

**University of Massachusetts – Boston**  
**Department of Chemistry Graduate Program**  
**www.chem.umb.edu**  
**Research Opportunities**

**Timothy Dransfield**

Ph.D. in Physical Chemistry from Harvard University  
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My lab explores Green Chemistry by seeking to understand human impacts on the chemistry of the atmosphere and environment. Particular emphasis is placed on understanding the links between the emission of volatile organic compounds and the formation of urban smog. Lab experiments are centered on a large flow tube into which gas phase reagents are injected, and the progress of a selected reaction is measured spectroscopically by observing the disappearance of reactants and appearance of products. Spectral analysis is done by Fourier-Transform Infrared Spectroscopy (FTIR), and plans call for the addition of mass spectrometry. Experiments are conducted over a range of temperatures and pressures. Each experiment is accompanied by an in-depth theoretical study to map out the potential energy surface on which the reaction takes place, identifying likely transition states and intermediates and allowing us to explain the pressure and temperature dependent effects observed in the experiments. Understanding these surfaces allows us to learn more about the reactivity of radicals and molecules, a field which is still not well understood. Students will learn about the physics and chemistry of the atmosphere, spectroscopic techniques, computational chemistry, gas phase kinetics, fluid mechanics, vacuum and pressure management, simple electronics, and instrument design and development. In addition, collaborations with researchers at Harvard University will expose students to more experimental techniques, including *in situ* detection of important gas phase molecules.

**Jason Evans**

Ph.D. in Analytical Chemistry from the University of Delaware  
Associate Professor and Graduate Program Director  
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Professor Evans' research group focuses on using high performance separation techniques and mass spectrometry to characterize biological samples. The two major areas of interest are lipidomics and proteomics. For instance, one of our externally funded projects involves the development of an LC-MS-MS method for the comprehensive analysis of complex mixtures of triglycerides, the major components of fats and vegetable oils. In addition, several collaborative projects are on-going with investigators in the Biology Department here at UMB. For further information, please see the Evans Group Research page at <http://alpha.chem.umb.edu/faculty/evans>.

## Research Opportunities in the Department of Chemistry

### **Michelle Foster**

Ph.D. in Chemical Physics from the University of Texas at Austin

Associate Professor and Associate Dean for Student Success

Department of Chemistry

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The Foster group uses traditional **surface science and experimental physical chemistry** techniques, such as Fourier Transform Infrared Spectroscopy and Atomic Force Microscopy, to investigate complex interfacial systems. There are a number of interesting projects being actively pursued in the Foster Lab. These include, but are not limited to, the following areas. **Atmospheric Chemistry** is being investigated by means of spectroscopic measurements examining the heterogeneous chemistry of volatile organic compounds (VOCs) and other trace atmospheric constituents on the surface of atmospherically relevant substrates to determine the fate and transport of these chemicals in the troposphere. The quest for **Alternative Energy Processes** is the motivation for our investigations of adsorption mechanisms on activated carbon surfaces for use both as hydrogen storage devices and in water filtration processes. **Green Chemistry** is being pursued by investigating the mechanisms of catalytic reactions occurring on solid acid catalysts. Lastly, there is a project in **Biophysical Chemistry** which involves the use of our AFM to visualize biological macromolecules. This varied and yet intertwined collection of projects is made possible by rich collaborations with many members of the UMass Boston Chemistry faculty.

### **Deyang Qu**

Ph.D. in Electrochemistry from the University of Ottawa, Canada

Assistant Professor

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My research interests are in the areas of renewable energy, biosensor and hydrogen storage. Both experimental and theoretical approaches are involved in the studies. All my research areas are balanced between scientific significance and potential practical industrial applications. The current three research projects aim to address the increasing concern of global warming and other automobile caused environmental issues by searching for high energy battery systems to meet the requirements for the next generation of PHEV (Plug-in Hybrid Electric Vehicle) and EV.

- 1) Rechargeable Li-air cells in non-aqueous electrolyte (Ph.D). The objective is to design and test the high voltage, high energy density Metal/Air (Li, Al/air) cells using non-aqueous electrolytes and determine the feasibility of the systems. The research will include understanding the mechanism of redox reaction on air cathode by using in-situ electrochemical spectroscopic methods e.g. GC/MS, LC/MS and synchrotron based X-ray techniques (in Brookhaven National Lab); developing high efficient non-noble metal catalyst and selecting non-aqueous electrolytes especially low temperature molten salts (ionic liquid). The project needs frequent co-operations with other groups within and outside the department. Reasonable knowledge of non-aqueous systems and basic analytical skills are essential.

## Research Opportunities in the Department of Chemistry

- 2) Rechargeable Zn-air cells in alkaline electrolyte (Ph.D). This research will be two-fold: 1<sup>st</sup> to understand the fundamental mechanism of carbon corrosion during recharge (oxidation), in-situ electrochemical EPR and UV-Visible will be the leading techniques; 2<sup>nd</sup> to explore the novel rechargeable Zn-air package design for PHEV. The second part of the research requires basic engineering skills (hands-on) and computer programming (LabView environment for power management design) experience.
- 3) Electrochemical investigation on Supercapacitor (M.S.). This project is heavily focused on engineering design of supercapacitor devices e.g. cell balance, self-discharge, energy/power balance. The project will only fly if the DOE funding can be secured.

### **Jonathan Rochford**

Ph.D. in Inorganic Chemistry from Dublin City University, Ireland.

Assistant Professor

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My current research interests are focused in the field of renewable energy. The security of an energy supply, its sustainability and environmental consequences are concerns at a national and global level in our society today. The exploitation of natural resources has led to an enormous increase of energy usage in our society, as well as a significant rise of CO<sub>2</sub> levels in the atmosphere. Solar energy has enormous potential as a clean, abundant and economical energy source, however first it must be captured and converted into useful forms of energy such as electricity or fuels. There are two primary research topics within the Rochford laboratory

#### *1. Photoelectrochemical Catalysis*

This research topic involves the study of transition metal catalysts in condensed phase and on solid oxide electrode supports. Projects include water oxidation and hydrogen evolution as well as carbon dioxide reduction. Employing a concerted approach, solar energy is used as a means of reducing large overpotentials for driving environmentally significant catalytic cycles.

#### *2. Photoinduced Charge-Separation*

The principle objective of this project is to investigate the dynamics of photoinduced charge-separation processes in supramolecular porphyrin systems in both the condensed phase and chemisorbed to metal oxide semi-conducting nanoparticles such as TiO<sub>2</sub> or ZnO. The contribution of these electron-transfer processes to solar cell efficiencies will be ultimately investigated in a working DSC device by measurement of *current-voltage* (IV) and *incident photon to current efficiency* (IPCE) responses.

In addition, side projects include fundamental studies on redox-active ligands, electrochromic displays and porphyrin synthesis. A combination of synthetic and physical chemistry approaches are involved in all studies where group members can gain valuable experience in organic and inorganic synthesis as well as photochemical and electrochemical methods. Collaborations are in development with Brookhaven National Laboratory NY, University of North Dakota ND, and the Indian Institute of Science, Bangalore, India.

## Research Opportunities in the Department of Chemistry

### **Hannah Sevian**

Ph.D. in Physical Chemistry from the University of Wisconsin

Associate Professor

Departments of Curriculum & Instruction and Chemistry

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Research in the Sevian group is concerned with how people learn chemistry, how specific teaching practices influence student learning in chemistry, how scientists can learn from teachers to communicate science more effectively, and what is needed particularly by and for underrepresented minority students to better enable them to study science. The unifying feature of our work is that it is directed at improving equity and creating capacity for more students to have access to learning science. Alongside our work in developing inquiry-based high school and undergraduate-level chemistry labs, our research also includes physical chemistry mixed experimental/theoretical studies of light emitting thin ruthenium-polymer diode films. For more information on the Sevian research group, please see:

<http://hsevian.googlepages.com/>

### **Bela Torok**

Ph.D. in Organic Chemistry from the University of Szeged

Associate Professor

Department of Chemistry

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The current focus of my research group's efforts is to develop new, environmentally benign chiral synthetic methods for biologically active compounds. These studies are based on metal nanoparticle catalysts and readily available, chiral ligands (preferably natural products). Our goal is to contribute to the development of new efficient chiral catalysts fulfilling the demand for *green* processes in asymmetric catalysis. As these processes already started to produce biologically active chiral compounds we launched another major area, the application of these compounds for medically relevant problems. Thus, our recent efforts focus on two major research topics. These major areas are:

(1) Organic Synthesis. Development and Application of New Metal Nanoparticle Based Catalysts for Organic Synthesis.

(2) Medicinal Chemistry. Synthesis and Application of Chiral Organofluorine Compounds as Novel Therapeutics for Alzheimer's Disease.

Minor Research projects, which accompany the above mentioned major areas:

Chiral organocatalytic Friedel-Crafts hydroxyalkylation reactions.

Development of polymer stabilized Pt and Pd nanoparticle catalyst.

Organic synthesis by microwave irradiation and/or ultrasounds.

Besides organic synthesis, during their work students also learn to use state of the art analytical methods used for the identification and analysis of our products (multinucleii NMR spectroscopy, gas-chromatography-mass spectrometry, high performance liquid chromatography, chiral separations).

## Research Opportunities in the Department of Chemistry

### **Marianna Torok**

Ph.D. in Biochemistry from the University of Szeged, Hungary

Assistant Professor

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Misfolded protein aggregates in the form of amyloid fibrils are related to many human diseases, including Alzheimer's disease (AD), Parkinson's disease, Type II diabetes, Huntington's disease, etc. Structural and mechanistic studies on amyloid fibrillogenesis are in the focus of our research. Particular emphasis is placed on two amyloidogenic peptides: Alzheimer's amyloid  $\beta$  ( $A\beta$ ), and diabetes-related amylin (human islet amyloid polypeptide, h-IAPP). We are also interested in biomedical and nanotechnological applications of the information gained from these studies.

For further information, please see:

<http://alpha.chem.umb.edu/faculty/mtorok/MariannaTorok.htm>

### **Wei Zhang**

Ph.D. in Organic Chemistry from the University of Pittsburgh

Associate Professor

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Research projects in the Zhang group cover the following areas: 1) *Fluorous Chemistry*. This new platform technology has been making increasing impact on many aspects of organic, biological, separation, and material sciences. Our group is a leader in the development of new fluorous reaction, separation, and immobilization techniques for solution-phase parallel and high-throughput synthesis. 2) *Organic Synthesis*. To develop new synthetic methodologies based on microwave reactions, multicomponent reactions, free radical reactions, and asymmetric organocatalysis. 3) *Medicinal Chemistry*. To design and synthesize drug-like molecules and natural product analogs for biological screening. 4) *Green Chemistry*. To develop new synthetic and separation processes which have the characteristics of high efficiency, easy product separation, easy reagent/catalyst recovery, and minimal waste disposal. Graduate students in this group will gain a significant amount of experience in advanced synthetic and analytical skills related to HPLC, NMR, LC-MS, and chiral separations