The Chemistry and Photophysics of Modern Organic Semiconductors

- Fall 2026 - CHEM 8990 -

Semiconducting materials are the functional components in technologies such as displays, solid-state lighting, bio and chemical sensors for detection, bio-probes for imaging, and bioelectronics for optical stimulation. Towards these applications, organic semiconductors have many advantages such as a large design window, readily tunable properties, easy processability, economic material cost, and less toxicity.

During this semester, you will build a theoretical foundation on the molecular design and fundamental photophysics of organic semiconductors. We will have a broad survey of major types of organic semiconductors, their design rules, structure-function relationships, and various modern applications. Through readings, group discussions, proposal development, and presentations, you will transform the textbook knowledge base to novel research directions.

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Schedule 14:55-16:15 PM
Tuesday/Thursday
2205, STEM2

Credit Hours 3

Office Hours By appointment

Course Outline

Photophysics

- Electric, vibrational, and spin configurations of electronically excited states
- Radiative transition between states
- Radiationless transitions
- Excimer, exciplex, energy transfer, and electron transfer

Molecular Design of Organic Semiconductors

- Organometallic complexes
- Metal-free organic phosphors
- Thermally-activated delayed fluorescence
- Radical semiconductors
- Conjugated polymers
- LCD/LED and Organic Photovoltaic Cells

Condensed Organic Matter

- Overview of solid-state physics
- Non-aromatic emitters and carbon dots
- Organic-Inorganic hybrid perovskites
- Phonons and exciton-phonon coupling
- Multi-exciton photophysics

- Organic lasing materials

Useful Prerequisites

Undergraduate organic chemistry; undergraduate physical chemistry; solid-state chemistry; solid-state physics or condensed matter physics

Course Materials

"Turro's Book" Nicholas J. Turro, V. Ramamurthy, J.C. Scaiano, *Modern Molecular Photochemistry of Organic Molecules*, University Science Books, 2010.

Grading/Assessment

Mid-term I (25%): photophysics of molecular semiconductors (closed book)

Mid-term II (25%): solid-state organic semiconductors (open book)

Rapid-Fire Literature Presentation (10%)

Team research proposal (10%)

Team proposal defense (20%)

Attendance (10%)

Course Policies

1. Religious/Cultural Observance

People who have religious or cultural observances that coincide with this class or any deadlines should let the instructor know by email by a week from the first class. I encourage you to honor your cultural and religious holidays. If I do not hear from you by then, I will assume that you have no conflicts with any of the class activities.

2. Ethics

Sharing any materials from this class with other individuals not in the class without written instructor permission will be treated as an Honor Code violation. Posting your own solutions on public sites is also prohibited. Keep your materials private!

3. Class climate

This class is a place where you will be treated with respect, and I welcome individuals of all ages, backgrounds, beliefs, ethnicities, genders, gender identities, gender expressions, national origins, religious affiliations, sexual orientations, ability – and other visible and nonvisible differences. I expect all class members to contribute to a respectful, welcoming and inclusive environment for everyone. I am dedicated to helping each of you achieve all that you can in this class. I may, either in lecture or smaller interactions, accidentally use language that creates offense or discomfort. Should I do this, I invite you to contact me and help me understand and avoid making the same mistake again. Anonymous feedback is also welcome. Please contact me if other fellow students detract from our class climate.

I will also make appropriate accommodations for students with disabilities.

Peer interaction is an integral part of this course. Strive to get to know one another as well as possible in this situation.

4. Academic honesty: As a student at UGA, you have agreed to the Student Honor Code: "I will be academically honest in all of my academic work and will not tolerate academic dishonesty of others." This code is important for many reasons: it ensures that each student develops their own understanding and skills, promotes fairness, and establishes academic integrity. You can learn more about UGA's policy "A Culture of Honesty," including examples of prohibited conduct and the procedures I'm required to follow in these cases, at https://honesty.uga.edu/Academic-Honesty-Policy/ Please ask me about any specific instances before you turn in your work.