# Introduction

This report is about the new gallium arsenide phosphide (red LED) wafers and my opinion on their suitability for large scale production

# Test sample preparation

The test LED was made by applying a gold contact to the bottom of the silicon wafer (N-Doped side). A small (0.1 mm^2) ‘dot’ of indium is cut from a lump and placed onto the top of the wafer (P-Doped side). This ‘dot’ is then pressed into a plating like form covering about 1mm^2 of the wafer, this wafer is then lightly heated diffusing the indium slightly into the gallium arsenide top layer. This then has a contact applied onto the gold and another contact applied to the indium on top, with a forward bias of around 2V applied (P-Doped(indium dot) is higher voltage than N-Doped(gold plate)) the LED is then quickly tested to see if a light is given off.

# Testing

Equipment:

1.Microscope with contact arms

2.PSU (Power supply unit)

3.Ammeter

4.Voltmeter

5.Wavelength meter

6.OPM (Optical power meter)

8. 2,3 and 4 were replaced with but are equal to a SMU (Source measurement unit)

Procedure:

V-I measurements:

The LED is connected to the SMU(8) via banana cables using the microscope contacts(1). The SMU voltage is increased in steps of 0.2V starting from -2V until 2V. The current is then measured in uA giving the results as shown in table 1 (LABEL RESULTS TABLE 1)

Wavelength and power measurements:

For this the LED is set at a constant 50mA forward current using the same setup as V-I measurements, the wavelength meter is aimed at the LED and the wavelength shown by the peak on the intensity vs wavelength graph, this gives us the most common wavelength given off, the intensity is then halved and at the point where the intensity is halved crosses with the wave generated the difference in wavelength is the full width at half height value which is generally used in LED descriptions defining the range of wavelengths. These measured values of wavelength and ranged are put into the OPM(6) with the input directed onto the LED to give the optical power output of those wavelengths in that area hopefully only getting the optical power of the LED.

The results for the red LED are shown below in table 2 (label results table 2)

|  |  |
| --- | --- |
| Applied voltage(V) | Current(uA) |
| -2.0 | -0.186995 |
| -1.8 | -0.160341 |
| -1.6 | 0.008457 |
| -1.4 | 0.046165 |
| -1.2 | 0.028645 |
| -1.0 | 0.011308 |
| -0.8 | -0.163203 |
| -0.6 | -0.013937 |
| -0.4 | 0.031988 |
| -0.2 | -0.166119 |
| 0.0 | -0.12898 |
| 0.2 | -0.145521 |
| 0.4 | 0.059947 |
| 0.6 | -0.152976 |
| 0.8 | -0.135876 |
| 1.0 | 0.153104 |
| 1.2 | 1.63163 |
| 1.4 | 47.8653 |
| 1.6 | 572.709 |
| 1.8 | 1914.84 |
| 2.0 | 4505.46 |

**Table 1** – table of results of current based on forward voltage

**Graph 1** – I-V curve for the created diode

This graph shows the turn on voltage being around 1.6 volts for this diode.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| V on(V) | V forward(V)  (at 100mA) | Colour | Peak wavelength  (nm) | FWHH(nm) | Optical power(mW)  (at 100mA) |
| 1.7 | 2.9 | Red | 660 | 21.8 | 1.8 |

**Table 2** – Table of results for the LED

Given the wafer is Gallium arsenide Phosphide and the percieved colour is red the wafer works as expected and isn’t falsely advertised.[1]

The Peak wavelength 660nm is in the middle of gallium arsenide supposed colour.[2]

The efficacy of the led is 6.2% from electrical input to optical output of that wavelength. This may be because the FWHH was input incorrectly due to a lack of understanding of the device so only a small percent of power is measured given we are measuring efficacy instaed of efficancy. Given by electrical input power over optical power of wanted wavelength.

# Sampling techniques and recommendation

Should we use this wafer batch or not, what sampling method would you use? Random wafer, how many wafers? Every 10 wafers use one?

# Further tests

Sensible achievable tests with justification and equipment needed.

# References

[1] - <http://www.newey.hk/doc/led2.jpg>

[2] - http://semesters.in/wp-content/uploads/2016/12/Light\_Emitting\_Diode\_Colours.png

Indium Malleability