Organic Light-Emitting Diode Fabrication and Exploration of the Organic Magnetoresistance Effect

Casey Sroda, Faculty Mentor: Dr. James Rybicki | Physics and Astronomy Dept., University of Wisconsin – Eau Claire

ABSTRACT
Please refer to CERCA 2019 Abstract booklet under Natural and Physical Sciences section for full abstract.

INTRODUCTION
Organic electronics have raised widespread interest across the consumer electronic industry for its many unique, beneficial properties. Before any organic electronic phenomena can be investigated, the fabrication process must be refined in order to produce efficient, longer lasting OLED devices. This project is a continuation of previous work done at UWEC focusing on the transition from fabrication at the University of Iowa. This transition is nearly complete. However, past operation of the devices has shown that further improvements to fabrication and encapsulation are necessary.

HOW OLEDS WORK
The organic layer is an insulator by nature. We want to utilize semiconductor properties it can exhibit. To do this, we use the metallic cathode and anode to inject electrons (e−) and holes (h+). The light is emitted when there is electron-hole recombination.

OLED WORK
The organic layer is an insulator by nature. We want to utilize semiconductor properties it can exhibit. To do this, we use the metallic cathode and anode to inject electrons (e−) and holes (h+). The light is emitted when there is electron-hole recombination.

DEVICE DESIGN
The electrodes are the ITO lines and the metal contact pads, which are square at the bottom to allow for a more secure contact during the testing stages. A metallic mask is used to cover parts that need protection from metal deposition. As a result, the three prong shape in the middle exists.

ANOMALOUS RESULTS
DESTRUCTION OF OLED DEVICES IN CLEANING
During the cleaning process of our second batch of devices, the ITO appeared to have lifted and move across the slide, essentially ruining them. We coined this accident as ITO smearing, due to the smear-like look it produced.

Before we could move forward, we needed to find out what caused this issue to make sure it wouldn’t happen again. Through process of elimination, the source of ITO smearing appeared to have been mainly from impurities in the water for that cleaning batch that reacted with the slide and moved the ITO around.

FUTURE GOALS

ORGANIC MAGNETORESISTANCE INVESTIGATION
Organic Magnetoresistance is the tendency for an organic material to change the value of its electrical resistance in an externally-applied magnetic field. Magnetoresistance is measured through magneto-conductance, expressed as:

\[ \text{Magnetoresistance(\%)} = \frac{I(B) - I(0)}{I(0)} \times 100\% \]

In the equation, \( I(B) \) is the current through a device when it is a B-field, while \( I(0) \) is current through the device when the B-field is 0.

FABRICATION ADVANCEMENTS
Fabrication of the devices is crucial for future experimentation. That being said, there are a few areas of the fabrication process that we still want to improve.

- **Encapsulation**
  - Protecting the devices from exposure from air, dust, etc.
  - will likely help increase longevity and success of devices.

- **Accurate Layer Thickness**
  - Currently, we have estimates for ranges of thicknesses that are possible in our devices based on how we deposit material. In the future, we would like to work with tools like a profilometer and confocal microscope to help reduce uncertainty in our thicknesses in order to get more consistent results.

ACKNOWLEDGMENTS AND REFERENCES
- Physics and Astronomy Department
- Dr. Matt Evans and Blugold Fellowship Program
- Office of Research and Sponsored Programs (ORSP)

PHOTOGRAPHIC CREDITS
We thank the Office of Research and Sponsored Programs for supporting the research and Learning & Technology Services for printing this poster.