

Flexible optitrode for localized light delivery and electrical recording

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The twisted-wire tetrode (TWT) for neuronal unit recording in the deeper regions of the brain, such as the hippocampus, has been indispensable to our understanding of how the neural mechanisms underlying normal learning and memory are usurped by drug addiction or disrupted by neuronal diseases. This simple device is fabricated by twisting four $\sim 13 \mu\text{m}$ insulated nickel-chrome wires together, thermally fusing the insulation, and clipping the end to create a probe with four closely spaced electrodes in a plane perpendicular to the cut wires. This letter describes the integration of a high-efficiency optical channel to deliver light to the sensing electrodes of a TWT while maintaining the fundamental flexibility of the TWT. Such a device could be used for molecularly specific control of in vivo neural activities by optogenetic stimulation and silencing with simultaneous electrical recording, which are essential for potential closed-loop feedback control. We present optitrode, a miniaturized flexible probe for integrated, localized light delivery and electrical recording. This device features an annular light guide with transparent polymer and fused silica layers surrounding a twisted-wire tetrode. We have developed a novel fabrication process, V-groove guided capillary assembly, to achieve high-precision, coaxial alignment of the various layers of the device. Optitrode with a length-to-diameter ratio ~ 500 (5 cm long, $100 \mu\text{m}$ diameter) has been fabricated, and both the electrical and optical functions have been characterized. The prototype can deliver 11% (110 mW) of the total laser power under abrupt bending angle 25° .

Biography

Wei-Chuan Shih is an Assistant Professor of Electrical & Computer Engineering with a joint appointment from Biomedical Engineering at the University of Houston. Prior to joining UH in Fall 2009, he was a postdoctoral fellow at Schlumberger-Doll Research Center in Cambridge MA. He earned his B.S., M.S., and Ph.D. from National Taiwan University, National Chiao Tung University, and Massachusetts Institute of Technology, respectively. His research interests include nanobiophotonics, biosensors and bioelectronics, N/MEMS, nanofabrication, and computational imaging and sensing. He received the NSF CAREER Award in 2012 and was a recipient of MIT Martin Fellowship in 2006.

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