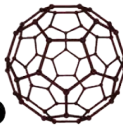


Goodie Bag #5: Electronic Materials

Handed out on 10.12.18 | Quiz #5 on 10.18.18

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This bag contains:

- 1 multimeter
- 2 alligator clips
- 4 large LEDs (red, blue, green, white)
- 4 small LEDs (red, blue, purple, white)

Do yourself a solid.



What to bring to the quiz: the multimeter, alligator clips, and your large LEDs

Introduction

This goodie bag will explore the relationships between band gap and wavelength of light by taking advantage of the LED's ability to act as both a light sensor and a light source. In doing so, you'll be able to feel the band gap itself – and measure it by seeing how the material reacts to the different color LEDs.

Instructions & Questions

You have been given a set of small LEDs that can be connected to your multimeter, which measures voltage and current. Hold each wire of the LED with an alligator clip, and connect the alligator clips to your multimeter at 10ADC and V Ω mA. Set the multimeter to 2000m DCV.

Question 1: identifying the colors of the small LEDs

Shine each large LED onto each small LED, recording the voltage each time. This should generate a set of 16 data points. Use your knowledge of the band gap and wavelength absorption, as well as the data you obtain from these measurements, to determine which of your small LEDs is which color.

Question 2: Finding the critical wavelength

Find and compare the critical wavelengths of light needed to excite electrons across the band gaps of each of your small LEDs, assuming that the red LED emits light of wavelength 650 nm, the blue has wavelength 450 nm, and the green has wavelength 500 nm.

Question 3: Doping

If you wanted to change your small red LED (made of Indium Nitride) to yellow, what would be the band gap of another nitride (XN) you'd alloy with? Where on the periodic table is X in relation to Indium?

Question 4: Free charge carriers: draw schematic energy band diagram

Blue LEDs are made of Indium gallium nitride, a semiconductor with a band gap of 2.5 eV. Sketch the absorption spectrum of InGaN, i.e., plot % absorption versus wave length. Show the value of λ at the absorption edge.

Question 5

When you shined the blue light onto the small red LED, if no photons are emitted from the red LED then how much energy is lost to heat in a minute (assume a power of 1 Watt)?

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