

Chemistry Research Projects Available to Undergraduates

Consult Individual Faculty Members' Web Sites for More Details

Updated 2009

Analytical Chemistry

Gary L. Long. *Environmental analytical chemistry and atomic spectrometry.*

- Chemical speciation of heavy metal ion using supported liquid membranes.
- Transport of trace metals in groundwater.
- Determination of heavy metals in soils using chelate-assisted extraction.

John R. Morris. *Surface analysis and reactivity.*

- Ultrahigh vacuum techniques applied to reactivity of surfaces.
- Destruction of chemicals on metal oxide films and nanoparticles.
- Reactivity on self-assembled monolayers as a model for pulmonary interfaces.
- Dr. Morris prefers to work with students who have completed Physical Chemistry.

Brian M. Tissue. *Analytical and materials chemistry.*

- Studies of luminescent nanomaterials to understand their fundamental optical properties and to explore their uses in functional devices such as phosphors, lasers, amplifiers, and analytical sensors.
- Current projects include preparation and surface modification of nanoparticles, self-assembly of luminescent nanoparticles in functional structures, and enhancement and quenching mechanisms of nanoparticle luminescence.
- Dr. Tissue prefers to work with students who have completed Analytical Chemistry.

Inorganic Chemistry

Karen J. Brewer. *Synthesis of mixed-metal light absorbers or catalytic centers.*

- Applications to solar energy conversion or electrocatalysis.
- Design and synthesis of mixed-metal transition metal complexes with applications to molecular devices, anticancer agents, catalysis and photochemical energy storage.
- Particular emphasis is placed on probing the properties of monometallic synthons upon their incorporation into supramolecular assemblies.
- Dr. Brewer prefers to work with students who have completed General Chemistry.

Brian E. Hanson. *Hydrothermal synthesis of metal-organic frameworks.*

- Synthesis of new materials, structural chemistry, and applications in catalysis.

Joseph S. Merola. *Organometallic chemistry.*

- Design and synthesis of inorganic and organometallic complexes for the selective transformation of organic molecules.
- Dr. Merola prefers to work with students with an eagerness to learn.

Gordon T. Yee. *Inorganic and materials chemistry.*

- Design, synthesis and characterization of molecule-based magnetic materials.
- Work involves synthetic organic and inorganic chemistry, SQUID magnetometry and mathematical modeling of data.
- Dr. Yee prefers to work with students who have completed general chemistry.

Organic, Biological, and Polymer Chemistry

Paul A. Deck. *Fluorinated aromatic compounds and polymers.*

- Fluoroaromatic chemistry and cyclopentadiene chemistry.
- Fundamental studies of the Diels-Alder reaction.
- Synthesis and reactions of fluorinated organic molecules, including polymers.

Felicia A. Etzkorn. *Chemical biology and medicinal chemistry.*

- Design, synthesis and evaluation of biologically active molecules. The molecules are used as probes of the cell cycle (mitosis) and have potential cancer therapeutic value.
- Dr. Etzkorn requires that all students have completed Organic Chemistry and Organic Chemistry Laboratory. Completion of the SynTech laboratory is also highly desired.
- She interviews all candidates individually; email her a brief resume and a transcript. Undergraduate researchers are required to attend research group meetings.

Richard D. Gandour. *Chemical biology and molecular architecture.*

- Design and synthesis of multi-use, multi-headed amphiphiles.
- Synthesis and physicochemical measurements of anti-HIV and anti-fungal topical microbicides.

Harry W. Gibson. *Rotaxane and polyrotaxanes, self-assembly, macrocycle synthesis, and polymerization.*

- Design, synthesis and self-assembly of "supramolecular polymers"
- Chemical modification of fullerenes for medical imaging / therapeutics and device applications
- Enantio- and diastereo-selective synthesis using Reissert compounds.
- The work focuses on organic synthesis and host-guest interactions; We employ several important analytical techniques to study our systems: NMR, mass spectrometry, X-ray crystallography and viscometry.

David G. I. Kingston. *Chemistry of biologically active natural products.*

- Synthesis of the side chain and analogs of the side chain of the anticancer agent taxol.
- Isolation and structural elucidation of new natural products with anti-cancer activity.
- Professor Kingston prefers to work with students who have completed organic chemistry and (for the synthetic projects) Organic Syn-Tech Laboratory.

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Organic, Biological, and Polymer Chemistry, continued.

Timothy E. Long. *Synthesis and characterization of new polymers and monomers.*

- Synthesis of new monomers for subsequent polymerization and the study of polymerization processes (mainly radical, anionic, and step growth).
- Synthesis of new polymers for semiconductor fabrication, polyurethane adhesives, living anionic polymerization, controlled radical polymerization, liquid crystalline polymers, polyesters, gas barrier polymers and carbohydrate containing polymers.
- Dr. Long requires that all students have completed Organic Chemistry and Organic Chemistry Laboratory. Completion of the SynTech laboratory is also highly desired.
- Undergraduate researchers would be required to attend group research meetings which typically are scheduled on Friday afternoon or Saturday morning. Interested students should make an appointment with Dr. Long to discuss individual interests and career plans.

James E. McGrath. *Synthesis and characterization of macromolecules.*

- Anionic (organolithium) homo-, block, and random copolymerization of hydrocarbon, polar vinyl, and cyclic siloxane monomers
- Synthesis of poly(aryl ether) sulfones, ketones, and related polymers via nucleophilic aromatic substitution
- Sulfonate and carboxylate ion-containing polymers
- Microphase and macrophase separations in block copolymers and physical blends
- Epoxy, elastomers, polyurethanes, biomaterials, and surface structures of organosiloxane and other block copolymers
- Dr. McGrath prefers to work with students who have completed organic lecture and lab, Syn-Tech, and who can attend weekly group meetings Saturday from 9 AM to 1 PM.

James M. Tanko. *Studies of the mechanism of free radical and radical ion processes.*

Organic electrochemistry, application of radical rearrangements to organic synthesis. Dr. Tanko prefers to work with students who have completed one year each of organic and physical chemistry, and he interviews all candidates individually.

Webster L. Santos. *Bio-organic chemistry and chemical biology.*

- Design, synthesis and evaluation of molecular entities that target specific proteins or mRNA of proteins related to disease states such as Malaria, influenza, cancer and neurodegeneration.
- Interested students must send transcripts and recommendation letters to Dr. Santos. Students must have time to work in lab and attend all group meetings.

Physical Chemistry

T. Daniel Crawford. *Quantum chemistry.*

- Development and application of quantum mechanical models for computing structural, spectroscopic, and thermodynamic properties of molecules.
- Research focuses on high-accuracy ab initio methods for UV/visible spectra, NMR chemical shieldings, and optical rotation for large molecules.
- Dr. Crawford prefers to work with students who have completed a full year of physical chemistry, or who have extensive backgrounds with computer programming and/or physics.

Harry C. Dorn. *New carbon based materials; magnetic resonance spectroscopy.*

- Study of new carbon based materials including fullerenes ("Buckyballs"), nanotubes, and endohedral metallofullerenes. Our laboratory has developed the expertise to prepare, purify, and characterize various carbon fullerene, endohedral metallofullerene, and nano-tube samples. In the US, we are leaders especially in the area of separation of endohedral metallofullerenes. We presently have active collaborations with 6 other groups at Virginia Tech and 20 other laboratories world-wide.
- Spectroscopic studies utilizing nuclear magnetic resonance (NMR), electron paramagnetic resonance (EPR), and dynamic nuclear polarization (DNP) to understand molecular structure and chemical reactivity.

Herve Marand. *Polymer physical chemistry and crystallization.*

- Polymer crystallization kinetics, polymer crystal melting, morphology of semicrystalline polymers, structure-property correlations, physical aging of polymers.
- Use of calorimetry, dilatometry, scattering of light and x-rays, microscopies, rheology and infrared spectroscopy techniques are used in a synergistic manner to probe the evolution of thermodynamic, morphological and relaxational behavior of polymers during their crystallization process.
- Dr. Marand prefers to work with students who have passed successfully the first semester of Physical Chemistry and who have a genuine interest in materials.

Diego Troya. *Computational chemistry.*

- We use cutting-edge computing technology to learn about chemical reactions that are very difficult to study in the lab. In particular, we combine very accurate electronic structure calculations with molecular dynamics simulations to study how gases interact with organic surfaces and polymers.
- Our goal is to understand the process whereby radicals can oxidize and degrade polymeric surfaces.
- Our focus is on the damaging collisions of radicals present in space atmosphere with the surfaces of the International Space Station, the Hubble Telescope, and other satellites and spacecraft designed for interplanetary travel.

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Physical Chemistry, continued

Edward F. Valeev. *Theoretical chemistry*.

- I am seeking students who want to develop advanced theoretical methods and apply them to predict properties of interests to chemists and engineers, such as: the energetics and kinetics of chemical reactions, rate of charge conductance in organic electronics, etc.
- My group's research emphasizes theoretical models which use only fundamental physical principles and no other assumptions.
- No previous experience is necessary. However, Dr. Valeev prefers students who have completed a full year of physical chemistry and who are interested in physics, math, and computer programming.