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Finding LEDs for an Implantable Optogenetics System

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Background

Optogenetics allows neural activity to be modulated by light, activating or inactivating neurons. Early research has shown it has great promise as a treatment for Parkinson's Disease.

Currently benchtop systems, with external coherent light sources coupled to fibre-optic cables, are used to deliver light to the modified neurons via a cannula inserted into the skull.

LEDs appear to be ideal for an implantable system due to their low power requirements and heat production.

Project Aim

To identify LEDs suitable to use as a coherent light source for an implantable optogenetics system.

Requirements:

There are 2 wavelength ranges predominantly used in optogenetic systems, each with a different required power output density. 450 nm – 470 nm light must emit at least 1 mW/mm^2 [(1)]; 530 nm – 590 nm light must emit at least 3.5 mW/mm^2 [(1)].

Fibre-optic cable with a 200 µm core diameter is typically used. The power densities have been converted into total power output in the table below.

Wavelength	Optical power at tip of 200 µm diameter fibre-optic cable
450 nm – 470 nm	> 32 µW
530 nm – 590 nm	> 110 µW

References:
(1): Yizhar, O., Fenno, L. E., Davidson, T. J., Mogri, M., & Deisseroth, K. (2011). Optogeneticss in Neural Systems. *Neuron*, *71*.

Method

A dual colour LED, containing 2 dies, capable of emitting light at 465 nm and 570 nm was tested to determine if it delivered enough optical power to meet the requirements. A micrometre adjustment stage was used to move one end of a fibre-optic cable relative to the LED. The optical power at the other end of the cable was measured using a THORLABS PM100D with a S140C sensor attached.

The fibre-optic cable was moved up to 130 µm from the centre of each LED die (assumed to be the brightest measured point) at a series of heights above the LED: 95 µm, 125 µm and 155 µm.

The LEDs were driven with a forward current of 30 mA.

Results

The 465 nm LED delivered sufficient power in nearly all positions tested. The 570 nm LED was unable to deliver sufficient power in any situation.

Summary

The 465 nm LED is suitable to be considered for future work on the implantable optogenetics system. Further investigations may yield a more suitable LED in the 450 nm – 470 nm range.

The 570 nm LED is not suitable; Finding a LED that emits sufficient power in the 530 nm – 590 nm range remains a priority.

Horizontal Single-Axis Power Distribution