ECE 693 Special Topic

Materials and Devices in Photovoltaics

Instructor: Dr. Dawen Li, Professor

Office: 2005 NERC

Phone: (205) 348-9930

Email: dawenl@eng.ua.edu

Course level: Graduate students

Pre-requisite: None

Lectures: TR 12:30 pm – 1:45 pm, room 2009, SERC

Office hours: Per appointment

Course description

This course is designed to provide graduate students with a broad overview of photovoltaic materials and devices with emphasis of research and practical applications. Topics covered include sunlight spectrum and irradiance, operational principle of pn junction and its application in photovoltaic devices, silicon based solar cells/solar modules, fabrication and characterization of organic and perovskite solar cells, methods to enhance efficiency and stability, and technologies for tandem and flexible solar cells.

Topics to be covered (tentative, subject to change):

Part I: Introduction of Solar Energy and Solar Cells

1. Solar spectrum and irradiance
2. PN junction diodes
3. Operational principle and circuit model
4. Electrical measurement (J-V and EQE)
5. Design rules and light management to improve performance

Part II: Traditional Silicon-Based Photovoltaics

1. Properties of silicon semiconductor and processing

2. Solar cell structure and manufacturing
3. Concepts for efficiency enhancement
4. From solar cells to solar modules

Part III: Organic Solar Cells

1. Basic organic chemistry
2. Conjugated small molecules and polymers
3. Heterojunction and cell structure
4. Thin film morphology and AFM characterization
5. Device stability

Part IV: Perovskite Photovoltaics

1. Structure and properties of hybrid perovskite crystals
2. Device architecture and operational principle
3. Thin film preparation and basic characterizations (SEM, XRD, UV-Vis)
4. Strategies to improved efficiency and stability

Part V: Multijunction and Flexible Solar Cells

1. Tandem solar cells: light utilization and structure
2. Roll-to-roll printing of flexible solar cells
3. Technologies and performance

Required textbook

No textbook required, lecture notes will be provided.

Reference books (on reserve in Rodgers Science & Engineering Library):

- Arno Smets, Klaus Jäger, Olindo Isabella, René van Swaaij, Miro Zeman*, Solar Energy: The physics and engineering of photovoltaic conversion, technologies and systems),* UIT Cambridge, 2016
- Website: pveducation.org

Homework and exam policy

Homework discussion in small groups is encouraged. However, each student must work through each paper review and presentation individually. Pop quizzes are possible to maintain class attendance and participation.

Grading

Homework (paper review and presentation) ……30%
Midterm project and topic presentation ……30%
Discussion and quiz ……10%
Final paper (literature survey or research proposal) ……30%

Statement on COVID-19

All University faculty, staff, and students are expected to maintain a commitment to the health and safety of our campus community. Due to the current COVID-19 pandemic, specific health and safety standards are in place to minimize exposure and community spread on campus. In the interest of your health and safety and that of all UA students, faculty and staff, the University reserves the right to change the mode of instruction or schedule of instruction at any time, based upon prevailing public health and other guidance. While the method of delivery may change, educational instruction and opportunities will continue. As such, the University will not provide a refund of tuition, in whole or in-part, based on any such changes. Detailed information on changes in format or schedule can be found at studentaccounts.ua.edu and financialaid.ua.edu.

UA students, faculty and staff are required to comply with University Spring 2022 Operations (https://healthinfo.ua.edu/news/university-spring-2022-operations/) guidance regarding face coverings and other measures.

Getting vaccinated is the best way to Protect Our Herd. COVID-19 vaccines are being administered by the University Medical Center, the Student Health Center and various businesses and healthcare providers.