

Abstract

Epiretinal prostheses typically stimulates the surviving neurons of the retinal circuitry, in blind patients with photoreceptor degeneration diseases like Retinitis Pigmentosa and Age related Macular Degeneration. Although, existing implants restore vision empowering patients with execution of daily life activities, enhanced resolution and color incorporation is necessary to improve the performance. In this dissertation, the electrode-tissue interface was studied under in-vitro condition to understand the conversion of external (electrical and optical) stimulus to biological signals in the retina. In this context, a multielectrode array (MEA) with a hexagonal arrangement, of alternating ground and recording electrodes surrounding a stimulating electrode, was proposed through simulation study of electrical and thermal parameters for focal stimulation and uniform recording from retinal ganglion cells (RGC) using COMSOL Multiphysics software. Further, using photolithography technique, the MEA of gold thin film disc electrodes was fabricated on flexible Polydimethylsiloxane (PDMS) surface, in which the buckling of thin film due to PDMS substrate added advantages over rigid substrate in terms of lower impedance and higher charge injection capacity. Additionally, normal goat retina, having morphology comparable with other vertebrates commonly used for retinal investigations, was standardized optically using histology and OCT, and electrically with impedance spectroscopy. To illustrate the contribution towards epiretinal prosthesis research, in vitro experiments were conducted with normal goat retina for comparison of light and electrically evoked responses. Wavelength information of a light stimulus and effects of variation of stimulus parameters for both light and electrical stimuli were decoded from the RGC responses through firing rate, interspike interval, latency analysis, and estimation of generalized linear model. Through successful clustering of certain light and electrical responses, this study proposes that the wavelength information could be encoded through specific electrical stimulus pulse parameters, which envisage the potential of introducing color through epiretinal prosthesis.

Keywords: *Epiretinal electrical stimulation, colored light stimulation, retinal ganglion cell responses, spike train, multielectrode array, flexible PDMS substrate, isolated goat retina, electrical impedance spectroscopy, thickness from OCT images.*