Microfabricated Ultrasound Transducer Array for Neural Stimulation

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Technology description

An innovative micromachined-ultrasound device has been developed for high spatial stimulation of neurons.
The all-in-one neural interface device comprises a piezoelectric ultrasound transducer machined using MEMS fabrication techniques, integrating microelectrode arrays (MEA), to deliver stimulating ultrasound waves to the brain, eitherin vivoorin vitro. In key contrast to electrical stimulation, ultrasound stimulation has the advantage of frequency control, allowing deep structures to be penetrated by low-frequency ultrasound waves and shallow structures to be penetrated by high-frequency ultrasound waves. Accompanying these higher wavelengths is a higher attenuation, thus preventing the stimulation of undesired neurons that can be an issue when using electrical DBS. The device has potential for utilization as anin-vitrodevice, to replace current electrical stimulation devices for neuroscience research, or forin-vivoneurological research in animals and potentially humans.

Background

Electrical stimulation is a traditional medical practice, to alleviate pain, reliant on exposing the body to electrical currents. Over the past couple decades, extensive research has been conducted on electrical stimulation, ranging from functional electrical stimulation (FES), spinal cord stimulation, pacemakers, retinal stimulation, cochlear implants, to deep brain stimulators (DBS). More recently, DBS has shown success in treating several debilitating neurological disorders, such as Parkinson’s disease, Tourette’s syndrome, and epilepsy. While DBS proves to be a powerful asset in the treatment of neurological disorders, it suffers from its inability to focus on a particular target. Due to the electrical conductivity of brain tissue, treatment via DBS typically results in the stimulation of undesired neurons outside of the target tissue, leading to adverse side effects, particularly in the treatment of Parkinson’s. Therefore, an improvement in spatial resolution is needed to truly cite neural stimulation as an effective treatment for neurodegenerative diseases.
Ultrasound is also an extensively used medical application; however, it is generally associated with imaging. Despite this fact, ultrasound’s ability to heat or agitate the body with high energy intensities has been shown to provide viable therapeutic effects. It has been used for cancer treatment, physical therapy, bone growth stimulation, and even blood brain barrier disruption for drug delivery

applications. Due to the mechanical stimulation effects and high resolution capabilities, ultrasound provides an ideal alternative to electrical stimulation.

Technology Description

A researcher at the University of New Mexico has developed an innovative micromachined-ultrasound device for high spatial stimulation of neurons. The all-in-one neural interface device comprises a piezoelectric ultrasound transducer machined using MEMS fabrication techniques, integrating microelectrode arrays (MEA), to deliver stimulating ultrasound waves to the brain, eitherin vivoorin vitro. In key contrast to electrical stimulation, ultrasound stimulation has the advantage of frequency control, allowing deep structures to be penetrated by low-frequency ultrasound waves and shallow structures to be penetrated by high-frequency ultrasound waves. Accompanying these higher wavelengths is a higher attenuation, thus preventing the stimulation of undesired neurons that can be an issue when using electrical DBS. The device has potential for utilization as anin-vitrodevice, to replace current electrical stimulation devices for neuroscience research, or forin-vivoneurological research in animals and potentially humans.

Application area

Higher spatial resolution than electrical DBS techniques
Negate adverse side effects associated with electrical stimulation
Treatment of neurological and central nervous system disorders
Parkinson’s disease, Tourette’s syndrome, epilepsy, and depression,
Significant commercial potential asresearch tool for neuroscientist

Institution

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