Design and Characterization of TiN Electrodes for a Planar High-Resolution DBS Probe

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High-resolution planar probes for deep brain stimulation consist of small electrodes (geometric surface area GSA ≤ 10^4 μm^2) that require high charge densities to achieve efficient neural stimulation. The current density distributions (CDD) across an electrode are usually non-uniform peaking at the edges. The extent to which CDD maxima are a factor in tissue damage is currently uncertain. We report here the design and *in vitro* characterization of GSA = 10^4-μm^2 TiN electrodes of three shapes: a circle, square, and a regular hexagram. Voltage transient studies using 50-Hz 200-µs rectangular pulses (current I from 100 µA to 1 mA) reveal the damage at the electrode starting to appear from $I > 0.5$ mA. This damage distribution correlates with CDD across the electrode. The results suggest that small electrodes with more uniform CDD may mitigate the onset of the tissue damage and hence provide more efficient neural stimulation.