Non-Confidential Description - PSU No. 3822
“Micro-Reaction Chamber Microelectrodes Especially for Neural and Biointerfaces”

Field of the Invention/ Keywords:
Neural electrodes, neural interface, biocompatible coatings, neural prosthesis

Links:
Inventor website

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Background
Electrical stimulation of selective regions of the brain has become an efficient therapy for sensory and motor impairments and also for a number of neurological disorders such as Parkinson’s disease, chronic pain, major depression, epilepsy, etc. Microwire electrodes are extensively used for chronic neural stimulation and recording purposes. Neural electrodes with smaller geometries are generally preferred to improve the spatial locality and to decrease the tissue damage resulting from insertion trauma. However, this leads to increases in interfacial impedance and increases in the required charge transfer density for a given stimulation impulse.

Invention Description
The subject invention consists of neural micro-wire electrodes with micro-reaction chambers (µRC) interfaces, which allow for improved sensitivity without impairing selectivity of the neural electrodes. The invention’s µRC electrodes showed about three (3) orders of magnitude higher charge storage capacity than a bare solid-planar (SPl) electrode. Because of its ability to pass significantly higher amount of charge, the invention’s electrode with smaller geometric surface area (GSA) can replace its SPl electrode counterpart with higher GSA, thereby reducing tissue trauma and increasing sensitivity. The combination of high frequency (~1 kHz) action potential recordings and lower frequency content (<300 Hz) local field potential records increases the signal-noise ratio of both action potential and LFP recordings, thereby providing useful information on the state and activity of the brain.

Status of the Invention
An assortment of prototypes have been manufactured and tested In Vitro for both stimulation and recording, and In Vivo for recording. The prototypes (including those having a 50 µm diameter) have demonstrated utility for enhanced microwire neural recording and stimulation electrodes. The Penn State inventors are currently testing the prototypes for recording in chronic implants. The invention is suitable for biological or other ionic-solution based systems.

Commercial Applications
The µRC electrodes have utility for both neural recording and micro stimulation under acute and chronic implantation conditions. The invention offers greatly enhanced electrode performance without increasing the electrode size. This minimizes tissue damage and improves the long-term viability of the electrode, which enhance the electrode’s performance for stimulation. Alternatively, by lowering noise and signal degradation, the invention has utility in neural recordings.