Department of Physical Electronics
School of Electrical Engineering
The Iby and Aladar fleischman Faculty of Engineering
Tel Aviv University

Department Student Seminar

Ieva Vebraite-Adereth

Ph.D. student under the supervision of Prof. Yael Hanein

Tuesday,
February 6, 2024

15:00-16:00
Room 011 Kitot Building

Development and Validation of High-Resolution Soft Electrode Arrays for Retinal Investigations

Abstract

Retinal degenerative diseases, such as Retinitis pigmentosa and Age-related macular degeneration, remain the primary cause of blindness worldwide, impairing the retina's ability to perceive light due to photoreceptor degeneration. Efforts to restore vision via retinal implants face significant challenges, including understanding the retina's response to electrical stimulation, effective stimulation methods, and improving device resolution and compatibility. This thesis addresses these challenges by focusing on the investigation of the intact retina's response to electrical stimulation, contrasting previous ex-vivo studies.

The study introduces a novel soft electrode array technology designed to record and stimulate retinal tissue. Utilizing polyurethane films for substrate and passivation layers, the array incorporates carbon electrodes with a diameter as small as 40 µm, enhanced with a EDOT layer. These arrays, including a 60-channel array and SoftC probes with bidirectional stimulation/recording capabilities, were employed for ex vivo and intact retina investigations. Ex-vivo analysis confirmed the effectiveness of soft electrode arrays, allowing successful electrophysiological investigations and single-unit recordings of retinal tissue. Integrating organic electrolytic photocapacitor (OEPC) pixels enabled photoelectric stimulation. Transitioning to intact retina studies using SoftC probes highlighted discrepancies between ex-vivo and intact tissue conditions. Notably, the ex-vivo
retina exhibited more pronounced spontaneous electrical activity and fading effects compared to the intact retina, indicating the importance of proper physiological conditions for consistent responses to electrical stimulation.

In conclusion, this thesis introduces high-resolution soft electrode arrays for in vivo retinal investigations, shedding light on intrinsic retinal activity and responses to stimulation parameters. This advancement promises to facilitate effective, cell-specific retinal stimulation protocols, contributing to the development.
of future artificial retina devices. The work underscores the significance of in vivo studies for understanding.
retinal behaviour and optimizing stimulation strategies.