ECSE 598: Green Photonics

Instructor: Zetian Mi
Phone: 734 764 3963
Office: EECS 2405
E-mail: ztmi@umich.edu

Lecture: EWRE 136, MW 12 – 13:30pm

Office hours: EECS 2405, M 11am – 12pm or by appointment

Prerequisite: ECSE 429, or equivalent

Course Description:
Energy, water, and environmental sustainability are among the most critical challenges we face in the next decades. "Green Photonics" is concerned with the application of semiconductor optoelectronics including light sources, detectors, and photovoltaic devices to these problems. The most familiar photonic technologies in this field are solar cells and LED lighting, which have had an enormous and growing impact over the past few decades. The course will cover the fundamentals of semiconductor photonic materials and devices, as well as new frontiers in green photonics, including integrated nanophotonic circuits and solar fuels. Important topics to be discussed include: solar cells, solar-to-hydrogen conversion, energy efficient nanophotonic devices including LEDs, lasers, and micro/nanoscale devices, as well as integrated nanophotonics.

Grading:

Assignments	25%
Midterm Exam	25%
Report and presentation	25%
Final Project	25%

Text book:
Book chapters, review papers, and lecture notes will be provided before each lecture.

Outline

1. Overview of materials for green photonics (6 lectures)
    a. Basic properties of semiconductors
    b. Excitonic effects
    c. Photocatalytic properties
2. Solar cells (4 lectures)
    a. Design and operation of solar cells
    b. Single junction devices
    c. Multi-junction devices
3. Solar fuels (6 lectures)
    a. Semiconductor liquid junction
    b. Basics of electrocatalyst

    c. Solar-to-hydrogen conversion
    d. Reduction of carbon dioxide
4. Energy efficient nanophotonic devices (6 lectures)
    a. Design of LEDs for lighting and UV applications
    b. Lasers for lighting, display, sensing and communications
    c. Emerging micro and nanoscale light emitters
    d. Other nanophotonic devices
5. Integrated photonics (4 lectures)
    a. Waveguides
    b. Modulators
    c. Photonic integrated circuits