

## ***Floating Light-Activated Micro-Electrical Stimulators***

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One of the limitations of neural stimulation is the mechanical stress and resulting trauma caused by the movement of the interconnects to the stimulating electrode. Remotely activated floating micro-stimulators are one possible method of eliminating the interconnects. As a method of energy transfer to the micro-stimulator, we use a laser beam at near infrared (NIR) wavelengths in this project. The two major questions addressed are: 1. How small can a floating stimulator be made without sacrificing the stimulation strength? 2. How deep can it be implanted into the CNS and still be activated without exceeding the NIR safety exposure limits on the surface?

To investigate these questions, first we have developed a finite element model of a floating micro-stimulator with bipolar contacts and studied the effects of various parameters on the stimulation strength, such as the separation between the contacts and the device size. The computer simulations indicated that the size of the device can be reduced down to 200 micrometer without compromising the stimulation strength in the vicinity of the contacts.

Secondly, we have fabricated silicon PIN photodiodes with various sizes and sputter coated the contacts with titanium nitride (TiN). The voltage generated by an individual diode in a volume conductor was tested experimentally by placing it in a diluted saline solution and activating with a NIR laser beam. A representative voltage seen in the volume conductor was an exponentially decaying function with a peak amplitude of approximately 200mV.

Next, the devices were tested in a rat sciatic nerve for their stimulation strength at various implantation depths. The micro-stimulators were fixed in the middle of a 1 mm wide conduit and placed underneath the tibial branch of the sciatic nerve after making a small slit with a 26g needle in the perineurium. The laser beam was aimed at the active area of the micro-stimulator. The thickness of the tissue above the micro-stimulator thus the distance that the laser beam traveled was varied by changing the height of the conduit. The NIR threshold for activation was measured for increasing pulse widths and the strength-duration curve was obtained for various thicknesses of the neural tissue. The initial tests with suboptimal devices demonstrated that implantation depths of at least 1.5 mm is feasible.

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