Response Properties of Retinal Neurons to Prosthetic Thermal Nanorod Arrays

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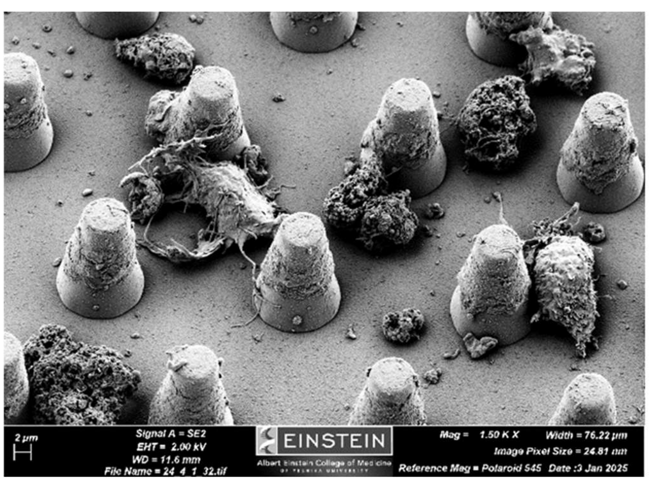
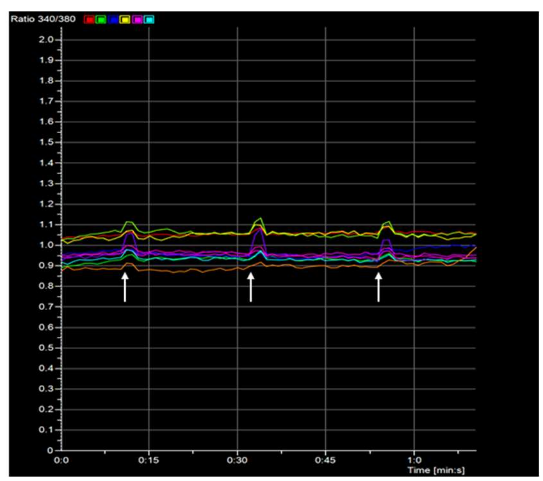
Loss of human neural retina leads to permanent vision loss due to mammalian retina lacking the ability to regenerate. An approach to restore vision is through the use of implantable stimulation devices. Following ocular disease or trauma-induced loss of photoreceptors, retinal prosthetics can be implanted to stimulate remaining bipolar neurons to drive visual response. Thermal stimulation of neurons has been shown to drive responses in neural retinal cells. Thermal PDMS nanoarrays have the potential to stimulate individual cells with a high level of resolution and stability, these thermal arrays are optimal because they can be stimulated via an extraocular light source. The relationship between nanorod thermal warming and neuron depolarization remains to be fully elucidated and will be analyzed in this work. To assess neuronal interactions with the pillar arrays, calcium imaging of Fura-2 loaded neurons receiving stimulation from nanorod thermal arrays was performed to quantify neural amplitude and time course responses to established thermal stimulation paradigms. Ultrastructure analysis has been performed to quantify neural connectivity to micropillar structures with gold nanorods and to guide microtopology optimization. Preliminary SEM data shows neurons forming structural connections with nanorod array pillars and driving calcium responses in mouse retinal progenitor cells (mRPCs). Overall, this work will provide data to support optimization of retinal stimulation device design, stimulation parameters, biocompatibility, neural response properties and advancement of practical and long-term implantable nanoarrays as a novel retinal prosthetic.





LEFT: SEM image (1,500×) depicting individual mRPCs in direct contact with the PDMS pillars. Cells exhibit elongated morphologies consistent with substrate-guided migration and initiate dendritic extensions toward adjacent microstructures. **RIGHT:** Time-course plot of the Fura 2 fluorescence ratio (340/380) in mRPCs following IR thermal stimulation at 224 mW, showing increases in intracellular calcium following stimulation, post-background subtraction.