Please note the following information can also be found on our hallway bulletin board located nearest room 8-321.

For the most accurate and up to date research opportunities, please contact the faculty directly.

Analytical

DR. GREGORY BARDING

Food crops are increasingly under duress as climate change has increased the severity and frequency of abiotic stresses, such as drought and flooding. Certain varieties of plants are innately resistant to these natural disasters. I am interested in elucidating the complex biochemical mechanisms responsible for plant survival by monitoring changes in metabolite levels (metabolite profiling) in the presence and absence of the stressors. By incorporating a variety of analytical techniques, including liquid and gas chromatography coupled with mass spectrometry, nuclear magnetic resonance, and UV/Vis spectroscopy, a broad representation of metabolites can be quantitatively measured, including TCA cycle intermediates, glycolysis intermediates, and amino acids. Understanding how metabolism and energy flux changes during the presence or absence of stress will aid in our understanding of the crop stress response.

Dr. Yan Liu

Yan Liu joined the Chemistry Department at Cal Poly Pomona in September 2012. His research focus is on the development of miniaturized analysis system for biological and environmental applications. This type of analyzer can integrate sample collection, injection, separation, and detection on a single microfluidic device. Current undergoing projects include:

1. Separations on microfluidic device. Different separation methods (CE and CEC) will be adapted from conventional analysis system to the microfluidic device format. Surface chemistry of polymer-based device is being studied to facilitate more efficient separations. Currently, the surfactant and polyelectrolytes are under investigation.

2. Portable analyzer for real-time monitoring of aerosol. The amount of components in air-borne particles is directly related to the anthropological activities. Air sample will be collected and deposited directly onto the microfluidic device, followed by the CE separation and detections. The species we are interested in include sulfate, nitrate, ammonium, and some organic acids.

3. Caffeine in energy drinks. Energy drinks contain high levels of caffeine and other stimulants. High-dose consumption of energy drinks could potentially lead to the death of human beings. We are developing a new analyzer for fast determination in energy drinks and/or body fluid.

4. Electrochemical properties of graphene. Graphene, a two-dimensional crystal consisting of a monolayer of carbon atoms arranged in a honeycomb lattice, exhibits unique electrical properties. Nitrogen-doped graphene exhibits n-type doping characteristic and has great potentials in high capacity lithium ion batteries, metal-free electrochemical catalyst in fuel cells, large capacity hydrogen storage, and remarkable low turn-on field emitters. We are studying the surface properties of graphene via electrochemical and spectroscopic methods.

DR. PENG SUN

My research interest is in the electrochemical characterization of chemical process or materials in mesoscopic dimension (dimension varies from 10 to 1000 nm, 1 nm= 10^{-9} m), such as electrochemistry of a single nanoparticle, charge transfer across a nanometer-sized liquid/liquid or liquid/solid interface. These studies can help us to develop ultrasensitive electrochemical sensors or novel sensing strategies. Here are some projects in my group:

(1) Electrochemical study of a single nanoparticle. The understanding of the relationship between the size and shape of a nanoparticle and its electrochemical properties allows us to improve their performance, explore new applications, and design new materials. Recently, we developed a method which can be used to accomplish the direct electrochemistry of a single nanoparticle (http://pubs.acs.org/doi/abs/10.1021/jp308501j). On the base of our method, we are studying the formation mechanism, electrocatalytic activity and thermodynamics of a single nanoparticle.

(2) Charge transfer at liquid/liquid interface. Under the influence of an electric field, hydrophilic ions can transfer from aqueous phase into an organic phase. This process can make a current flow which is proportional to ion concentration. Thus, it can be used to make a sensor. Kinetics and mechanism of ion transfer at nanometer-sized liquid/liquid interface will be studied.

(3) Electrochemistry in very low electrolyte solutions. Normally, large amount of electrolyte is used in an electrochemical measurement so as to increase solution conductivity. However, the using of electrolyte can introduce contaminations and even change the kinetics and mechanism of an electrochemical reaction. The effect of electrolyte on the electrochemical response on a nanometer-sized electrode will be studied.

(4) Instruments. With the development of nanoelectrochemistry, one has to use a ultrasensitive potentiostat which can detect current as small as 10^{-15} A. However, there is no such kind of commercial instrument. We will use microprocessor and ultraprecise operational amplifier to make such a potentiostat.

Chemical Education

DR. MICHAEL PAGE

The Page Group research projects focus on two main areas including Green Materials and Chemical Education. So we have a little bit for everyone! If you would like to schedule a meeting to discuss a project in more detail place contact me at mfpage@csupomona.edu

Green Materials

Research dealing with Fatty Acid Methyl Esters (FAME) [Biodiesel] has a special niche at a polytechnic university. Alternative fuel research blends hands-on education with emerging technologies. Seed oils from plants consist of triglycerides that have demonstrated utility in the synthesis of Biodiesel. Value can be added to this budding industry by using organic chemistry to repurpose FAMEs as a feedstock in the synthesis of polymeric "Green" plastics, urethanes, ureas. It is our goal to provide additional avenues for the use of Biodiesel in consumer products in place of petroleum-based compounds.

Chemical Education

We have several projects that are analyzing the most effective teaching method for solving stoichiometry and mass-relationship problems. Currently Ratio and Proportions (RAP) is proving to lead to deeper student comprehension! This teaching method, based on proportional reasoning, is similar to the more highly used method of Dimensional Analysis (DA). We have found RAP emphasizes the relationships represented in the balanced molecular equation and leads to the development of better prepared students in general chemistry. If you have an interest in teaching, then consider completing your undergraduate Senior Research project in Chemical Education!

Biochemistry

DR. RAKESH MOGUL

Our current research efforts encompass two main tracks: (1) student-centered laboratory work in extremophile biochemistry; and (2) policy-based research and analysis in a subject known as Planetary Protection.

(1) Our student-led efforts focus on the proteomic and survival features of differing *Acinetobacter* that have been isolated from the cleanroom facilities where spacecraft are assembled (*e.g.*, Mars Odyssey orbiter and Phoenix lander). *Acinetobacter* are Gram-negative bacteria that are broadly associated with water, soil, and clinical environments. Our work has demonstrated that *Acinetobacter radioresistens* 50v1 and other novel *Acinetobacter* species possess biochemical features that confer resistance towards low humidity conditions, high concentrations of hydrogen peroxide, and large doses of ultraviolet radiation. We recently reported (McCoy et al., *Astrobiology* 2012) that *A. radioresistens* 50v1 displays a survival against hydrogen peroxide that is among the highest known for non-spore forming and Gram-negative bacteria, and is based upon the enzyme-based degradation of hydrogen peroxide (catalase and alkyl hydroperoxide reductase), energy management (ATP synthase and alcohol dehydrogenase), and modulation of the membrane composition. While these findings have particular implications regarding the cleaning of spacecraft hardware, the biochemical features also suggest that clinically-associated *Acinetobacter* may possess (or have the ability to adopt) similar extremotolerant survival features. This research is based upon the work of undergraduate and Master's level students, includes enzymology, proteomics, and microbiology methods, and has been supported through the NASA Astrobiology Institute-Minority Institutional Research Support program.

(2) My policy-related work in Planetary Protection centers upon the review of regulations that are designed to minimize the contamination of extraterrestrial environments, such as Mars and Europa, which may result from spacecraft exploration. In order to ensure the scientific integrity of life-detection missions (*e.g.*, to avoid detection of false positives), a specific set of bioburden limits and cleaning procedures have been defined at both the international and Federal levels. Currently, I am re-drafting the Mars-related policy language in the NASA Procedural Requirements document, NPR 8020.12D, which is the primary Federal document that describes the NASA planetary protection guidelines for robotic missions. In parallel, I am conducting a comparative analysis of the bioburden regulatory limits (*i.e.*, number of total allowed spores, maximum allowed surface

density of spores, and probabilities of contamination) using both past and current policies from NASA, the European Space Agency (ESA), and the Committee on Space Research (COSPAR). This work is currently supported through the NASA Research Opportunities in Space and Earth Sciences grants program.

The following list briefly describes my additional research interests:

(A) In Barnes, et al., *J. Inorg. Biochem.* 2011, we demonstrated the detection of *Bacillus* spores using the luminescent and cost-effective reagent of Tb(EDTA). We showed that the inclusion of hexadentate chelators, such as EDTA and DO2A, enhance reagent stability in complex mixtures and that (under un-optimized conditions) a gamma-resistant *Bacillus* spore could be detected at ~10^4 cfu/mL. While there are no current students on this project, I anticipate future projects focusing on additional biochemicals and field-based assays.

(B) I am the Director of the NASA/CSU Spaceward Bound program, which is an astrobiology field learning experience in the Mojave National Preserve that functionally integrates pre- and in-service K12 STEM teachers into the scientific study of the Mojave Desert (www.csupomona.edu/~rmogul/spacewardbound). On a yearly basis, students from the CSU, along with scientists from both the CSU and NASA, converge in the Mojave desert and combine their efforts towards the genetic, biochemical, and geochemical study of biological soil crusts, which are symbiotic microbial communities that assist in the nutrient and water cycling in arid lands.

Inorganic

Dr. Joe Casalnuovo

Our Research is focused on a class of compounds known as Fischer carbenes. Fischer carbenes are organometallic compounds that have been widely used as reagents in organic synthesis. Notably, they have been very useful in synthetic routes to natural products that have potential applications in medical reteach. In our laboratory, we have recently discovered the first efficient route to *diphosphinated* Fischer carbenes, a new and exciting variation of this class of compounds. We are interested fully in exploring the synthesis, characterization (IR and NMR spectroscopies), and reactively of these compounds. We are especially interested in the potential of *chiral* dipsophinated Fischer carbenes to carry out *asymmetric* syntheses, a vital tool in the synthesis of natural products. Because many have the opportunity to learn how to carry out in the airless environment using Schlenk glassware techniques.

Dr. Chantal Stieber

Website: http://www.cpp.edu.edu/~sestieber

The Stieber Lab focuses on solving problems through complementary efforts in synthetic inorganic chemistry, spectroscopy and computational chemistry. Current directions in the group include:

- Expanding the scope of X-ray emission spectroscopy to allow for identification of small molecules (eg. NO, NO^{1-}, NO^{2-}) bound to transition metal centers. Results of this work will be applied to understanding how biological systems reduce and capture airborne pollutants.
- Synthesize novel first-row transition metal compounds for benchmarking spectroscopic signatures of small molecules bound to metal centers. This work will help develop new methods for characterizing compounds and elucidating mechanisms.
- Development of first row transition metal catalysts for transformations such as C-C bond formation and polymerizations. First row transition metals are more earth-abundant than many of those currently used in catalyst and may also harness new reactivity.

Organic

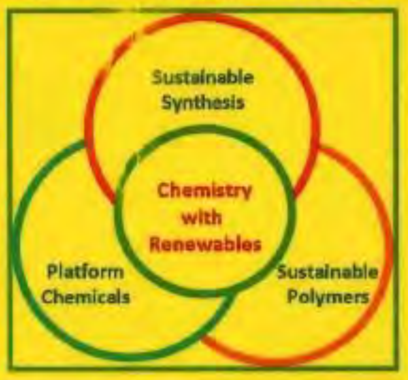
DR. FRANCIS FLORES

My research interests revolve around reaction mechanisms, structure - reactivity relationships and intrinsic barriers of reactions. Research in this area focuses on understanding fundamental processes such as proton transfer and nucleophilic addition/substitution reactions in organic as well as transition metal carbene systems. Research tools include a variety of kinetic methods including stopped- flow spectrophotometry for fast reactions as well as conventional UV-Vis spectroscopy for slower reactions.

The study of coal structure constitutes another area of interest. Identification and quantitation of functional groups and moieties in different rank coals is of particular interest. Both chemical as well as standard analytical methods such as ^{1}H NMR, FT-IR and VPO are employed. Of current interest is the development of calibration methods for using HPLC as a potentially powerful tool for coal structure research.

Dr. John Alex

Fossil resources have abundantly supplied for our energy, fuel, material and consumer needs etc. over the last century. Concern over its dwindling supplies together with environmental impacts from its exorbitant use has resulted in a global hunt for alternate sustainable resources. The scientific community has thus been faced with the challenge of identifying suitable substitutes or replacements for our current petrochemical feedstock. While solar, wind, fuel cells etc. can help us meet our energy needs of the future, biomass being the source of renewable carbon atoms could supply for our chemical feedstock. However, biomass and biomass–derived being structurally, compositionally and functionally different from petrochemicals demand the development of alternate methods for their efficient utilization. From a synthetic chemist's perspective this calls for a paradigm shift in how we think about our starting materials, reagents, catalysts, solvents and so on. Keeping this in mind, my research program will be directed towards efficiently incorporating biomass-derived molecules in chemical processes. Research in the group will scour different inter-related aspects like,



(*a*) developing synthetic methods that use renewables,
(*b*) converting bio-derived molecules into platform chemicals or feedstocks, and
(*c*) developing sustainable plastics sourced from biomass.

Specifically, the first project will focus on developing synthetic methods for employing aliphatic carboxylic acids as replacements for alkyl halides in C_{sp}^2–C_{sp}^3 coupling reactions *via* decarbonylation. The second project will be aimed at achieving selective hydrogenation of lignin-derived phenols to the corresponding cyclohexanones, which in turn can be converted to the respective caprolactone, caprolactam, amines etc. Broadly defined, this project will seek efficient methods for accessing functionalized alicyclics from the corresponding arenes that are obtained by lignin valorization. The third project will focus on using γ-R-α-methylene-γ/δ-butyrolactone monomers sourced from fatty acids as soft segments in block polymers for developing novel sustainable thermoplastic elastomers or thermoset plastics. Research output from these projects will enhance our fundamental understanding of the reactivity of these bio-derived molecules, and thus open avenues for continued research in this area and their effective utilization.

DR. FLOYD KLAVETTER

We design and prepare polymeric materials that conduct electricity. These substances are similar to graphite in that they possess extensive pi-electron delocalization, but they differ in their properties: the materials are flexible, moldable, and soluble in common solvents. The research involves textbook organic synthesis, characterization of organic molecules, and processing these materials into forms useful for semi-conductor devices. We have developed a wax which upon setting at room temperature for 24 hours is converted into a dark green, highly-conductive polymer.

When electrical current flows through some of these conducting polymers, they glow (emit light). These materials are being developed into light-emitting diodes for flat panel displays. Interestingly enough, a physics group in Cambridge, England has found that when these conducting polymers are illuminated with light, they generate electricity! These conducting polymers also serve as photovoltaic cells. They can convert electricity into light, or light into electricity.

Recent Publications:

"Model Studies for the Corrosion-Inhibiting Interactions at Pani/Metal Surfaces" by M. Rouser, B. Hetayothin and F. L. Klavetter, "Polym. Prep.", 2004, Volume 45(1), pp. 238-9.

"Polymerization of N-Phenylhydroxylamine: A Novel Route to the Family of Polyanilines" by F. Klavetter, "Polym. Prep.", 2004, Volume 45(1), pp. 145-6

DR. LAURIE S. STARKEY

My research interests lie in the areas of both Chemical Education and Organic Synthesis. My main focus in Chem. Ed. research is the utilization of technology in teaching and learning, especially in the Organic teaching labs. Recent activities include the creation of online pre-lab quizzes and online lab tutorials/demonstrations, and the use of "clickers" in the classroom (student response systems). Student research projects could involve the development of new online tools, or measuring the impact of such resources on student learning. My laboratory research projects involve the development and optimization of new experiments for the undergraduate Organic teaching labs. The goals of any new experiment include discovering interesting synthetic transformations and laboratory techniques while being learning-centered, safe, time-efficient, cost-efficient, environmentally friendly (green), and inquiry-based.

Physical

DR. SAMIR ANZ

The main aspects of my research involve the study of electron-hole recombinations in nano-scale materials, and the rapidly growing science of the properties of nano-phase materials and MEMS, the growth and/or etching of the underlying material must be understood.

Low energy Electron Enhanced Etching (LE4) is a relatively new procedure for etching materials and produces high-fidelity features in materials. My research can thus be divided into two categories. The first pertains to understanding the chemical processes and kinetic mechanisms, which are involved in the LE4 etching of semiconductors. The second is the commercialization of LE4 and the development of fabrication protocols that will produce the desired features for MEMS applications.

DR. TIMOTHY CORCORAN

Research in this group sits at the intersection of spectroscopy, analytical chemistry, biotechnology and medicine. It starts with the needle in a haystack problem: how does one track and quantify tiny quantities of a substance of interest (e.g., proteins, genetic material, cells, etc.) within a system of relatively large volume? Fluorescent labels have become extremely useful tools for this purpose, since they offer exquisite selectivity when coupled with suitable antibodies, and terrific sensitivity without the hassles of radioisotopes.

Our work seeks to maximize the utility of fluorescent labels in biomedical contexts by allowing greater flexibility in the choice of labels and in the number of different colors which can be used simultaneously with good quantitative accuracy. The center area of expertise is innovative applications of spectroscopy, the interaction of light and matter for quantitative purposes. The fundamental tools are light sources (mostly lasers), optics and detectors, as well as the arsenal of fluorescent-labeled antibodies now available. By applying better spectroscopic methods, particularly a variety of multidimensional spectroscopy called excitation-emission matrices to the problem of fluorescence detection and imaging in biotechnological and medical applications, we hope to open up new approaches to finding and analyzing correlations in large data sets, enhance the data throughput of measurement processes, lower costs (particularly routine labor) and heighten productivity and accuracy.