マイクロダイアリシス機能を集積化したオプトジェネティクス用マイクロ LED 光刺激デバイス
Micro LED-based photo-stimulation devices integrated with microdialysis functionality for optogenetics

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I. Introduction

Optogenetics is a recently developed technique that uses light to perturb the neural excitation process, allowing for a more direct investigation of neural activity and its correspondence to animal behavior. In this regard, advancements in both the functionality and structural conformability of optogenetic devices will be invaluable to neuro-scientific research.

Herein, we demonstrate multiple lightweight implantable devices capable of optical stimulation and concurrent monitoring of neurotransmitter levels near the cortical surface and in deep brain regions by strategically integrating micro-LEDs with microdialysis probes.

II. Micro LED-based photo-stimulation devices for rodent models

In this study, the devices were able to stimulate a broader region of neuronal tissue because of the diffuse nature of light supplied by micro LEDs as compared to conventional optical fibers. The compact size of the micro LEDs also enabled customization of their spatial patterns which is necessary for uniformly illuminating the target brain region in its entirety. Furthermore, the use of electrical wires instead of optical fibers imparted greater flexibility to the implanted devices which allowed the animals to move with minimal restraint during tethered experiments.

Two types of photo-stimulation devices capable of simultaneously measuring dopamine concentration in the vicinity of implantation were developed: first, a linear-type device consisting of four LEDs is used for deep brain implantation (**Fig 1**); and second, a ring-type micro LED pattern is applied to the cortical surface in which both microdialysis and electro-physiological probes can be inserted to the opening (**Fig 2, left**). InGaN ($\lambda \simeq 460$ nm) and AlGaInP ($\lambda \simeq 625$ nm) LEDs were utilized to stimulate ChR2- and ChrimsonR-expressing neurons in transgenic rodents, respectively. Together, these miniature lightweight devices are highly suitable for *in vivo* behavioral studies in freely moving conditions.

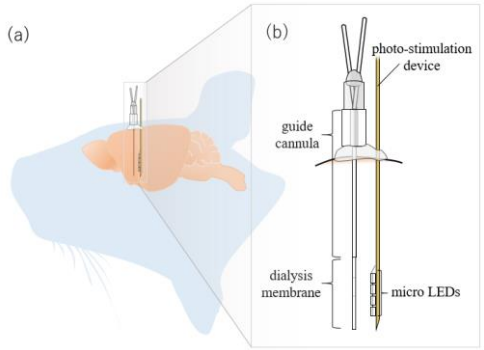

Fig 1. Schematic of implantation site in mouse deep brain region (a) and enlarged view (b) of the linear-type device combined with microdialysis functionality.

Fig 2. Micrographs of ring- (left) and linear-type (right) devices for stimulating neurons in transgenic rodents.

III. Conclusion

We proposed and realized photo-stimulation devices based on micro LEDs with integrated microdialysis functionality for measuring dopamine release. Optimization results on stimulation power and temperature of the micro LEDs during operation will be presented in the conference.

Acknowledgements

This work was supported by CREST, JST 'Elucidating the higher-order brain functions by optogenetic manipulation of large-scaled circuits in nonhuman primate brain.'

References

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