A self-powered device for Deep Brain stimulation

Abstract

A new approach for Deep Brain Stimulation (DBS) is proposed. We propose a development of self-powered self-sustainable device, which is integrated in the neuro-glial network *in situ*. The electric power is being generated in the composite polymer with embedded nano-piezo-elements through the transduction of the mechanical movement of the body into electromotive force (EMF). The EMF will generate an electric current is to be utilized by the adjacent neurons to facilitate the cellular membrane depolarization and further propagation of the action potential along the axonal network. Due to enhanced biocompatibility and the spatial distribution of the polymer electrode, the operating power is to be lower compared to the currently available DBS technology. Thus, the novel DBS system is to have an increased maintenance-free *in situ* life, reducing complications, health care costs, associated with metal wire-based battery-operated contemporary devices for DBS. This novel approach may also be applied to stimulate other excitable tissues such as peripheral nerves and muscles.

Current state-of-the-art electrical DBS include portable electrical device. Typical stimulation parameters for chronic DBS are: monopolar point electrode stimulation, voltage 2.5–3.5 V, impulse duration 60–90 μs, frequency 130–180 Hz,point electrodes mounted in the designated area of brain (e.g. *subthalamic nucleus*) output about 30mC/cm^2. These devices are commercially available, FDA approved, and widely used devices are battery-powered. The battery is placed outside the head under the skin on the torso. The routine battery change is every 5+ years. The exact nature of therapy effect of this system is unknown.

Invention:

We develop a novel self-powered and self-sustainable system for DBS. One example of image the structure of distributed electrode with capability of self power generation is to picture two-dimensional (2D) or three- dimensional (3D) polymerstructure with embedded in its matrix a piezo-electric material. The piezo-electric material structures, each has dimension form nano-to-micro scale, which will generate an electrical field during any movement due to displacements of a piezo-electric material in respect to polymer matrix. The density of piezo-electric material in polymer is about 10^2-10^4 piezo-electric elements per 1 mm^2 of polymer matrix. The estimated volume of the polymer electrode is about 3-5 cubic mm.