Raney-platinum electrodes for functional electrical stimulation

Boretius T.[1], Jurzinsky T.[1], Köhler Ch.[2], Kerzenmacher S.[2], Stieglitz T.[1],
[1] Laboratory for Biomedical Microtechnology, Department of Microsystems Engineering - IMTEK
[2] Laboratory for MEMS Applications, Department of Microsystems Engineering - IMTEK
University of Freiburg, Freiburg, Germany
boretius@imtek.de

Introduction

This abstract is about the fabrication of platinum thin-film electrodes with defined roughness and microporosity. This is achieved through surface modification of a sputtered platinum layer on a polyimide substrate via deposition, annealing and subsequent etching of an aluminium layer. The electrochemical properties of the resulting layers were characterized by cyclo-voltammetry (CV), pulse testing and electrochemical impedance spectroscopy (EIS).

Methods

First, a platinum layer (300nm) was deposited by sputtering techniques onto a polyimide substrate and patterned via lift-off process. After a second polyimide layer was attached, cured and patterned via dry etching, an aluminium layer (150nm) was sputter deposited and patterned onto the active sites of the electrode. Following to an additional curing step at 300°C for 2h, which results in the formation of an alloy at the Pt-Al interface. Afterwards, the aluminium layer was selectively wet etched in 1M potassium hydroxide leaving a rougher platinum surface. All electrochemical tests were performed within a three-electrode configuration comprising the working electrode, a platinum counter and an Ag/AgCl (3M) or saturated calomel reference electrode.

Results

EIS measurements of the active sites showed a decrease of 75% in impedance values and 70% in phase angle when compared to non-treated Pt sites. CVs were recorded from -0.25 to 1.4V vs. SCE. The roughness factor RF increased from 2 for sputtered Pt to 47 for the treated Pt layer. Pulse tests were performed with biphasic, rectangular pulses with an injected charge of 20nC/phase (@200Hz) over a timespan of 250M pulses. After iR drop compensation, the cathodic and anodic peak voltages were measured and stayed almost constant over the 250M pulses (cathodic peak decreased from -450mV to -275mV; anodic peak behaved likewise).

Conclusion

It could be shown that roughening of Pt microelectrodes on flexible substrates is feasible by depositing, curing and subsequent etching of an aluminium layer. An increase of the electrochemical active area was observed by EIS and CV. Pulse tests remained stable over the complete timeframe, suggesting a stable coating.