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Quantum Efficiency in Perovskite Light Emitting Diodes under Low to High Current Densities

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The 2017 Interdisciplinary Materials and Physics

Research Experience for Undergraduates

Quantum Efficiency in Perovskite Light Emitting Diodes under Low to High Current Densities

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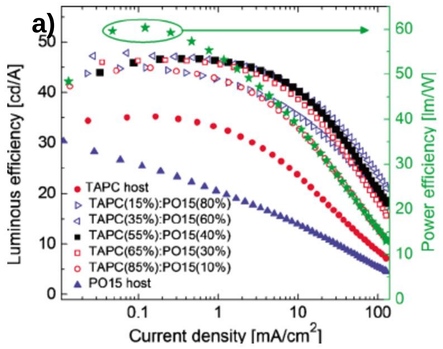
Introduction

- Light emitting diodes (LEDs), have attracted much attention in research and industry thanks to their versatility and efficiency
- Unfortunately every LED is limited by their efficiency as they reach higher levels of brightness (roll off)
- Exploring the Perovskite's External quantum efficiencies (EQE's) are imperative to uncover the fundamental causes of efficiency roll-off in these devices

Motivation

a)



a. Devices with varying composition

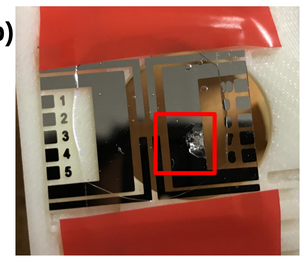
- Quantum efficiency is an important characteristic for any photovoltaic/LED device.
- Allows us to determine the ratio of the number of photons emitted from the LED to the number of electrons passing through the device

$$EQE = \eta_{ex} = \frac{photons\ out}{electrons\ in} = \frac{photons/s}{electrons/s} = \frac{\phi}{I}$$

Device Specs

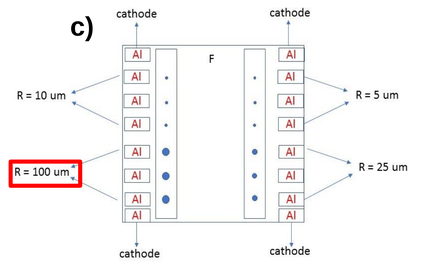
Applications	Advantages
✓Sensors	✓High Color Purity
✓Solar Cells	✓Tunable Bandgap
✓Optoelectronics	✓Efficient
✓Lasers	✓Low Cost
✓Light Emission	✓Semi-Conducting

b)



b. OLED Overheating

c)



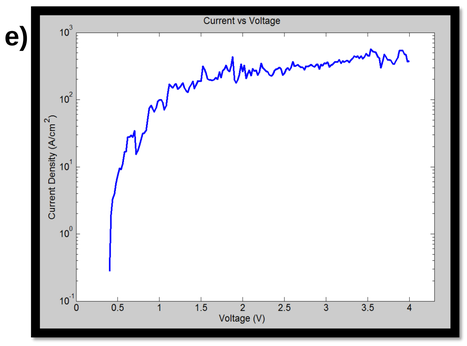
c. Finding a device can be challenging

Steady State Measurements

d)

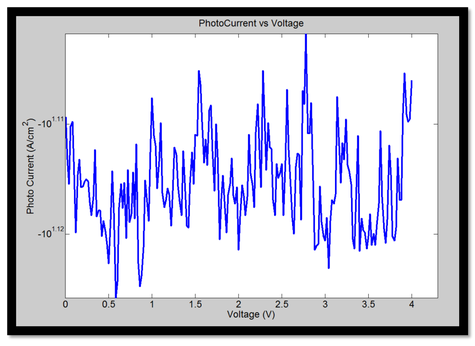
d. Keysight used for a DC Sweep (Lab View)

e)



e. IV Curve

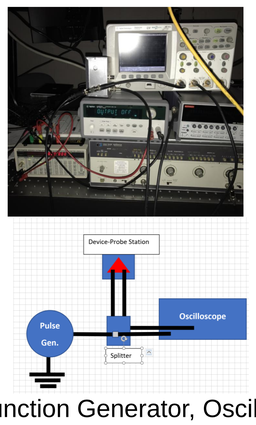
f)



e. LV Curve (Noise)

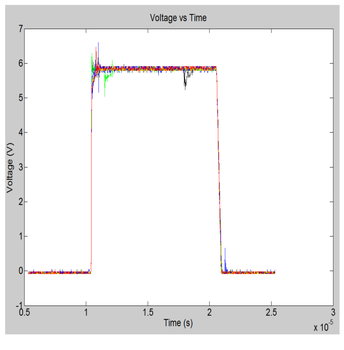
Pulsed Measurements

g)



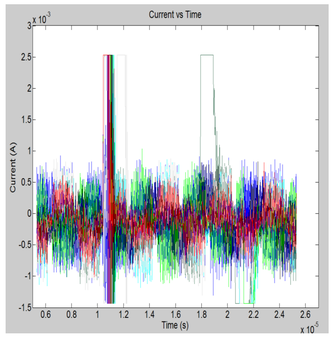
g. Function Generator, Oscilloscope, Probe Station & Source Meter,

h)



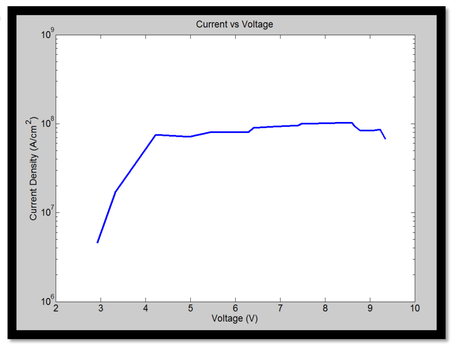
h. Raw Voltage Data

i)



i. Raw Current Data

j)



j. Created IV Curve (MATLAB)

Conclusion

- Perovskite LEDs are still in their infancy due to reoccurring instabilities and their high level of sensitivity. Unfortunately, leading us to be discontent with our results. The efficiency of the perovskite is still not better than a conventional LED, but it is still an area to be studied.
- There are many advantages that present it as a promising material. Common advantages of the Perovskite LED is low cost synthesis. Perovskites are easily created from a solution to further explore other areas.

Acknowledgements

- Giebink, Noel, and S. R. Forrest. "Quantum Efficiency Roll-off at High Brightness in Fluorescent and Phosphorescent Organic Light Emitting Diodes." *Https://link.aps.org/doi/10.1103/PhysRevB.77.235215*. Macmillan Publishers, June-July 2008. Web. June-July 2017.
- Xiao, Zhengguo AU, Lianfeng Zhao, Nhu Tran,, ,, Kyung Lee, Tae-Wook Koh, Gregory Scholes, and Barry Rand. "Efficient Perovskite Light-emitting Diodes Featuring Nanometre-sized Crystallites." *Nature*. Macmillan Publishers, 16 Jan. 2017. Web. 05 July 2017.

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