solution (MEA/Water) data, researched Kent Eisenberg Thermo to calculate the H<sub>2</sub>S/CO<sub>2</sub> vapor pressures, researched the weak acid/weak base reactions, and created the thermo for this model. Basically, it is medley of liquid activity correlations I created, ionic reactions, solubilities, etc. Now that I am done with the model, and the simulated results fall almost perfectly on top of actual plant data....*

*I just had to say thanks. I didn't think I'd ever need the stuff you taught, but I was wrong. I would be remiss not to express my appreciation for being taught how to approach a problem like this."*

Mark Edling, Class of 2008

## DONORS - FISCAL YEAR 2010

The Department of Chemical and Biomolecular Engineering would like to take this time to honor the following donors to our department from FY 2010 (07/01/09 - 06/30/10). Financial support is always critical to the operation of the department - without it we would not be able to fund our initiatives that help us attract the best students and faculty. If you would like to help contribute to our department this year, please use the enclosed business reply envelope. All monies you donate can be tax deductible and will be used to further the goals and vision of the department. Thank you so much to the donors listed below and to all those thinking of donating in the future. Your generosity is sincerely appreciated!

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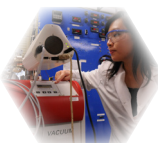


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Advanced Materials  
Biosensors and Biochips  
Chemical & Biomolecular Separations  
Energy  
Kinetics and Catalysis  
Molecular Modeling and Simulation



## PHD GRADUATES



**Dr. Bharat Bhut**

Dissertation: "Design of Advanced Ion-Exchange Membranes and their Performance Assessment for Downstream Chromatographic Bioseparations"

Advisor: Dr. Scott Husson  
Current Position: Engineer  
Pentair Filtration Solutions  
St. Paul, Minnesota



**Dr. Ward Burgess**

Dissertation: "Prediction of Liquid Crystalline Content and Molecular Structures Present in Carbonaceous Pitches"

Advisor: Dr. Mark Thies  
Current Position: Post Doc  
National Energy Technology Lab  
Pittsburgh, Pennsylvania



**Dr. Eduardo Cervo**

Dissertation: "Isolating Petroleum Pitch Oligomers via Multistage Supercritical Extraction"

Advisor: Dr. Mark Thies  
Current Position: Engineer  
Eastman Chemical Company  
Kingsport, Tennessee



**Dr. Jia Gao**

Dissertation: "Catalysis of Ethanol Synthesis from Syngas"

Advisor: Dr. James Goodwin  
Current Position: Sr. Process Engineer  
Lubricol Corporation  
Avon Lake, Ohio



**Dr. Juan Pablo Hinestrosa**

Dissertation: "Self-Assembly of Architecturally Complex Block Copolymers"

Advisor: Dr. Mike Kilbey  
Current Position: Post Doc  
École Polytechnique Fédérale de Lausanne  
Switzerland