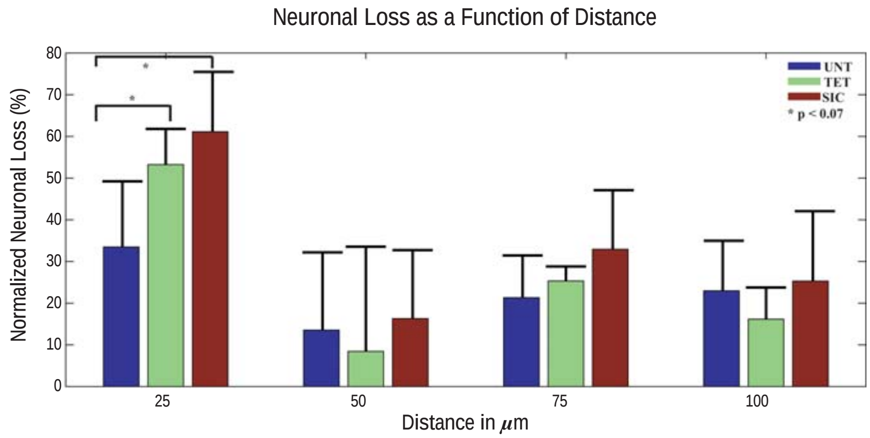
The Role of Flexible Polymer Interconnects in Chronic Tissue Response Induced by Intracortical Microelectrodes

Jeyakumar Subbaroyan and Daryl R. Kipke



Normalized neuronal loss plotted as a function of distance from probe-tissue interface (UNT - Untethered implant, TET - Tethered implant, and SIC - Free-floating implant).

Chronic tissue response induced by tethering is one of the major causes for implant failure in intracortical microelectrodes. We have explored the hypothesis that flexible interconnects can provide strain relief against forces of "micromotion" and hence can result in maintaining healthy tissue surrounding the implant. Finite element modeling results indicate that flexible interconnects, made from polyimide (E = 2 GPa) and polydimethylsiloxane (E = 6 MPa), reduce interfacial strain by 66% and two orders of magnitude, respectively. Three implants—an untethered probe, a tethered probe ("stiff"), and a free-floating probe ("flexible") in a fluidic chamber—were implanted in rat motor cortices. Quantitative immunohistochemistry results indicate that significant neuronal loss and up regulation of glial fibrillary acidic protein (GFAP), a marker for reactive astrocytes, occurred up to 100μm from the probe-tissue interface for all implants. Untethered probes caused significantly less neuronal loss ($n = 3$, $p < 0.07$) than both tethered and flexible implants in the first 25μm from the probe-tissue interface. These results are of considerable importance in the design of implantable neural microsystems.