**Introduction**

Electrical and Transcranial Magnetic Stimulation (TMS) of brain neural system have showed to be beneficial to treat some neurological disorders like Parkinson’s disease, stroke, major depression, speaking disorders, dystonia, and essential tremor. In spite of their successes, both methods suffer from some technical, efficacy, and safety problems that limit their applications. In this study, for the first time, we show on-probe Micro-TMS coils that can overcome some of the limitations and problems of the electrical stimulation and conventional TMS. These Micro-TMS coils are fabricated on very small probes that can reach deep brain area without surgery. Also the stimulation elements, the coils, have micro-scale sizes that provide a very high spatial resolution.

**Concept: Magnetic Stimulation of Brain Neural System**

1. Applying a time-varying current to the coil to generate magnetic flux density.
   \[ \frac{\partial B}{\partial t} = \frac{\mu_0}{4\pi} \frac{\partial}{\partial t} \int_0^l f \times \hat{n} \, dl \]

2. According to the Faraday’s law, then we will have an electric field.
   \[ \oint_C E \, dl = - \frac{d}{dt} \int_S B \, dS \]

3. According to the Lorentz Force’s law, a force is applied to the ions and generate an electrical signal in the neural network.
   \[ F = qE + q \nu \times \vec{B} \]

**Optical Microscope and SEM Pictures of Fabricated Probes**

Mounted Probe on PCB

Probe length: 7mm

Inductor Size: 80 × 40 µm

SEM picture of the probe

A wire bonded probe to the PCB

Inductors with different direction on a single probe.

Probes with 12 inductors applicable for human-computer interaction

Inductor Size: 40 × 40 µm

**In-Vitro Test Setup and Simulation Results**

Finite Element Method (FEM) Simulation of a Probe Magnetic Flux Density Magnetic Flux Vector

CA1/CA3: Recorder

CA3: Stimulator

Rat Hippocampal Neural Network

Probes functionality has been verified and In-Vitro tests are still in progress.