

Fabrication process of hexagonally arranged needle electrodes for direct retinal contact

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Introduction

Current retinal implants are still not able to restore natural vision due to several challenges linked to spatial resolution of electrical stimulation. The reasons for this include low electrode density, high distance between target cells and electrodes and high crosstalk between adjacent electrodes. One approach to address these problems are penetrating needle electrodes, which are implanted epiretinally into the tissue. Here, a concept for a CMOS compatible fabrication process is presented, where needle electrodes are arranged in a hexagonal array with a local ground configuration to reduce the crosstalk and enable local stimulation.

Methods

The fabrication process can be divided into two sections. First an internal wiring is fabricated by depositing and etching a conductive material. The conductive lines are passivated and then planarized by a CMP process. Subsequently, vias are etched into the passivation and filled with tungsten. On top TiN is deposited and patterned to form planar electrodes as a base for the needle electrodes. In the second phase cylindric openings in a thick film lithography process are created as templates for the needles. They are filled with a metal by electrodeposition. The released metal cores are encapsulated with a thin ALD layer, which is structured afterwards to isolate the electrodes from each other. The resulting electrode array is characterized by EIS and CV measurements. Additionally, first biocompatibility experiments are performed on the integrated materials.

Results

The fabrication of the flat base electrodes was performed successfully to create a hexagonally array of electrodes while the optimization of the second fabrication part is still in progress. The first biocompatibility experiments showed promising results and will be continued with structured chips.

Conclusion

The approach of using penetrating needle electrodes in a hexagonally arrangement with local returns can improve the confinement of electrical field and reduce crosstalk to enable higher electrode densities.