ADVANCED IMPLANTABLE SYSTEMS FOR CHRONIC NEUROMODULATION AND RECORDING

Background

One of the current market trends is growth in neurotechnology-- specifically, brain-computer interfacing (BCI) as well as deep brain stimulation (DBS) to treat a handful of afflictions, including: Parkinson's Disease, essential tremor, and major depression. Brain computer interfacing refers to connecting the brain's natural electrochemical properties to computers, in order to modulate or monitor the brain's activities. This usually comes in a non-invasive form using an electroencephalogram (EEG), which is a cap made of a mesh of electrodes, each able to pick up on the brain's unique wavelengths based on users' thoughts. Those electrical impulses are then translated into digital signals and can result in digital data storage or controlled mechanical movement. Neural prosthetics have made large improvements in this space throughout the past decade.

EEG offers researchers lots of avenues to explore potential uses of BCI, but the electrical signal from the brain is weak compared to more invasive methods, so the potential applications are limited. Invasive methods require surgery that involves drilling a hole into a patient's skull to implant one or more neural probes into the neural tissue. These probes often have multiple electrodes and are able to record chemical, electrical, and biological data from the surrounding tissue. Some electrodes are able to emit small electrical pulses, stimulating the surrounding neurons.

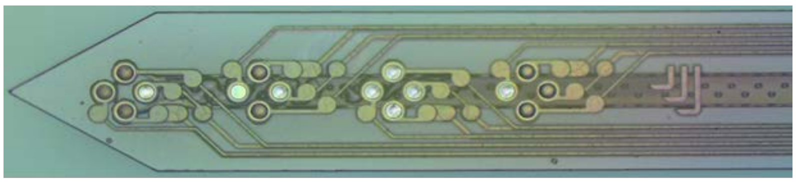
For chronic DBS implantation, wires connect to the top of the probes and are implanted underneath the skin of the patient and extend down the neck, to a small implanted electronics device usually at the top of the chest. The FDA has approved DBS to treat Parkinson's and essential tremor, and there are currently over 160 active DBS clinical trials worldwide to treat a wide variety of indications.

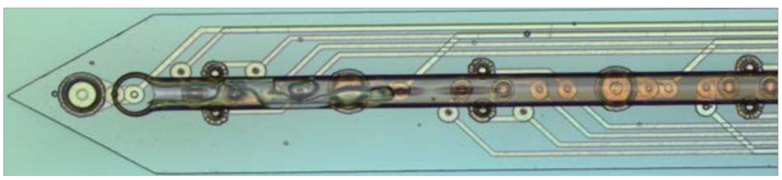
IL13065: IMPLANTABLE NEUROMODULATION SYSTEM FOR CLOSED-LOOP STIMULATION AND RECORDING SIMULTANEOUSLY AT MULTIPLE BRAIN SITES (PCT Application WO2017100649)

This technology relates to a modular system for deep brain stimulation (DBS) and electrocorticography (ECoG). The system has an implantable neuromodulator for generating electrical stimulation signals adapted to be applied to a desired region of a brain via an attached electrode array. An aggregator module is used for collecting and aggregating electrical signals and transmitting the electrical signals to the neuromodulator. A control module that communicates with the aggregator module is used for controlling generation of the electrical signals and transmitting the electrical signals to the aggregator.

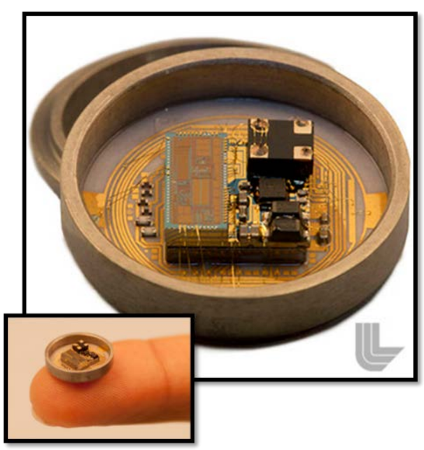
Other currently available DBS systems are considered "open loop," which allow a physician to adjust the DBS setting based on direct feedback from the patient, such as how they are feeling with each incremental change in treatment. However, this method is time-delayed and based on subjective observations from the patient.

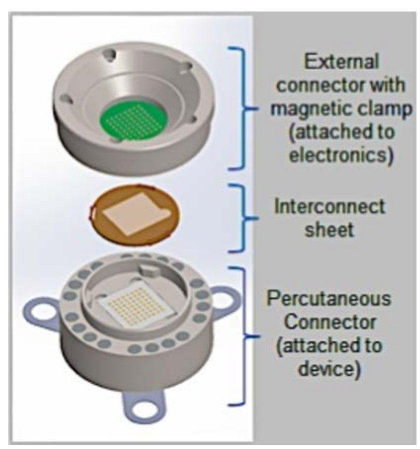
LLNL is developing a "closed loop" stimulation system, which monitors neuron activity and automatically adjust its own electric pulses based on real-time electrode information. Closed loop DBS systems hold promise in tailoring treatment to the individualized needs of each patient. This neuromodulation system is an advanced apparatus made up of state-of-the-art components.





IL12594: HIGH-DENSITY PERCUTANEOUS CHRONIC CONNECTOR FOR NEURAL PROSTHETICS (US Patent [9,138,571)]

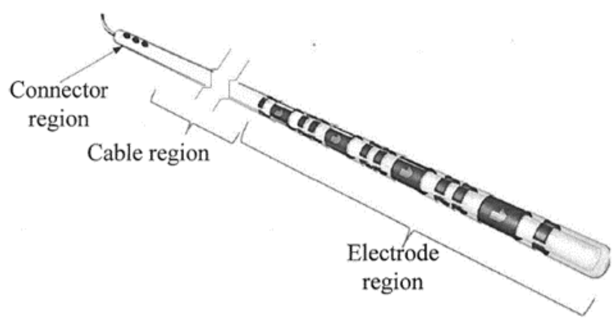




A handful of companies currently develop and sell invasive deep brain stimulation (DBS) systems to healthcare providers, but only few of them provide connectors needed for DBS research. Moreover, the connectors currently in the market are neither robust nor reliable; they are widely considered ineffective by the research community.

A high density percutaneous chronic connector, having first and second connector structures each having an array of magnets surrounding a mounting cavity. This connector can be fabricated from biocompatible material, and has a long lifetime and a high density of electrical feedthroughs. The magnetic closure apparatus enables a quick-release feature, which is particularly useful when working with animal models that may dislodge the connector. Without the quick-release feature, the apparatus would be damaged and the experiment would need repeating, costing time and money.

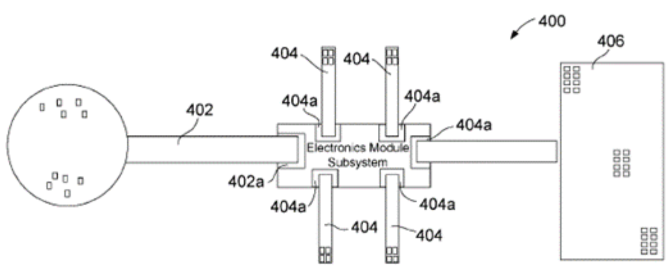
IL13007: A CYLINDRICAL MICROELECTRODE ARRAY FOR NEURAL STIMULATION AND RECORDING (PCT Application WO2016/201151)



This multilayer cylindrical structure has integrated sections including electrodes exposed through electrically insulating layers, a connector section with conductive bond pads for interfacing with external electronics, and a cable section with conductive traces encapsulated in electrically insulating layers and which connect the electrodes and their corresponding bond pads.

This cylindrical shape of the probe is advantageous as it allows for directed neural stimulation and recording. As advances are made in the scope of what neuromodulation can do, the ability to precisely target tissue becomes paramount. This probe offers a unique precision through directed targeting, with a minimally invasive footprint.

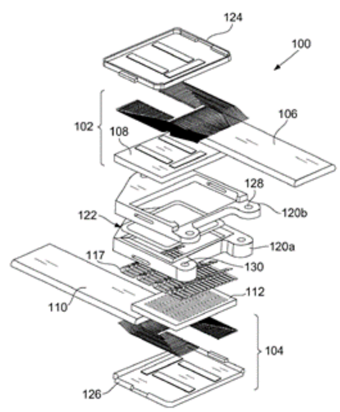
IL12829: SYSTEM AND METHOD FOR NEURAL INTERFACE WITH MODULAR ACTIVE ELECTRONICS (PCT Application WO2016168279)



This system is a modular, high-density electrical system with an interface component well-suited to be in contact with animal or human anatomy. The system is releasably coupled to an electronics module by many conductive interconnect pads. The electronics module may have a substrate that supports both a circuit and pads.

This technology is essential in development of a closed-loop system, where chemical signals are sensed and cause a sensor to generate an electrical signal in response to the surrounding stimuli.

IL12939: SYSTEM AND METHOD FOR IMPLANTABLE ELECTRICAL CONNECTOR (US Patent Application US2016/0380381)



This technology is a high-density electrical connector system which makes use of first and second connector components. Both connector components have a substrate with many electrical feedthroughs that are in communication with electrically conductive bond pads. An electrical coupling subsystem makes electrical contact between the first and second connector components and electrically conductive bond pads. Many fasteners may be used for clamping the first and second connector components in a facing relationship.

Current neuro-stimulation devices typically have 2-16 channels, where a standard connector may be acceptable. However, for new devices with hundreds or even thousands or more of independent channels, it is no longer feasible to use bulky electrical connectors. Applications in the neural space which are being investigated at the present time will require literally hundreds of independent channels requiring hundreds of independent connections.

Potential Applications

Research applications for this LLNL portfolio include connecting an MEA neural probe to external electronics, cochlear implants, micturition, DBS, as well as various types of paralysis research.

This technology may find use in electrode/tissue interfacing, as well as long term neural implants. Current and future studies are assessing the efficacy of DBS to treat Parkinson’s disease, essential tremor, epilepsy, turrets, obsessive compulsive disorder, dystonia, depression and other neuropsychiatric disorders.

These systems may find additional use in linking neural stimulation and recording to thought-controlled prosthetics and other brain-machine interfaces.

Development Status

LLNL is seeking industry partners with a demonstrated ability to bring such inventions to the market. Moving critical technology beyond the Laboratory to the commercial world helps our licensees gain a competitive edge in the marketplace. All licensing activities are conducted under policies relating to the strict nondisclosure of company proprietary information.

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