An Implantable CMOS Image Sensor Using Fiber Coupled Laser Excitation

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Fluorescence imaging technology has been widely used for neural activities monitoring because of high resolution, selectivity, and sensitivity. To observe fluorescence signals in the deep area of animal brains under freely moving condition, an implantable fluorescence imaging device based on CMOS image sensor has been developed [1]. However, measuring brain neuronal activity with high spatial resolution and high sensitivity is still an issue because it has been difficult to achieve high excitation rejection performance in lensless imaging systems. Recently, we proposed and demonstrated a novel multilayer emission filter structure based on fluorescence and emission filters [2]. In this study, we improved the imaging potential of implantable imaging device by multilayer emission filter and delivering light in specific area of brain slice using fiber coupled laser illumination.

We fabricated multilayer filter consist of short-pass interference filter that will cutting of light at wavelength longer than 550 nm, green absorption filter and yellow filter as shown in Fig 1. This structure will attempt the image sensor and green fluorescence protein (GFP) have approximately the same spectrum operation. The interference filter reflects not only red fluorescence from a brain tissue but also the angled blue excitation light due to the spectrum shift with the incident angle. The yellow filter absorbs the excitation light scattered by the tissue. The green filter reduces the sensitivity to the angled red fluorescence. The assembled low numerical aperture (NA) optical fiber in freely-moving apparatus suggest the light can be delivered almost parallel with imaging device tightly. In addition, the fiber provides laser coupling to improve the selectivity by its narrow spectrum in comparison with blue LEDs.

In preliminary study, we measured the image sensor sensitivity spectrum as shown in Fig. 2. The measurement result indicated the device spectrum is relatively associated with the GFP emission. The in vitro experiment confirmed that the image sensor capable of capturing GFP emission moderately. This result, will need to be considered in the development of an implantable image sensor.

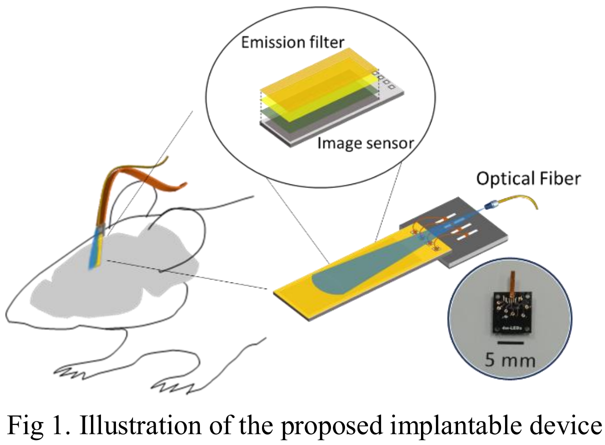

Fig 1. Illustration of the proposed implantable device

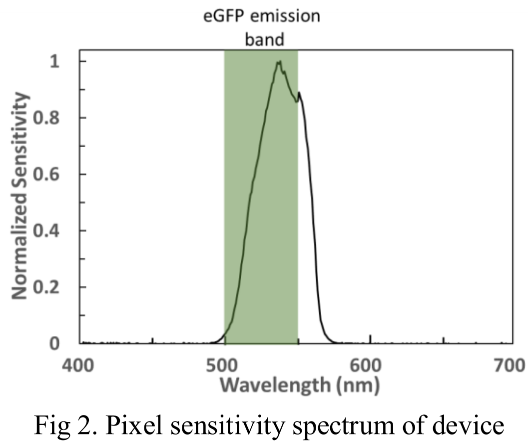

Fig 2. Pixel sensitivity spectrum of device

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