Cortical Epidural Stimulation by rGO and Pt-Ir Microelectrodes in Chronically Implanted Awake Rats

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Abstract

In peripheral and cortical neuroprostheses, sensory feedback has a key role in motor control, embodiment and reducing phantom limb pain [1]. Due to its excellent electrochemical properties and biocompatibility [2], graphene is a promising material for chronic stimulation of neural tissue. In this preliminary study, we implanted a 16-channel reduced graphene oxide (rGO) microelectrode array (active site diameter: 25 µm) in the hindlimb area of primary somatosensory cortex (S1) of a Wistar albino rat. Two other rats were similarly implanted with 16-channel platinum-iridium arrays (NeuroNexus). After recovery from surgery, biphasic (first cathodic), charge-balanced electrical pulse trains were randomly applied at two frequencies (40, 100 Hz), two pulse widths (125, 205 µs), and current amplitudes in ascending series (10-120 µA). In a block design, different number of channels (4, 8, 12 or 16) were stimulated in parallel and the animals' behaviour was recorded on camera. A motor threshold was defined when the rat stopped chewing or the movement it was already doing. Discomfort level was defined if the rat closed its eyes or bent its neck. These two response types were studied based on the stimulation parameters (Fig. 1). On average, the total charge required for the motor threshold and the discomfort level was lower in the rGO array (1.97 and 4.04 µC respectively) compared to the Pt-Ir arrays (Pt-Ir #1: 3.08 and 5.34; Pt-Ir #2: 5.78 and 8.73). The preliminary data suggest that cortical surface stimulation with rGO array can provide a safe and effective means for somatosensory feedback.

References

[1] Güçlü, B. Introduction to Somatosensory Neuroprostheses. In Somatosensory Feedback for Neuroprosthetics; Güçlü, B., Ed.; Academic Press, 2021; pp. 3–40.
[2] Park, D. W., et al., ACS Nano, **2018**, 12 (1), 148–157.

Figures

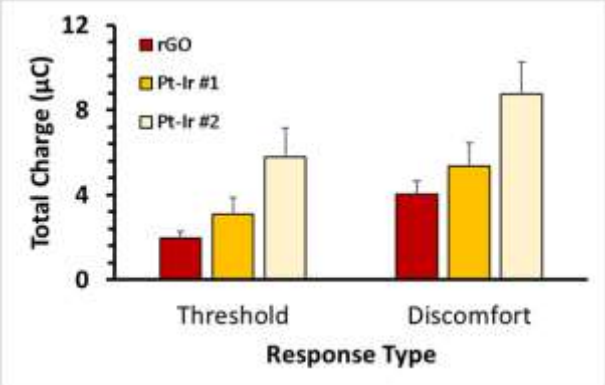

Figure 1: Preliminary comparison between chronically implanted rGO and Pt-Ir microelectrodes for cortical surface stimulation. Motor threshold and discomfort levels are shown based on total charge applied with various stimulation parameters and combination of channels.