

Laboratory Teaching Modules on Organic Electronics & Liquid Crystal Displays for Undergraduate & Graduate Education



NC STATE UNIVERSITY

Optoelectronics & Lightwave Engineering Group

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Electrical & Computer Engineering

Objectives

Overall Goal: To develop a series of laboratory modules that afford **hands-on** experience with Organic Electronic Materials & Liquid Crystal Display Technology

Educational Topics:

- Self-Assembly
- Partial Order
- Polymer Science
- Fabrication Methods
- Light Emission / Absorption / Polarization
- Charge Injection / Transport in Organic Materials
- Electrical / Optical Characterization Concepts & Devices

Target Students:

Graduate & Advanced Undergraduate in: Physics - Electrical Engineering - Materials Science

Guiding Principles:

- Hands-on instruction
- Low-cost infrastructure
- Multidisciplinary background

Dissemination

http://www.ece.ncsu.edu/oleg/wiki/NSF_Lab_Modules

Freely available online:

- ▶ all lab documents (background, procedure, prelab)
- ▶ bill of materials / parts / vendors / assembly tips
- ▶ examples of student work
- ▶ companion course materials

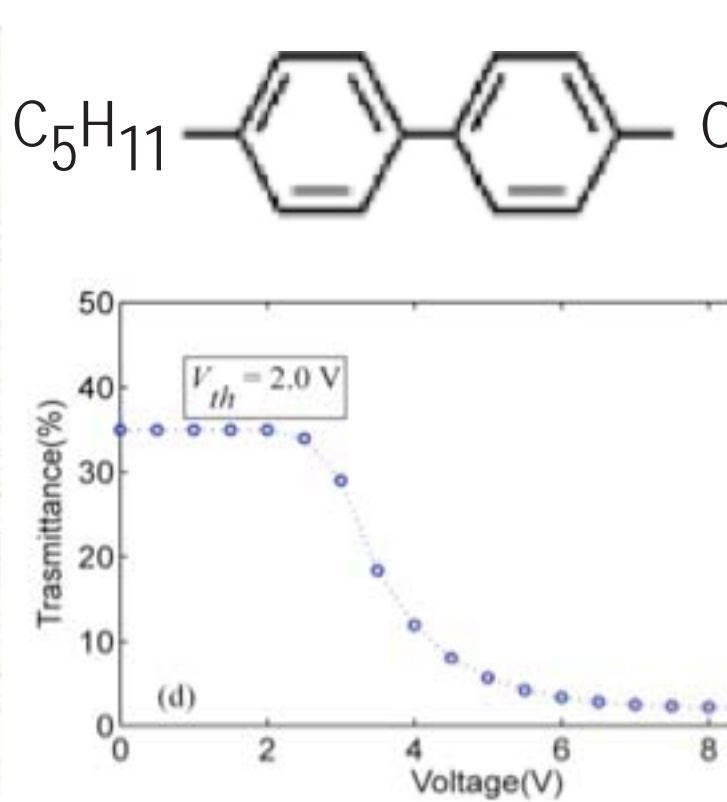
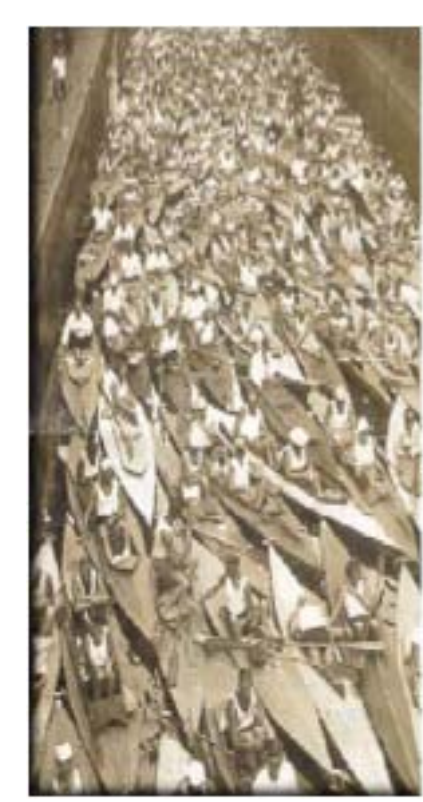
Workshop in Spring '09 inviting local and international educators:

- ▶ perform lab modules
- ▶ present related research

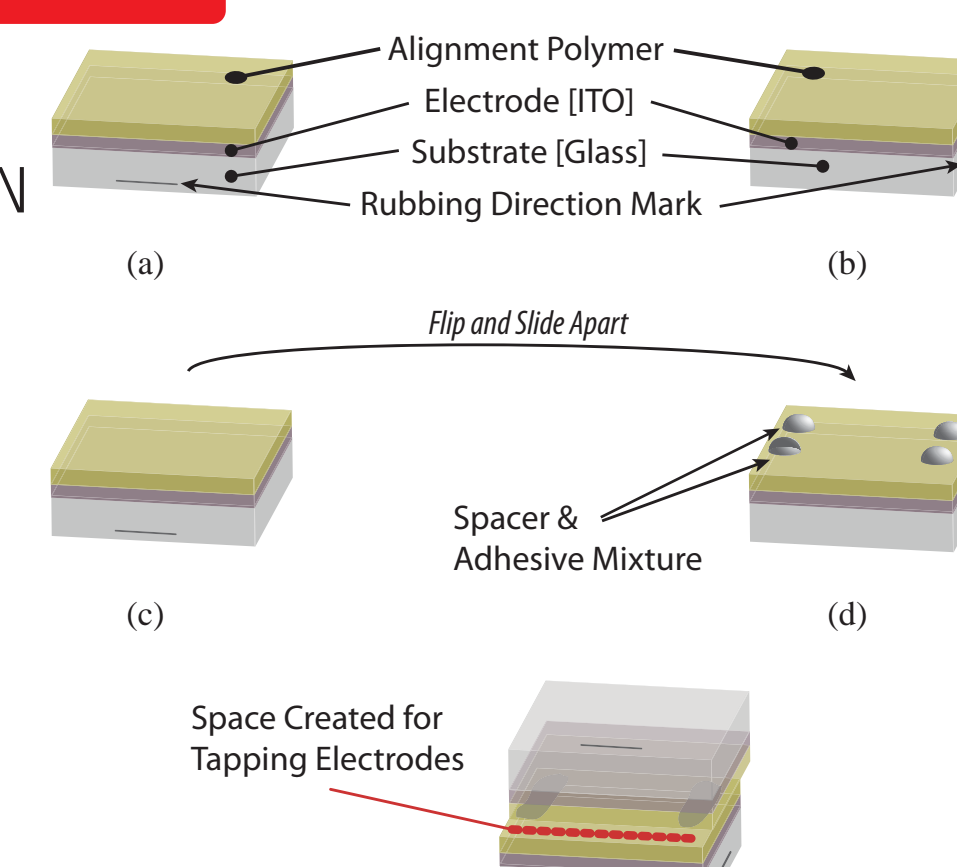
Liquid Crystal Display (LCD) Pixel

Educational Topics [1]:

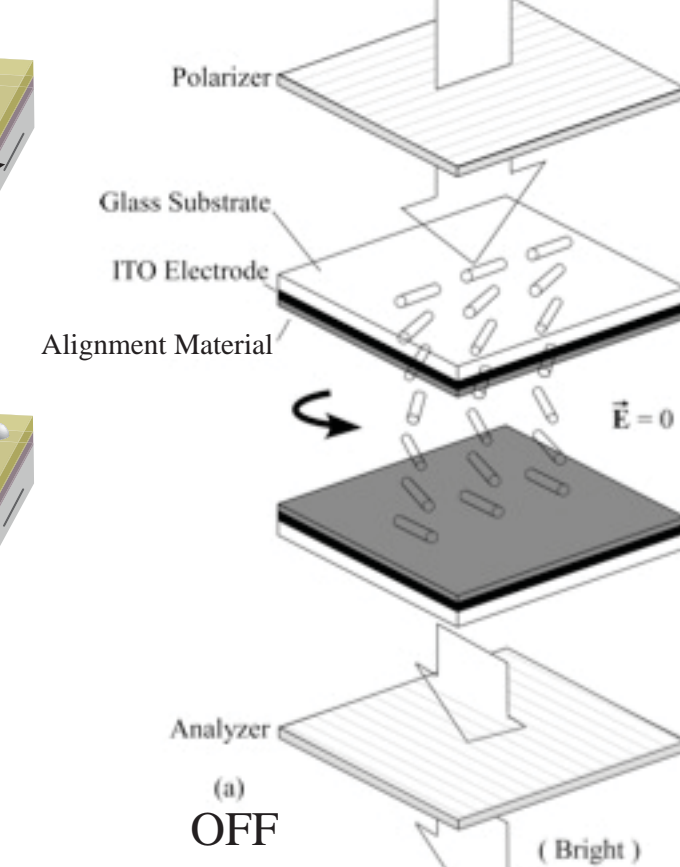
- Polarization of Light
- Polarizers
- Partial Order
- Optical Transmittance
- Liquid Crystal Chemistry
- Photonic Characterization



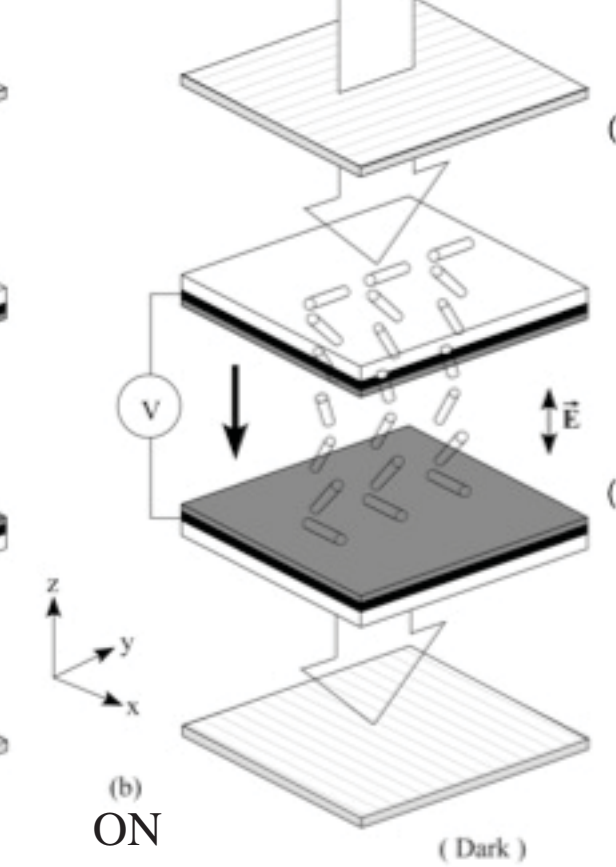
Fabrication Method



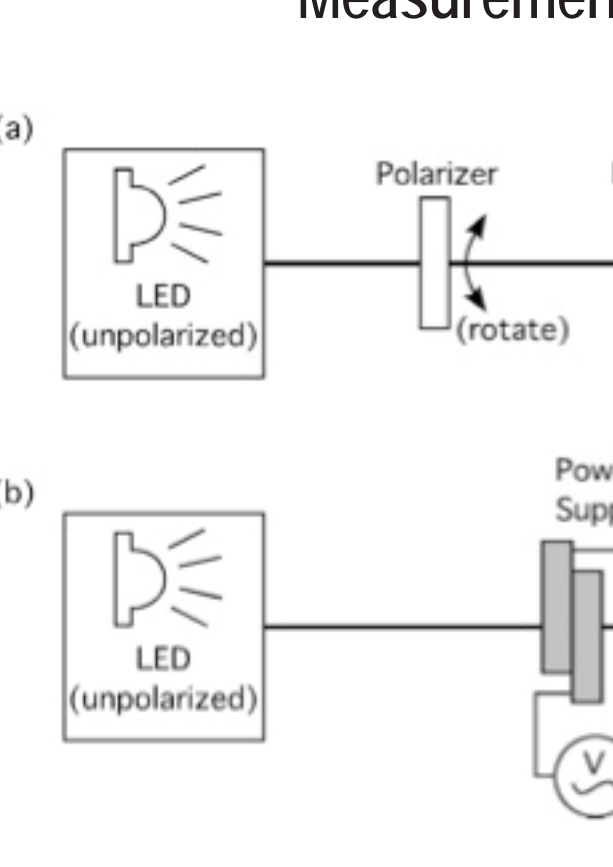
Unpolarized Light TN Mode



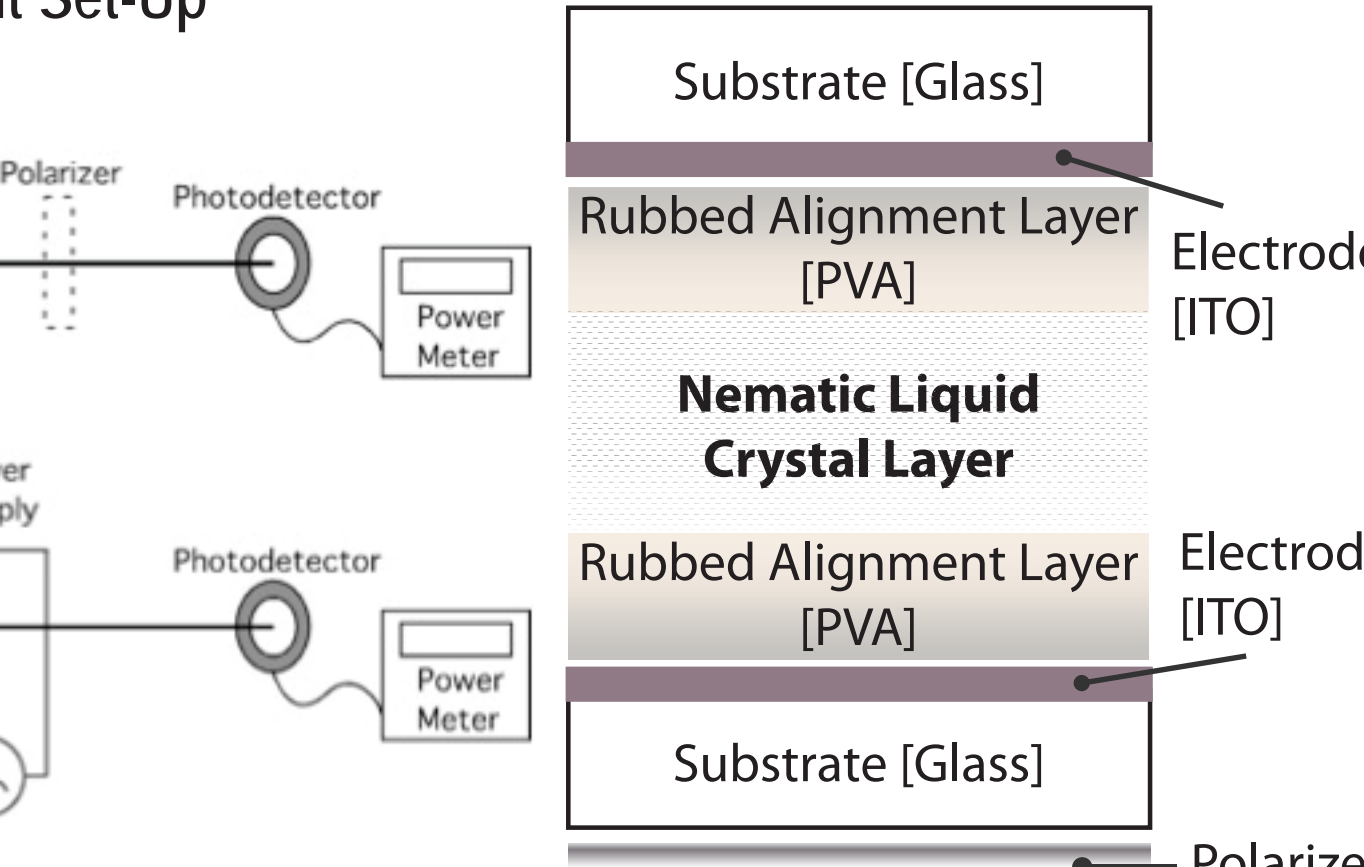
Measurement Set-Up



Measurement Set-Up



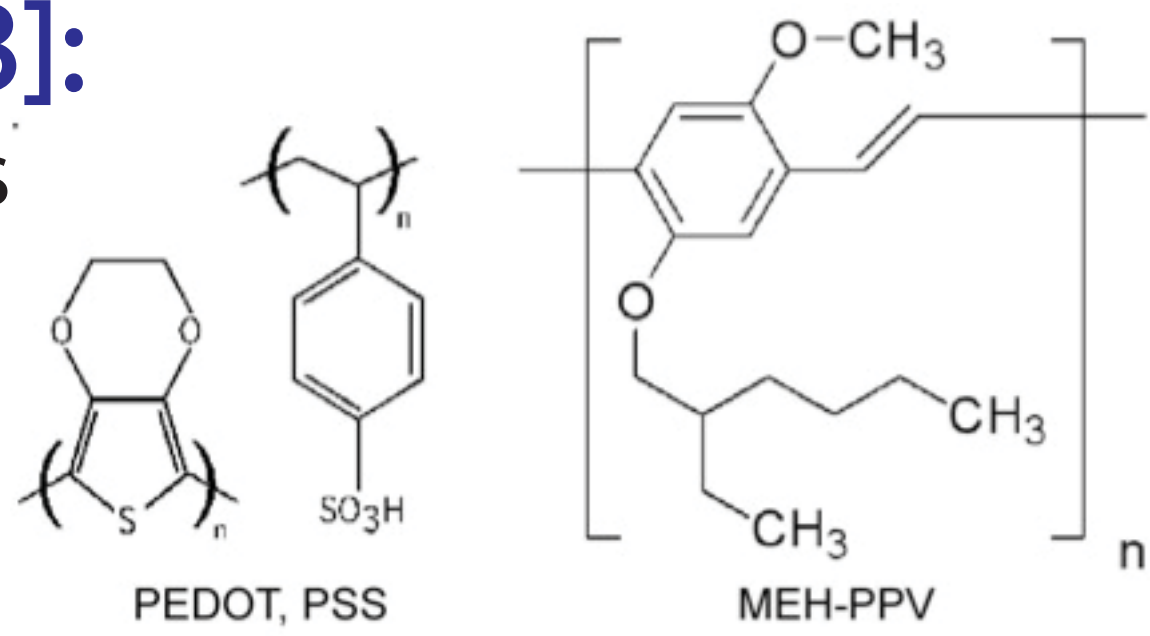
Measurement Set-Up



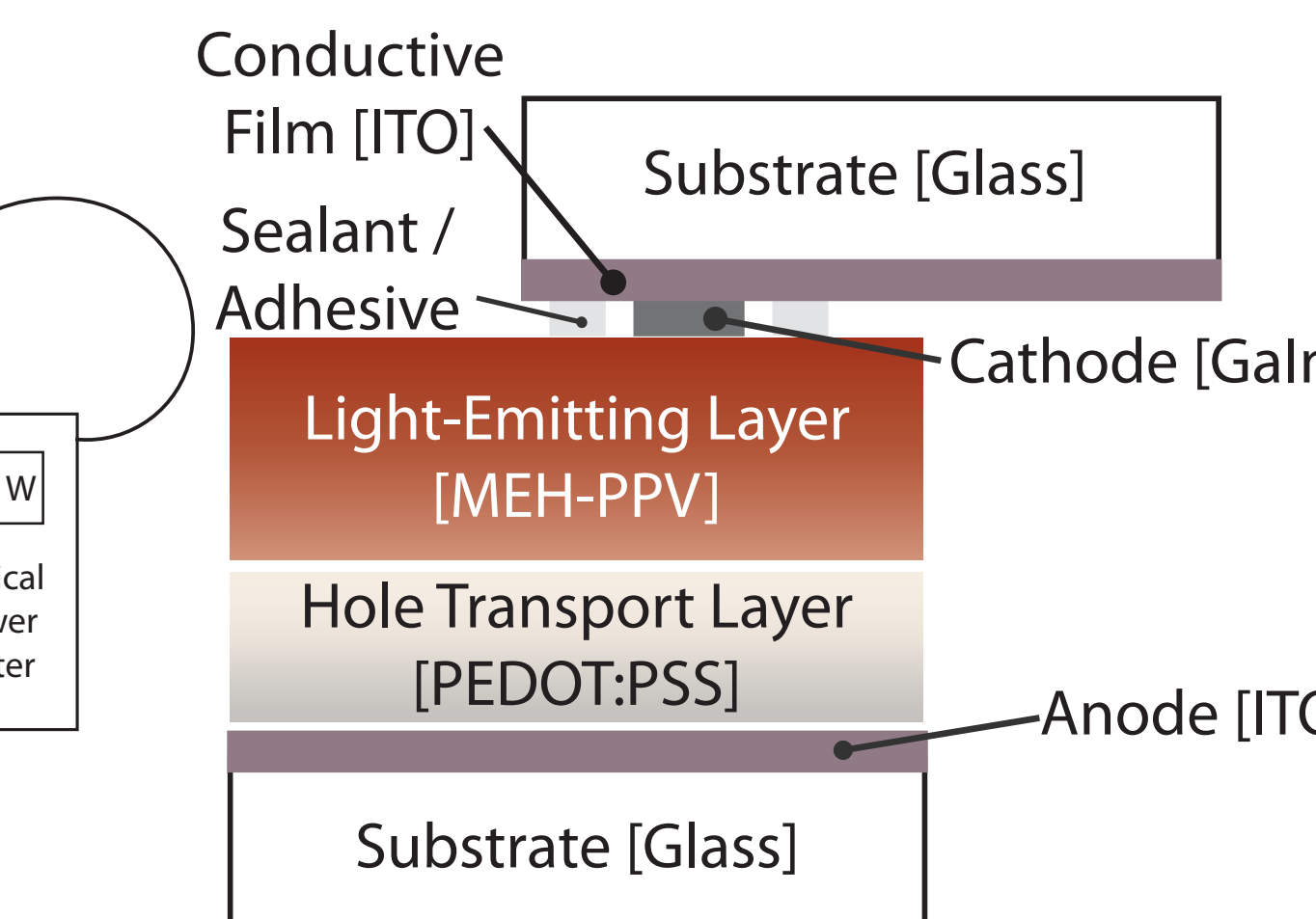
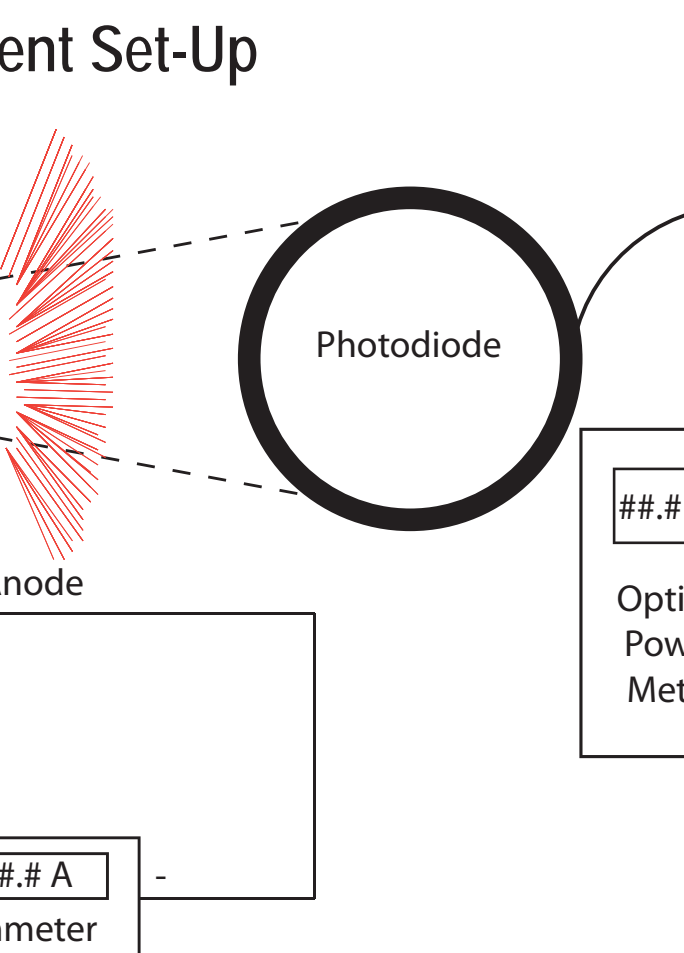
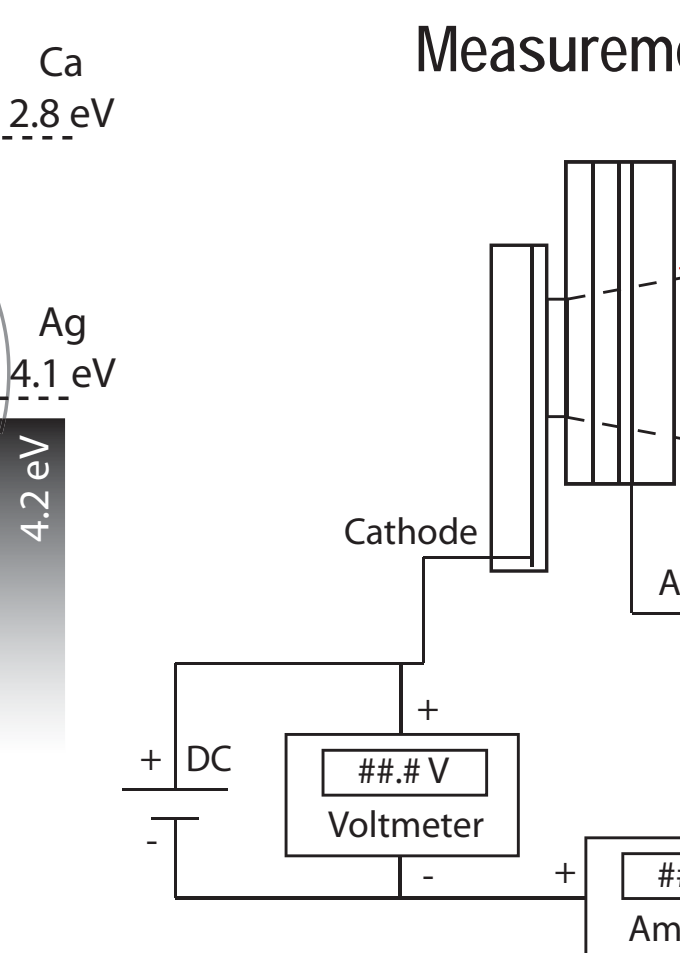
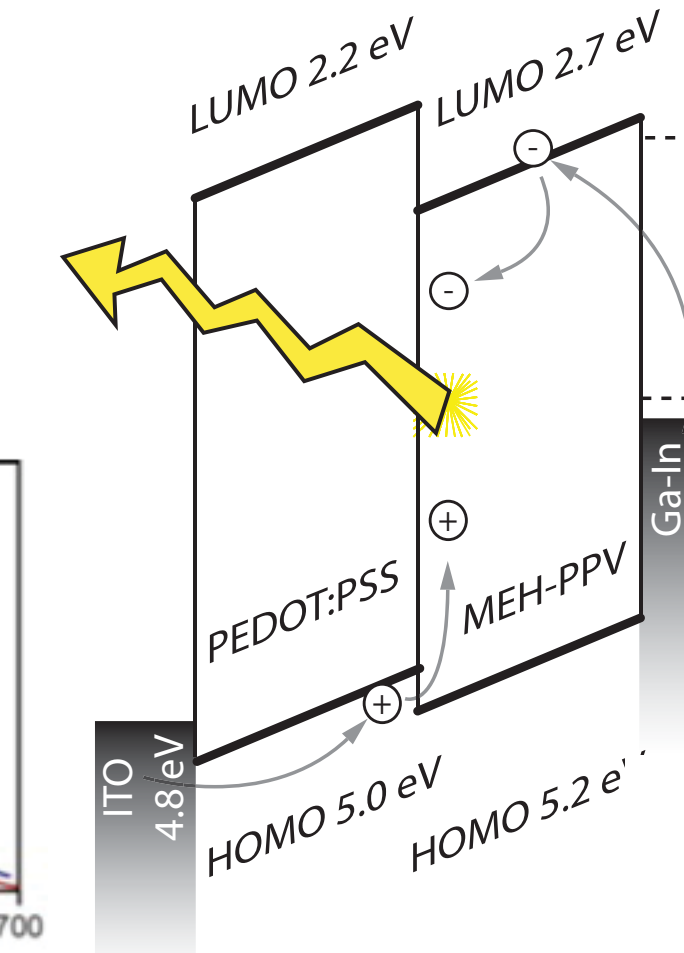
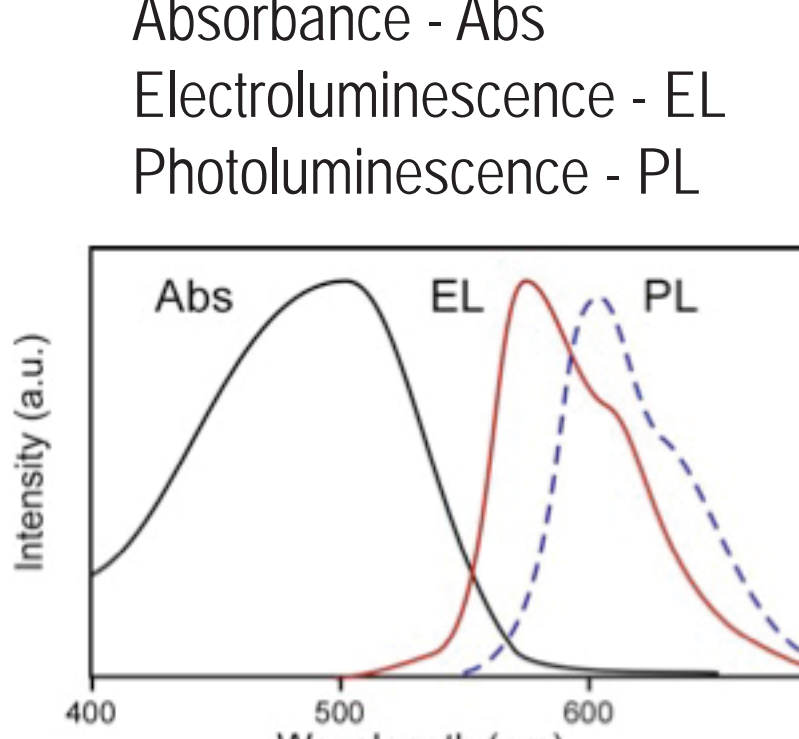
Polymer Light-Emitting Diode (OLED)

Educational Topics [2,3]:

- Lifetime of Organic Materials
- Photometry / Radiometry
- Polymer Science
- Electroluminescence
- Photoluminescence
- Use of Optical Power Meters / Photodiodes



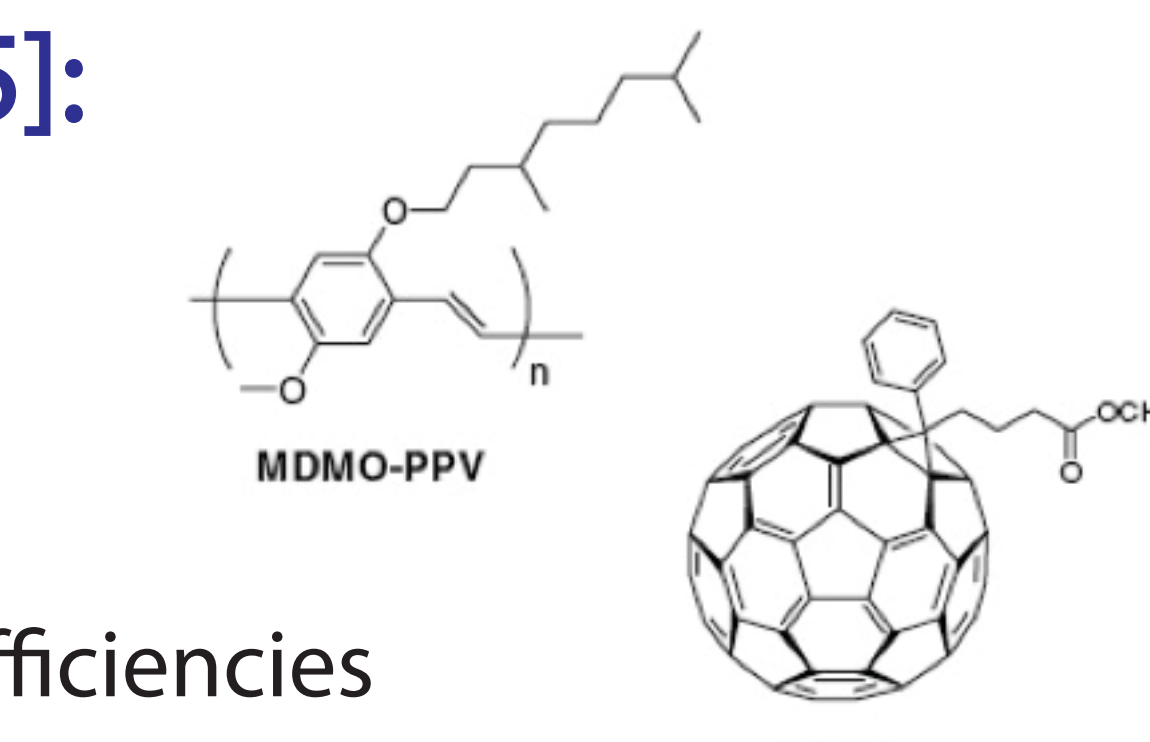
MEH-PPV Characteristics



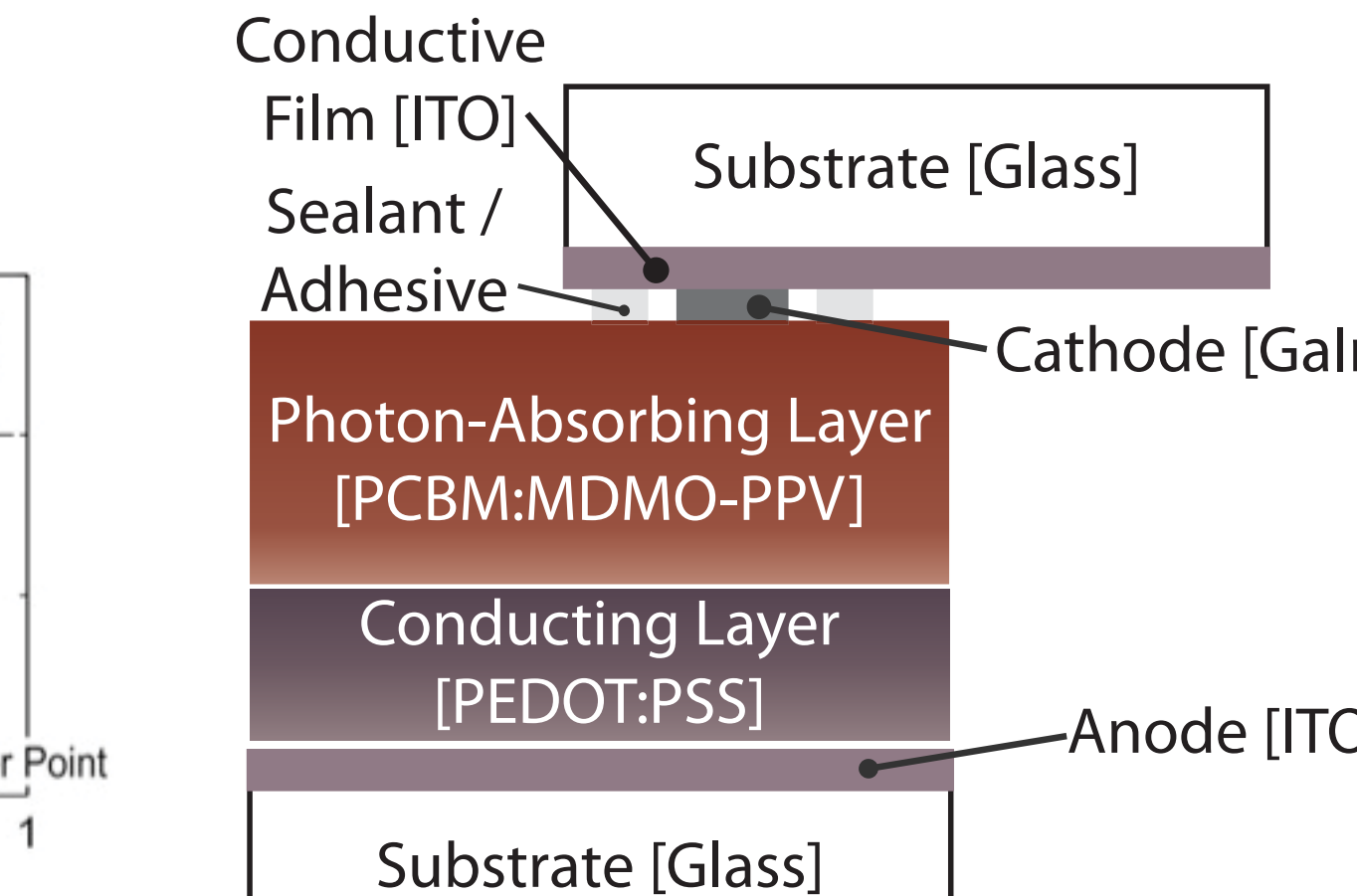
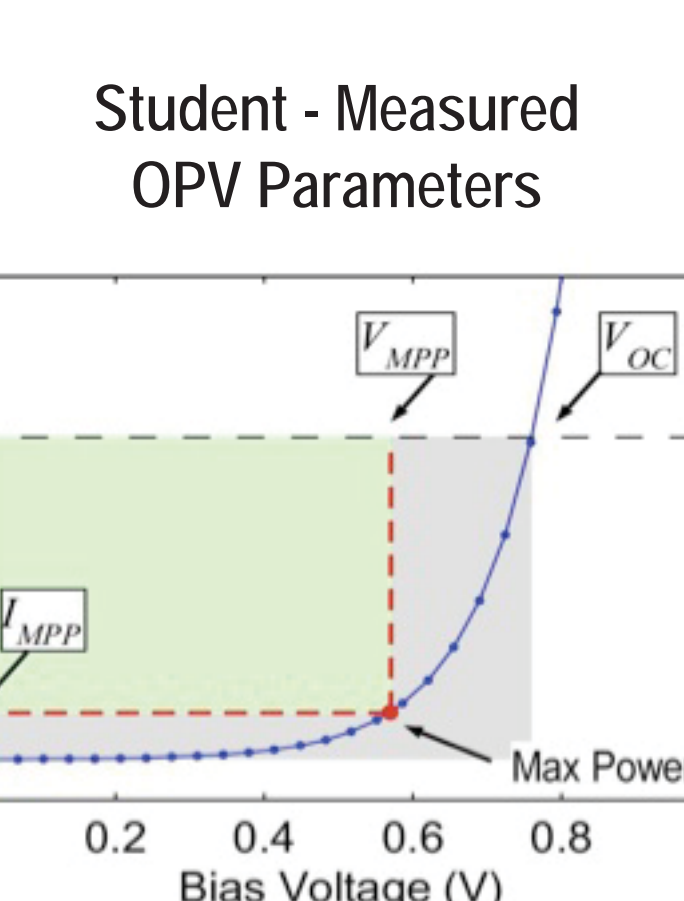
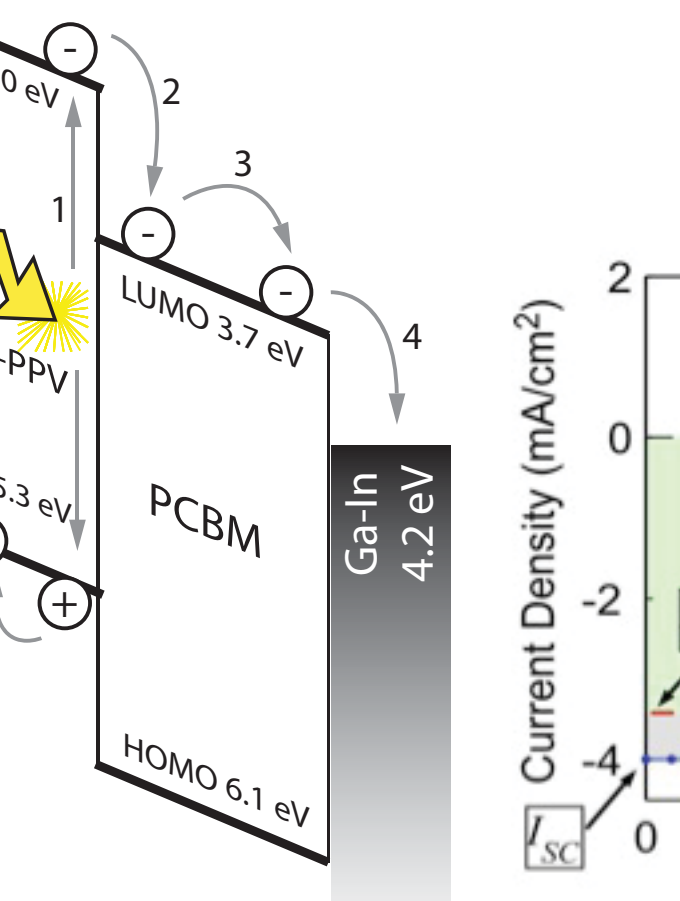
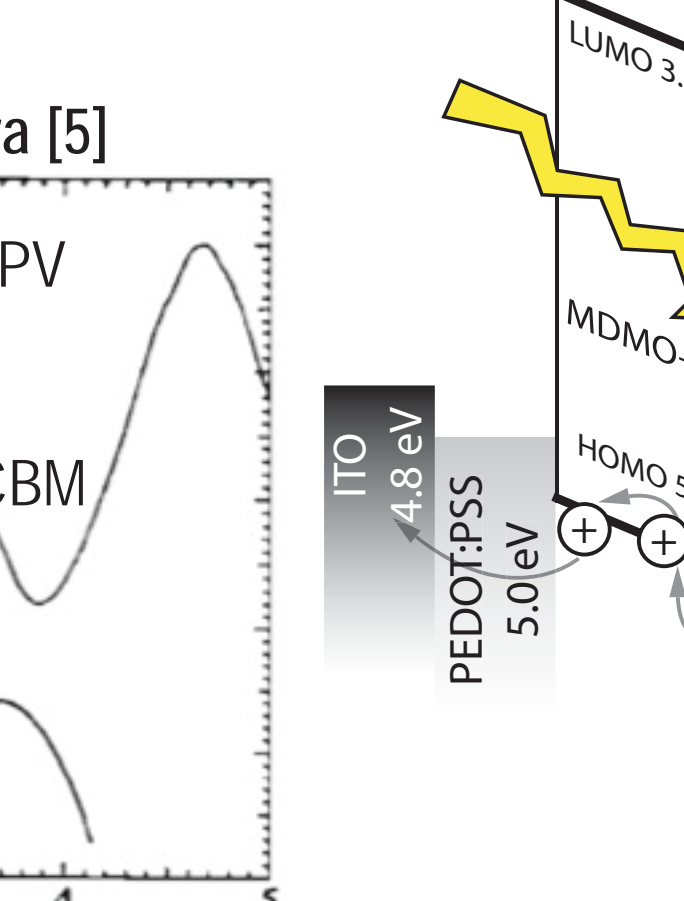
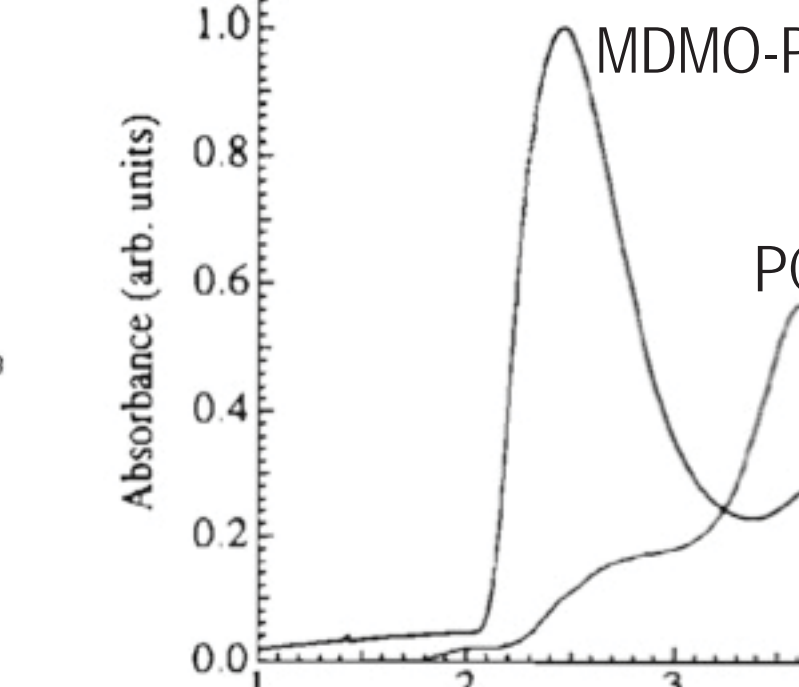
Polymer Photovoltaic Solar Cell (OPV)

Educational Topics [4,5]:

- Power Generation
- Charge Transport
- Polymer Science
- Excitation Creation
- Measurement of Solar Cell Efficiencies



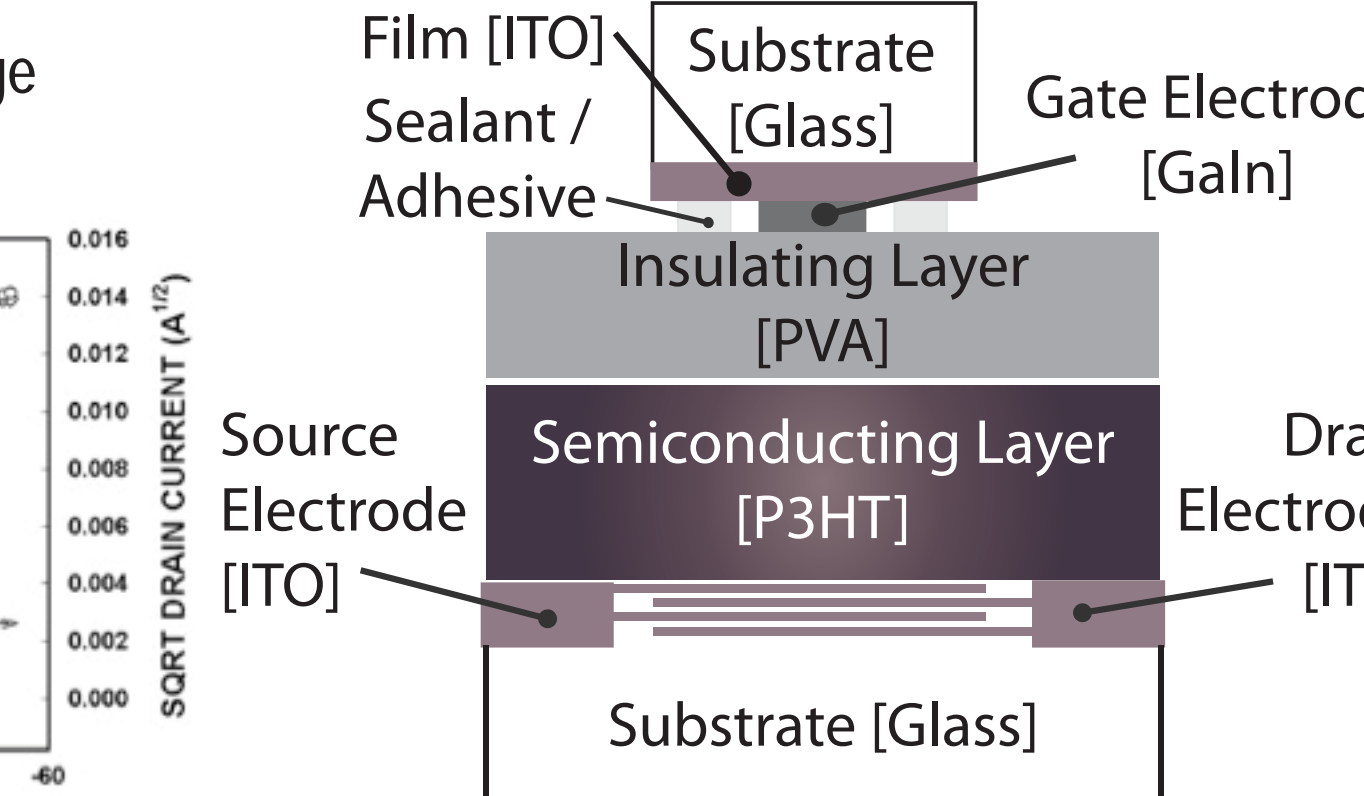
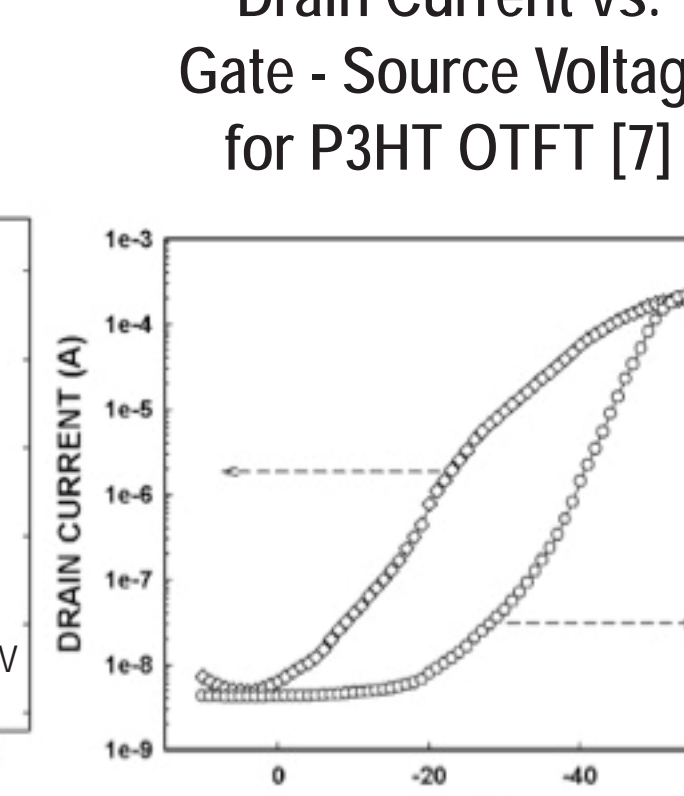
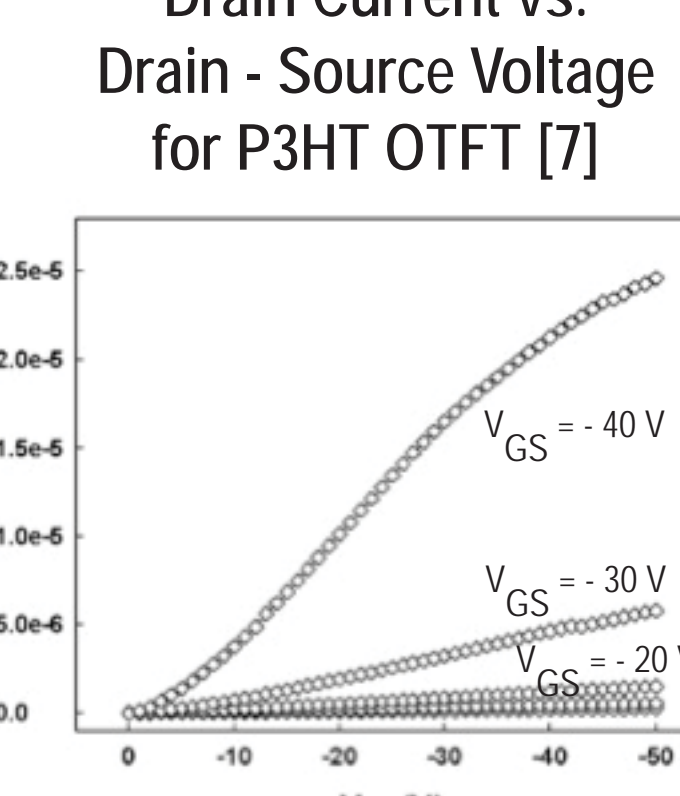
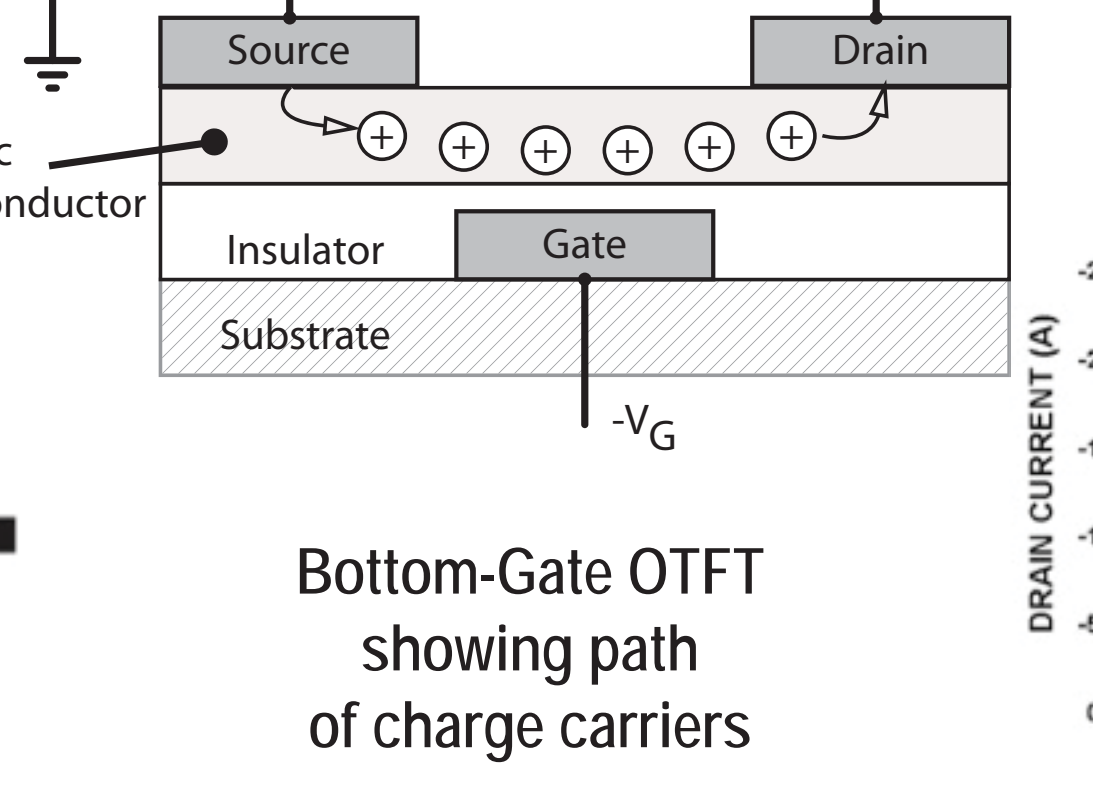
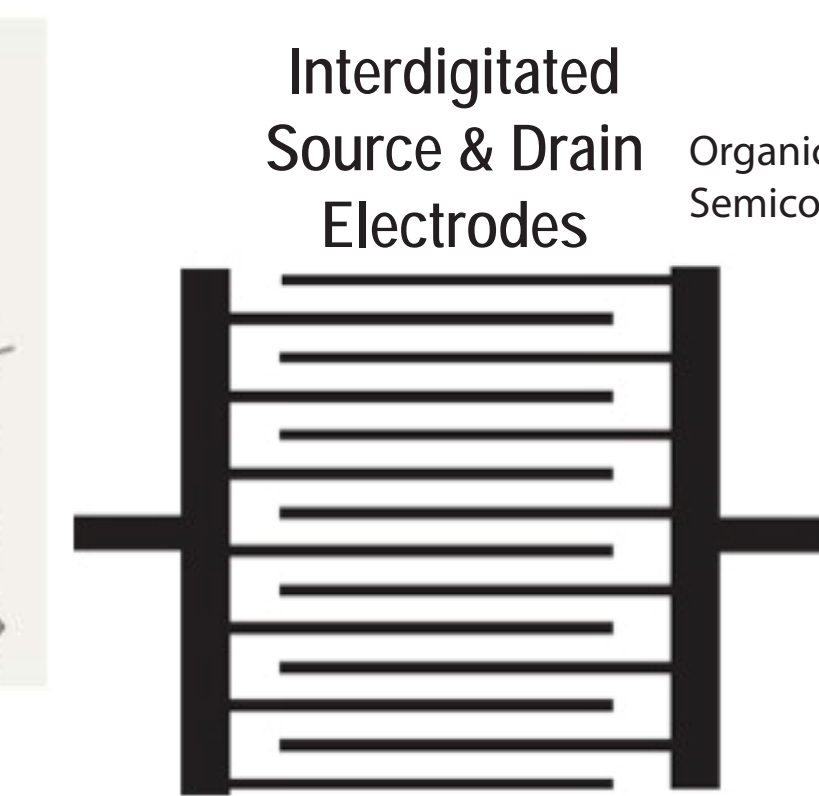
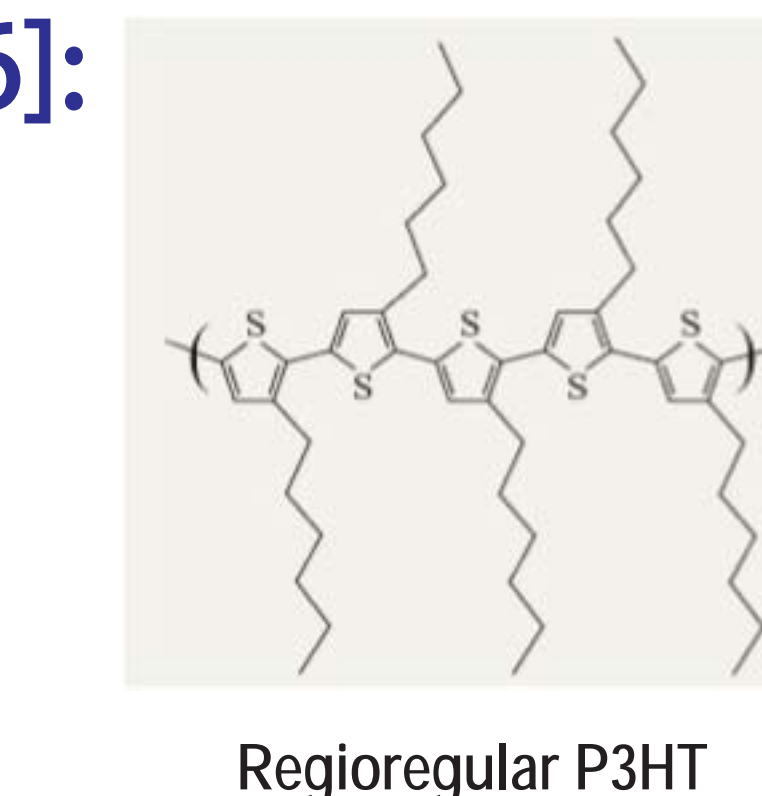
Absorbance Spectra [5]



Polymer Thin-Film Transistor (OTFT)

Educational Topics [2,6]:

- Transistor Device Physics
- Charge Transport
- Carrier Mobility
- Charge Injection
- Organic vs. Inorganic Transistor Operation



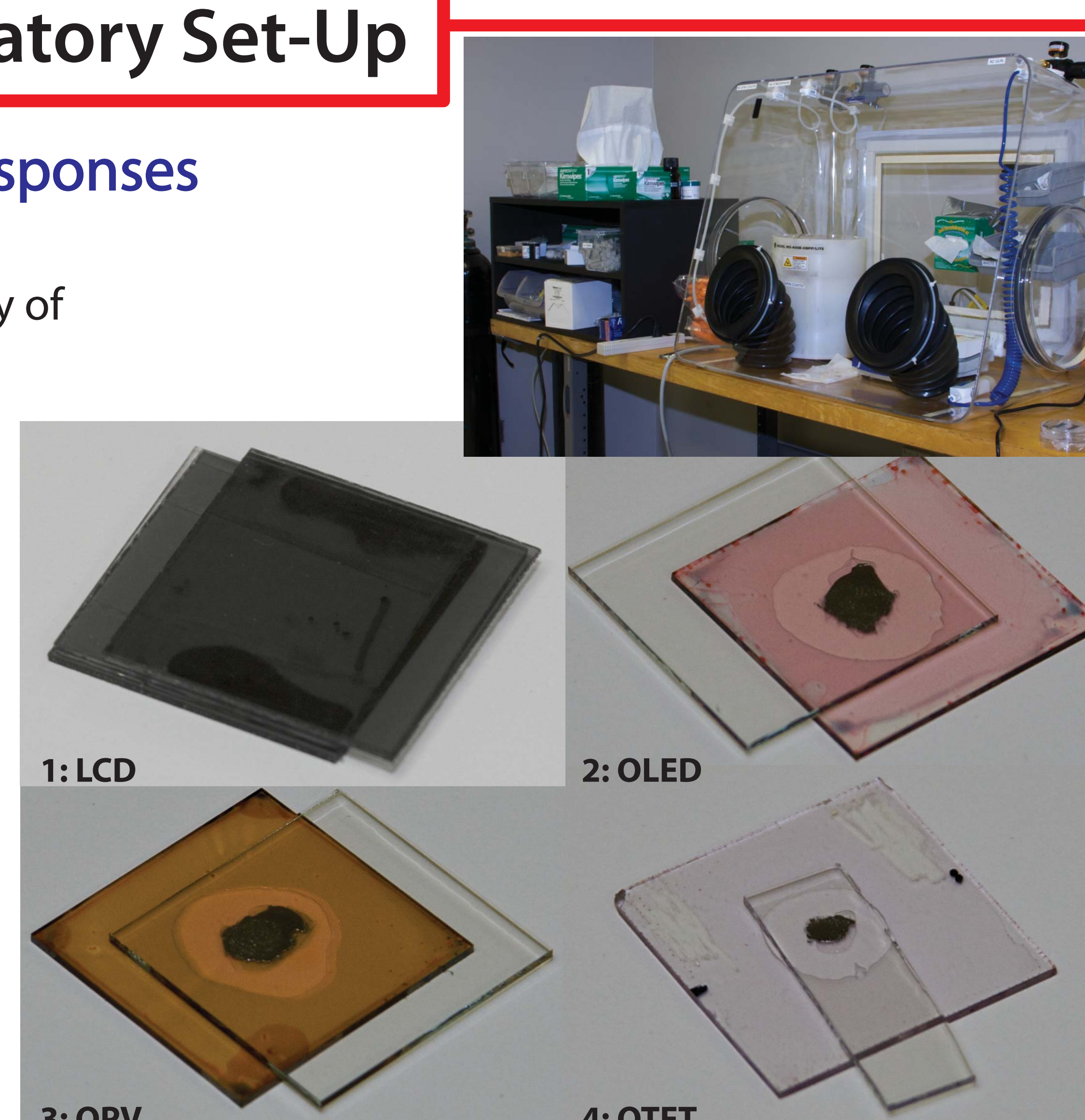
Assessment & Laboratory Set-Up

Composite Student Survey Responses

(anonymous, 27 students):

- ▶ Lab sessions contributed to mastery of course concepts (4.73 / 5.0)
- ▶ Lab facilities, equipment, supplies, etc. were adequate (4.69 / 5.0)
- ▶ The degree of lab difficulty was appropriate (4.66 / 5.0)
- ▶ Overall, the labs were effective learning experiences (4.70 / 5.0)

Total Cost of Laboratory:
US\$9000 Initial Investment
US\$1000 Per 30 Student Operation



Acknowledgments



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Univ of Texas at Austin

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