Georgia Tech College of Engineering
School of Materials Science and Engineering
Georgia Tech College of Sciences
School of Chemistry and Biochemistry

Laboratory for Interface Science of Printable Electronic Materials (LISPEM); PI: Erin L. Ratcliff

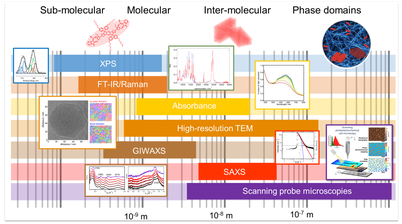
Our research is focused on the application of electrochemistry and spectroscopy to better understand the functionality of printable electronic materials, interfaces, and devices.

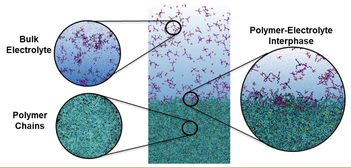
Conducting Polymers & Organic Electronics

The group focuses on fundamental structure (chemical and physical) and functionality of soft semiconducting materials for energy conversion and storage and sensing. Students will learn a variety of characterization approaches, work in teams with other research groups, and develop new scientific models for this exciting class of materials.

Fundamentals

The group is highly interested in **developing new capabilities** to understand charge transport, redox reactions and durability in a number of organic electronics.

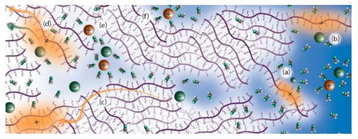


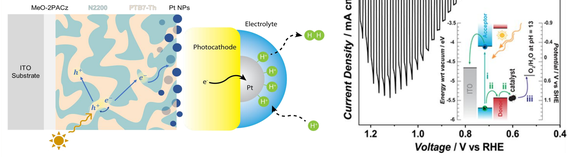


Conducting polymers demonstrate a three-dimensional swelling and **electrochemical doping** behavior that enables a number of new devices.

Solar Fuels: Chemicals from Sunlight

The development of chemical fuels from sunlight requires exquisite control over multiple processes and length scales.

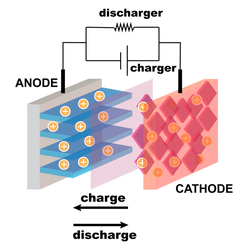


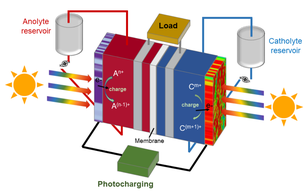


This highly interdisciplinary project is funded through a large center grant, starting first with the production of hydrogen. New areas include multi-electron transfer reactions and catalytic site attachment.

Energy Storage

Batteries and capacitors require balancing both transport and capacity of anodes and cathodes. Emerging projects in the Ratcliff group include both polymer and redox flow batteries.

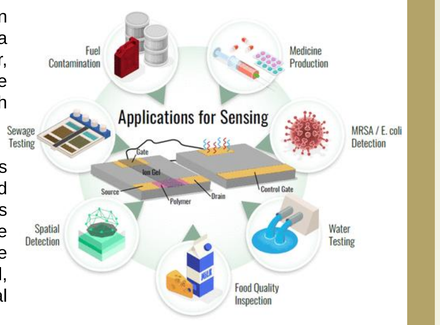




Transistors as Sensors

A transistor acts as an amplifier element for a chemical sensor, where low signals are enhanced with minimal power input.

The Ratcliff group has developed patented transistor geometries in areas of peptide sensing, to reduce biofouling in jet fuel, and for environmental sensors.

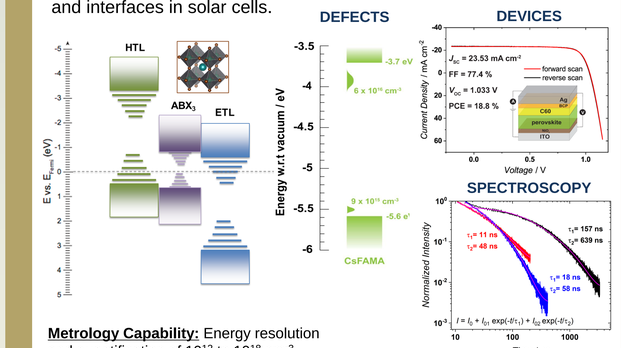


Metal Halide Perovskites

The group focuses on use-inspired characterization (i.e., *operando)* of these high performing materials for optoelectronic applications including solar, photo and X-ray detectors, LEDs, lasers, and sensors. The group's main areas are stability of materials and interfaces in photovoltaics applications and electrochemical reactions that occur far from equilibrium. Students working on metal halide perovskites will experience a fast-paced engineering focus or concentrate on hypothesis-driven fundamental research. Both areas include working with industrial, academic, and national lab partners around the country and world.

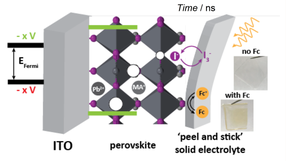
Solar Cell Stability

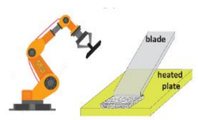
The Ratcliff group has a patented electrochemical quantification approach that enables quantification of chemically-reactive defects throughout the band structure of the material. These defects are hypothesized to contribute significantly to degradation of materials and interfaces in solar cells.

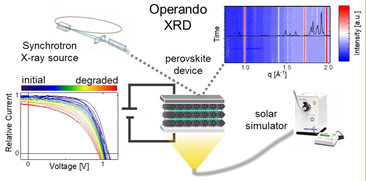


Metrology Capability: Energy resolution and quantification of 10^{12} to 10^{18} cm^{-3} including buried interfaces. The approach is compatible with a number of spectroscopic approaches.

We are currently developing wavelength-dependent capabilities and robotics to include with roll-to-roll processing. For large-area devices.

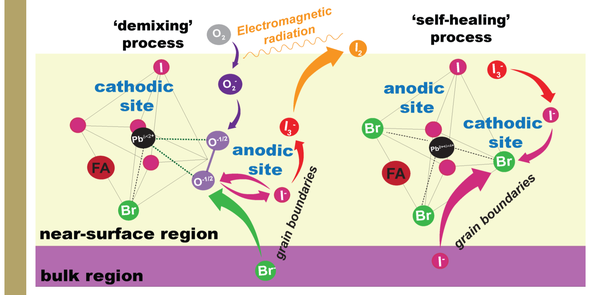




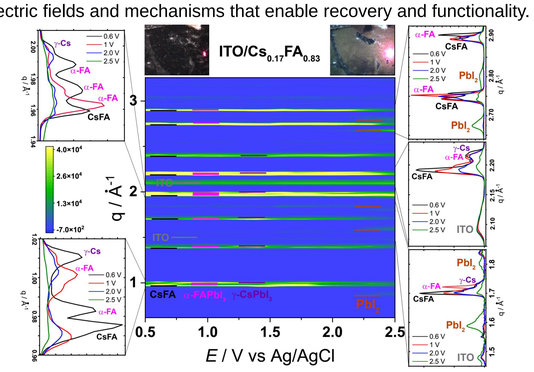


Devices Far From Equilibrium

Many optoelectronic devices operate at high voltages, which results in pushing the system far from equilibrium. In metal halide perovskites, species can undergo (photo) redox reactions that are exasperated under high voltages (ex. activated corrosion).



This project is focused on understanding degradation under high electric fields and mechanisms that enable recovery and functionality.



What is it like working in LISPEM?

- **Highly multidisciplinary and diverse scientific projects that span from fundamental chemistry and physics to design and engineer new systems and devices**
- **Projects come with inherent flexibility to pose new hypotheses**
- **Students are encouraged to do a 10 week "internship" – Ratcliff helps you find these in academic, industry, or national laboratories (many turn into new career directions for the students)**
- **Highly mentor-oriented – graduate students are also mentored by postdocs and research scientists with opportunities for mentoring undergraduates**
- **Collaborations with industry, national laboratories and international research groups**

Where do LISPEM graduates find jobs?

- **Postdoctoral fellowships (in US and abroad)**
- **National laboratories**
- **Consulting and patent firms**
- **Semiconductor manufacturing or research innovation industries**
- **Start-up companies**

Check out some of our work in Science, ACS Energy Letters, ACS Nano, Advanced Materials, and more.