Lab on a Chip

SUPPLEMENTARY INFORMATION

A minimally invasive flexible electrode array for simultaneous recording of ECoG signal from multiple brain regions †

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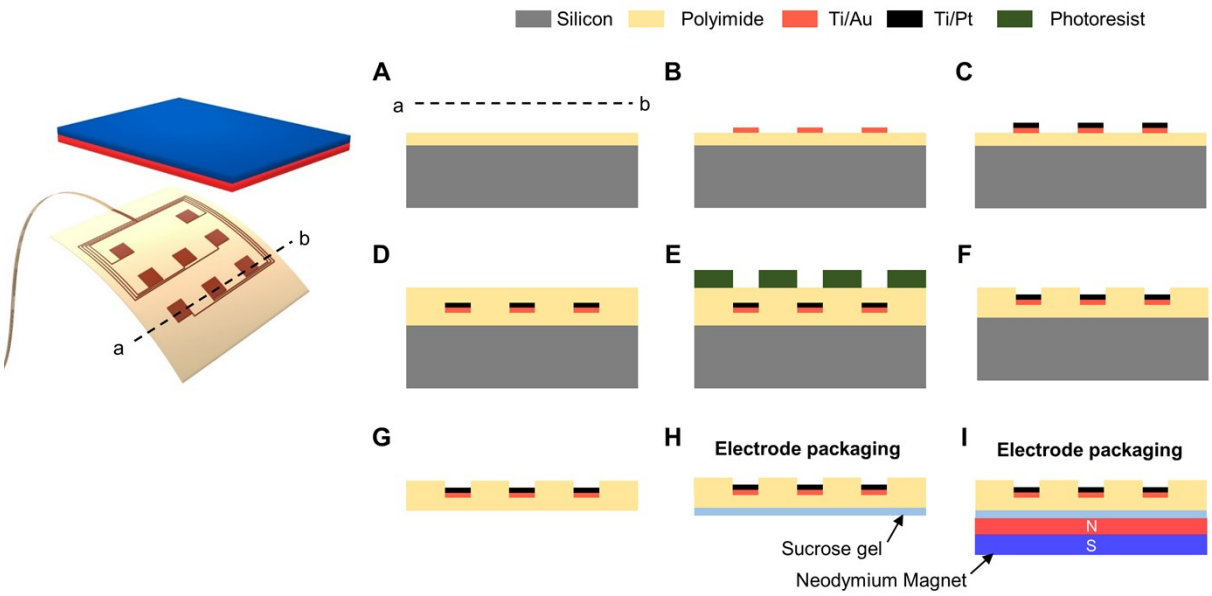

Fig. S1. Outline of the fabrication process flow. A) 1st Polyimide layer coating using spin coater. B) Metal line and electrode patterning for Ti/Au deposition using e-beam evaporation. C) Pt electrode patterning and Ti/Pt deposition using sputtering. D) 2nd Polyimide layer coating. E) Device layout patterning. F) Polyimide etch using asher. G) Device detach from wafer. H) Device packaging by applying biodegradable material. I) Neodymium magnet attatched on device.

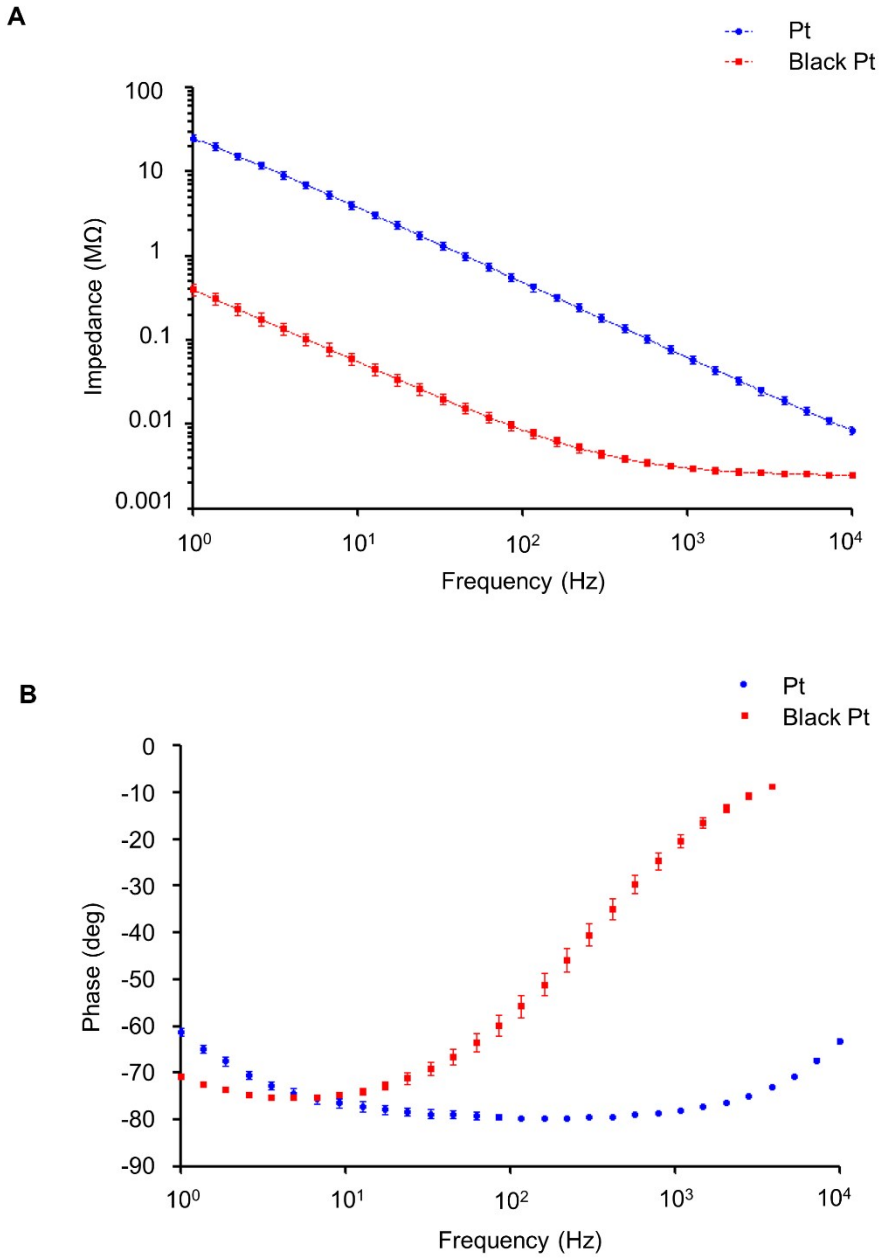

Fig. S2. Characterization of the ECoG electrode array. A) Electrical impedance of 8 electrodes with Pt electrode (blue) and plated black Pt (red). B) Phase of Pt electrode (blue) and plated black Pt (red).

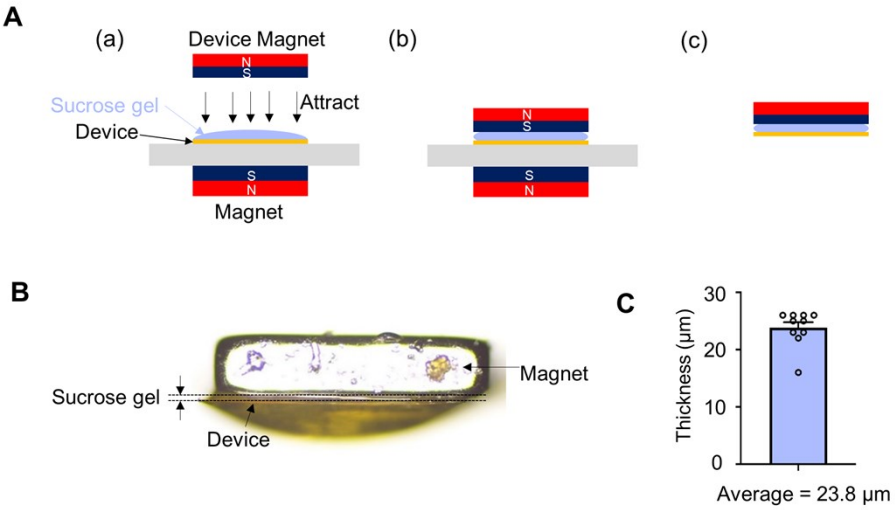

Fig. S3. Device packaging procedure of magnet attachment. A) Device packaging process for attaching the guiding magnet to the recording part of the electrode. B) Microscope image of the packaged device. C) Average thickness of applied sucrose gel of 10 samples.

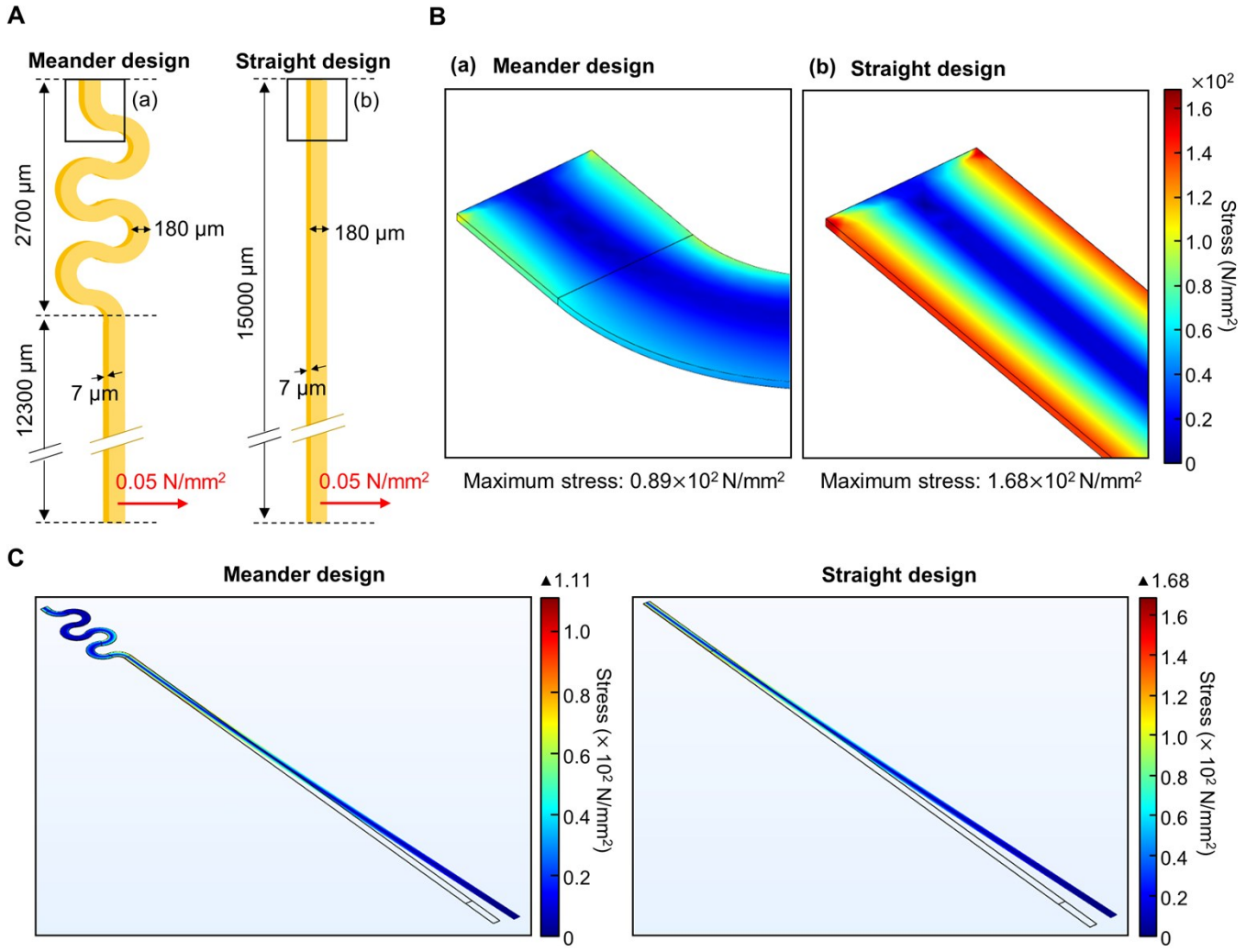

Fig. S4. Mechanical stress simulations of the ECoG electrode array. A) Geometry and design parameters of two types of legs (a, meander design, b, straight design). B) Comparison of stress distribution and maximum stress applied on connecting parts of the legs when the device is under a lateral pressure of 0.05 N/mm^2. C) Distribution of stress on the entire leg when the device moves with an applied lateral pressure of 0.05 N/mm^2 at the end of the electrode array

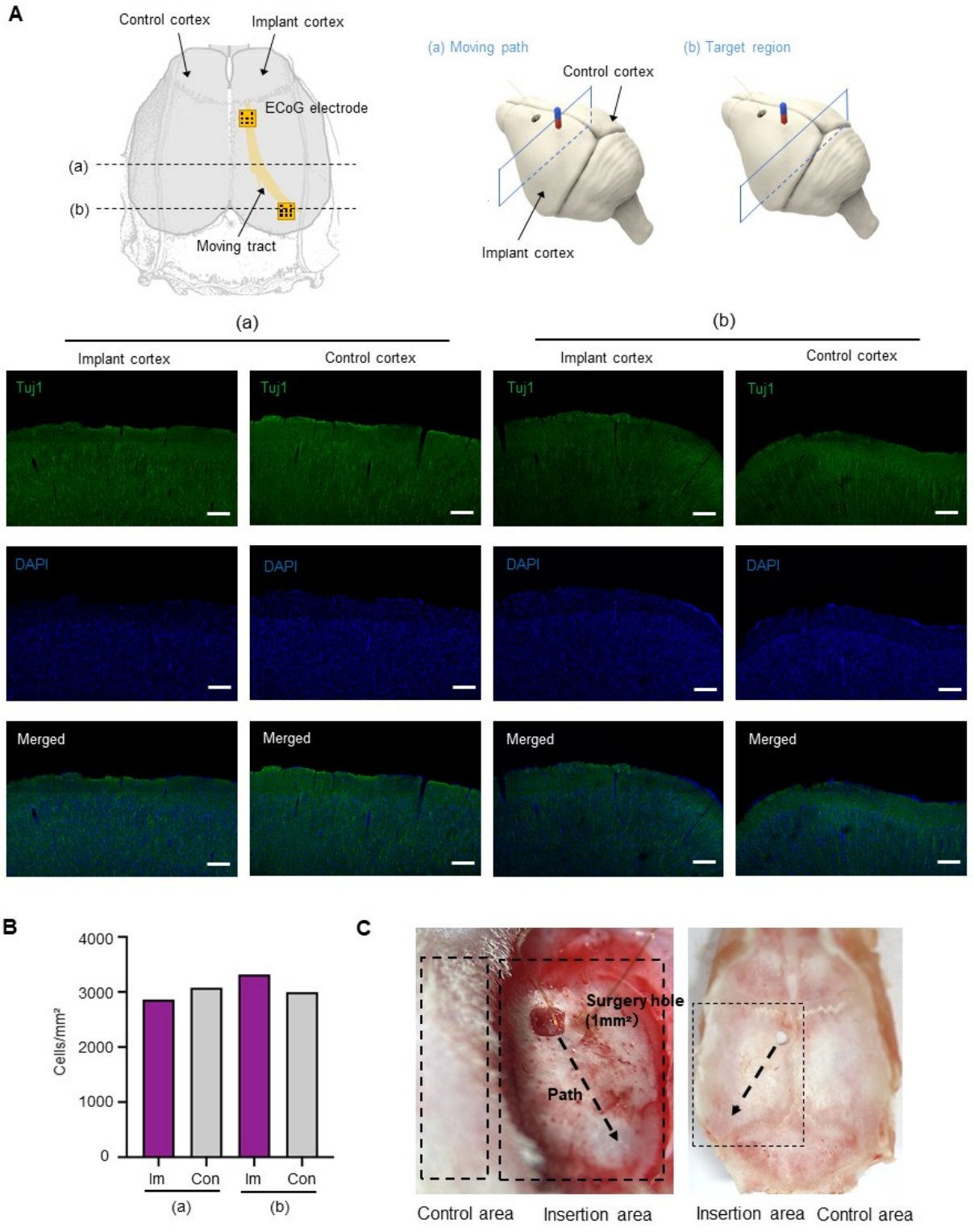

Fig. S5. Changes in cortical cytoarchitecture and mechanical damage from the device guiding process. A) Histological analysis of Tuj1-labeling (left) DAPI-labeling (middle) and merged (right) signal of coronal section image (a, Moving path: -3.0 to bregma, b, Target region: -6.0 to bregma, scale bar, 200 μm). B) Comparison of cell nuclei in moving path and target region. C) Skull damage confirmation of each condition in the guiding process (left: surgery process, right: the inner side of the skull after recording).

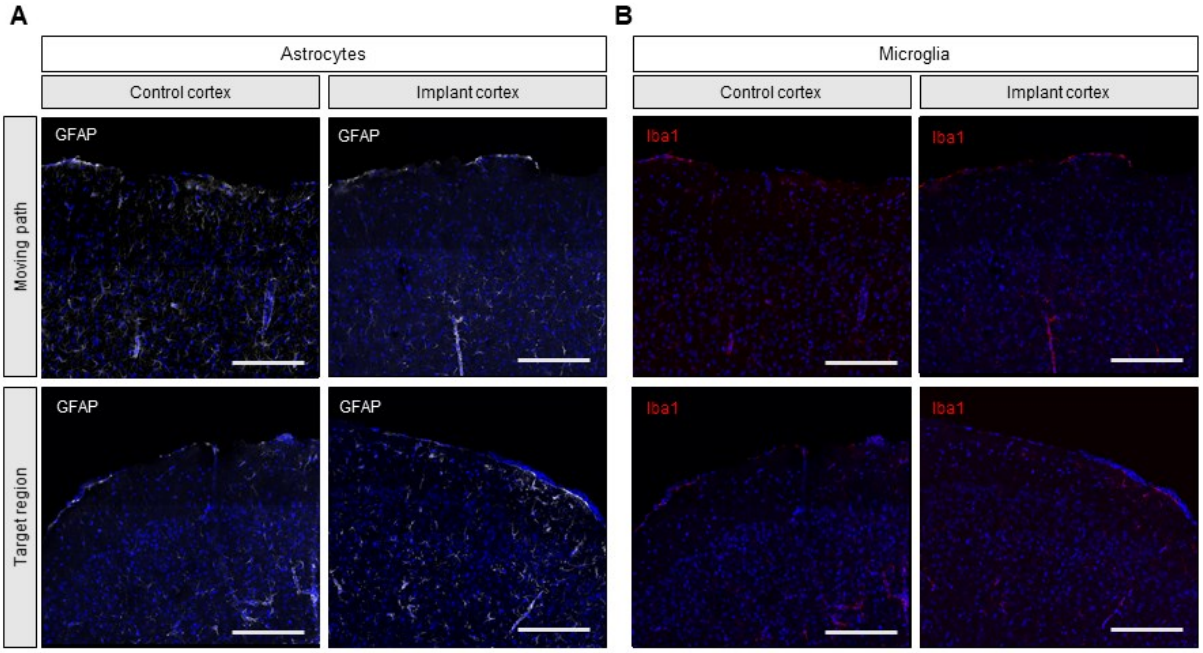

Fig. S6. Immune response of cortical layer after ECoG electrode implantation. Astrocyte reaction (GFAP-labeling, gray) and Microglia reaction (Ib1-labeling, red); comparison of the stained coronal section image, between insertion area and control area (Moving path: -3.0 to bregma, Target region: -6.0 to bregma, scale bar, 200 μm).

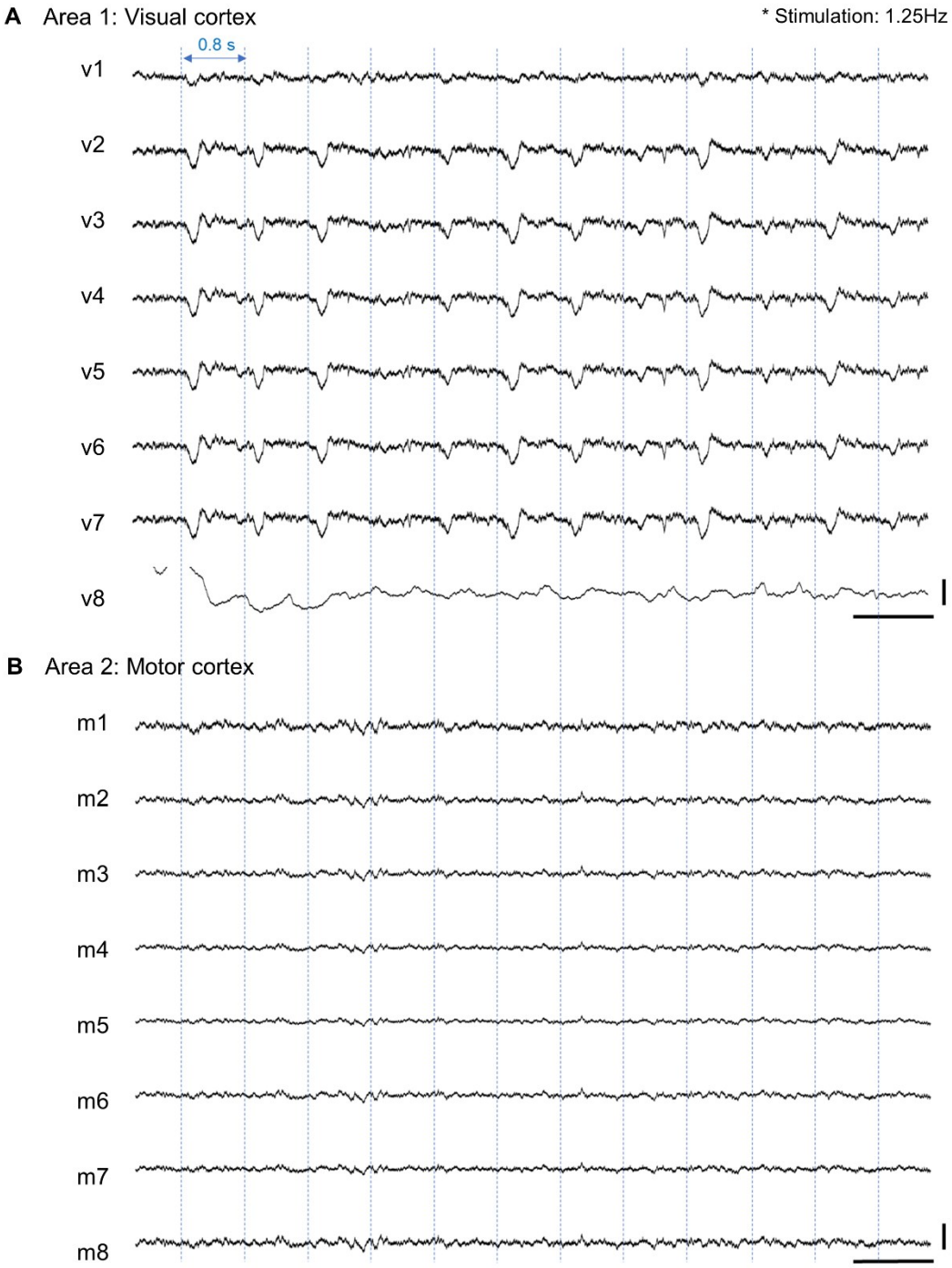

Fig. S7. Light stimulated raw ECoG signal of visual cortex and motor cortex. A) Stimulated signal of total channel positioned on visual cortex, a dotted line is light stimulation time (time interval; 0.8 s, scale bars: 500 μV, vertical, 1 s, horizontal). B) Signal of total channel positioned on motor cortex measured simultaneously (scale bars; 500 μV, vertical, 1 s, horizontal).

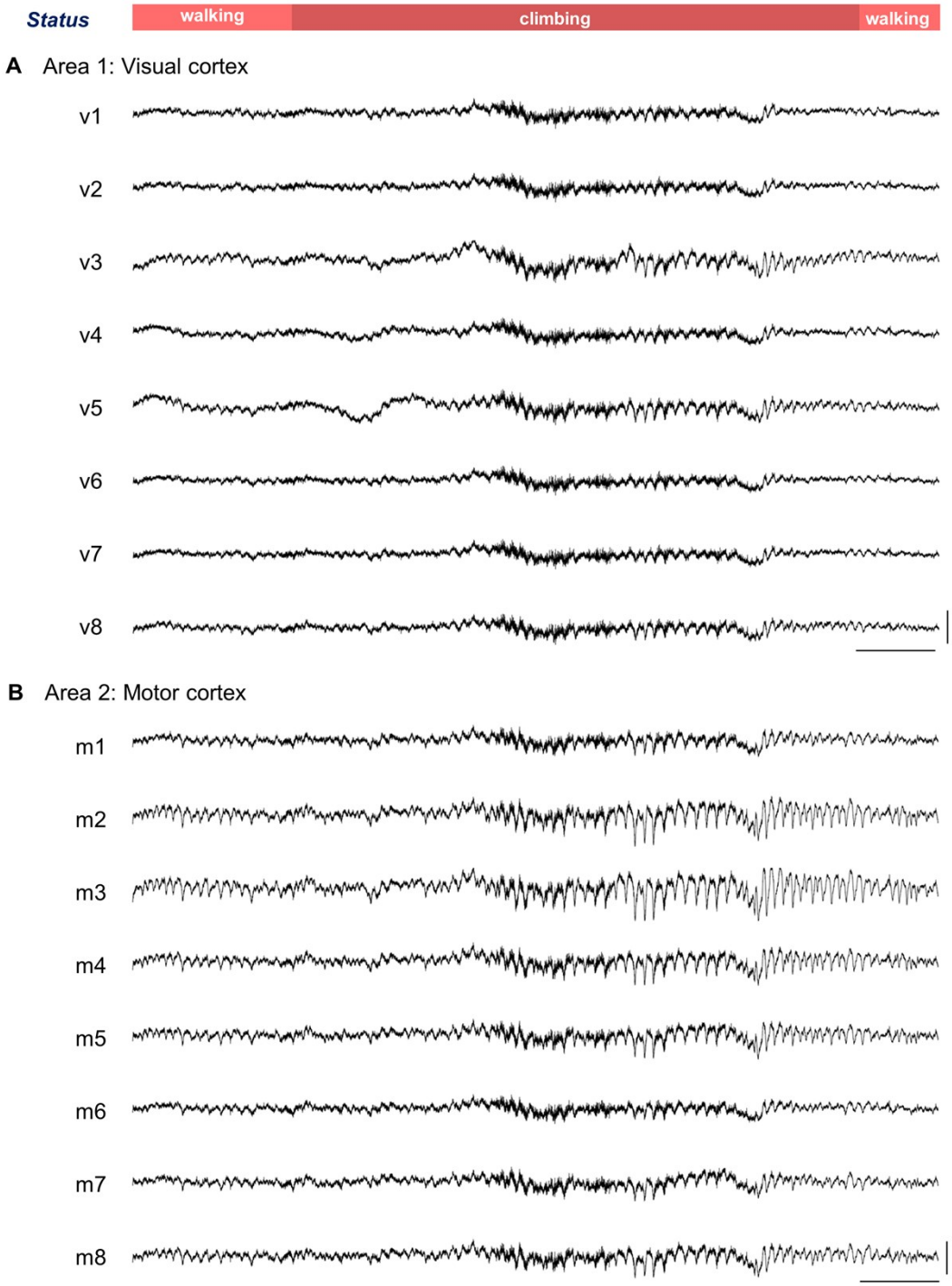

Fig. S8. Simultaneous recording of two regions of freely behaving rat on moving condition. A) Raw ECoG signal of total channel positioned on visual cortex (scale bars; 1000 μV, vertical, 1 s, horizontal). B) Raw ECoG signal of total channel positioned on motor cortex (scale bars; 1000 μV, vertical, 1 s, horizontal).

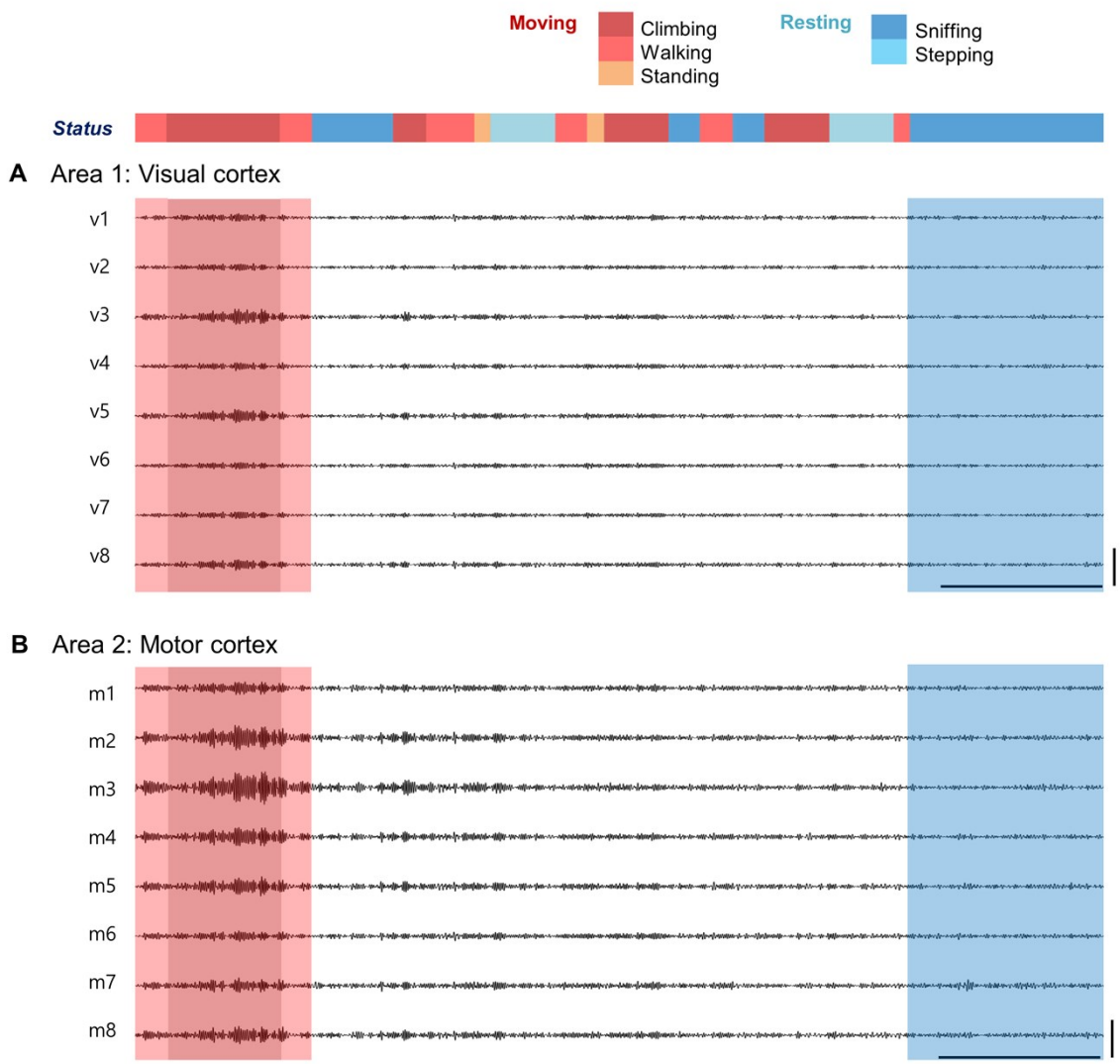

Fig. S9. Theta frequency LFP signal of freely behaving rats. A) Band-pass filtered traces of theta wave from visual cortex (scale bars; 1000 μV, vertical, 10 s, horizontal). B) Band-pass filtered traces of theta wave from motor cortex (scale bars; 1000 μV, vertical, 10 s, horizontal, color shading: red, moving, blue, resting).

Video S1 (separate file). Positioning of the flexible ECoG electrode array in target area using magnetic force (Speed reduced by 0.6 from the original).

Video S2 (separate file). Retrieve the magnet out from the skull (Speed reduced by 0.6 from the original).