Flexible microLEDs for Optogenetics

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Oral contribution

Neuroprostheses traditionally use electrical stimulation to excite neuronal tissue. While this approach has led to successful peripheral devices, it is not suitable for direct cortical prosthesis. Largely, this is due to the unspecific activation of various types of neurons by electrical current and the low spatial resolution achievable with practical electrodes. Optogenetic stimulation, a technique that has revolutionized systems neuroscience in the past decade, has largely solved the specificity problem. While previously unimaginable, optogenetics makes it possible to target specific, genetically defined subsets of neurons in the brain to stimulate or inhibit them with light [1]. The method, as currently employed, does however not solve the problem of insufficient spatial control over the stimulated brain region, particularly for prosthetic applications, which require large stimulation areas and high robustness.

While the biological side of optogenetics has seen massive progress, with the development of hundreds of new light sensors or opsins and application in various model systems, improving the mode of light delivery, the second fundament of optogenetics, is still an ongoing challenge. The aim of this presentation is to show the different strategies in place, their advantages and limitations, and the activities developed by our laboratory in this field.

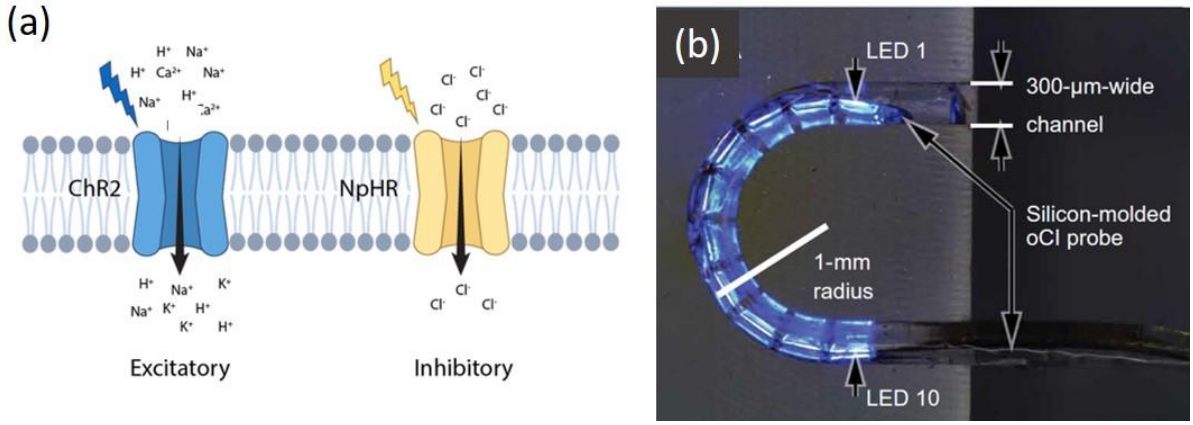

Fig. 1 (a) Optogenetic tools of excitation and inhibition: different opsin variants. Upon exposure to blue light, Channelrhodopsins 2 (ChR2) allows cations to enter the cell causing an excitatory response. In contrast, Halorhodopsin (NpHR) upon exposure to yellow light, results in an inhibitory response. (b) a silicon molded optical cochlear implant undergoing a bending test [2].

References

[1] K. Deisseroth, Optogenetics: 10 years of microbial opsins in neuroscience, Nat. Neurosci., 18, 1215 (2015)

[2] D. Keppeler et al Multichannel optogenetic stimulation of the auditory pathway using microfabricated LED cochlear implants in rodents. Sci. Transl. Med.12, eabb8086 (2020)