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TITLE : Design and manufacture of flexible implantable and energy autonomous neuroelectronic devices

Abstract

Neurodegenerative diseases such as age-related macular degeneration (AMD) are increasing with the aging of the population [1]. In AMD, the photoreceptors in the center of the retina degenerate and die, which results in vision loss. The Institute of Electronics, Microelectronics and Nanotechnology (IEMN) and Axorus, a startup founded in 2019, are collaborating on a retinal implant prototype which aims at restoring the visual capacities of AMD patients. IEMN developed and patented an electronic circuit which reproduces the electrical signature of a biological neuron. Axorus has integrated this "artificial neuron" into an implant powered by light.

One objective of this thesis is to develop a thin bendable silicon substrate following the shape of the eye. It has to be bendable for easy insertion, with a large implant size to provide a maximum visual field [2][3]. Our aim is to push the limits of substrate thinning and reach a thickness of 10 μm . At this thickness, the silicon should be bendable.

Another objective of this thesis work is to select an energy source able to be stored and provide enough energy to stimulate biological neurons [4][5], in the case where photovoltaic energy is not usable. The energy source will also have to be biocompatible and reach a lifetime of at least 10 years.

This will pave the way for other applications using the artificial neuron. The implant will be adapted to implantation areas with strong dimensional constraints and will be self-sufficient for unlit areas.

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