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Actively Multiplexed µECoG Array Based on Thin-Film Electronics for High-Resolution Brain Mapping

H. Londoño-Ramírez[1, 2, 3*], X. Huang[1, 2], Jordi Cools[2,3], A. Chrzanowska[1,3], P. Coulson[1,2,3], C. Brunner[1,3], M. Ballini[2], N. Van Helleputte[2], C. Mora Lopez[2], J. Genoe[1,2], S. Haesler[1,2,3]

[1]KU Leuven, Leuven, Belgium;[2]Imec, Leuven, Belgium; [3]Neuro-Electronics Research Flanders, Leuven, Belgium

*Nerf, Kapeldreef 75, 3001 Leuven, Belgium. E-mail: horacio.londonoramirez@nerf.be

Introduction: Electrode arrays are used in neuroscience research and the clinic to record electrical activity from the surface of the brain. However, current passive electrocorticography (ECoG) technologies have low spatial resolution and/or limited cortex coverage. The electrode-count and density are restricted by the fact that each electrode must be individually wired. Here, we present an active µECoG that circumvents these challenges while achieving significantly lower noise compared to other existing active µECoG arrays.

Material, Methods and Results: The proposed neural interface consists of a flexible, actively-multiplexed 256-electrode array and an incremental-ΔΣ readout integrated circuit (ROIC) [1, 2]. The 1×1-cm^2 µECoG array is based on a metaloxide thin-film transistor technology on a 15-µm flexible foil, Fig.1(a), and is coupled to a 1.25×1.25-mm^2 CMOS ROIC fabricated in a 22-nm FDSOI process. Thanks to the 256:16 time-division multiplexing achieved in the electrode array, only 16 multiplexed channels are required to acquire signals from all the 256 electrodes simultaneously. The proposed system has been validated in-vivo by recording spontaneous activity and somatosensory-evoked potentials in anesthetized mice, Fig.1(b).

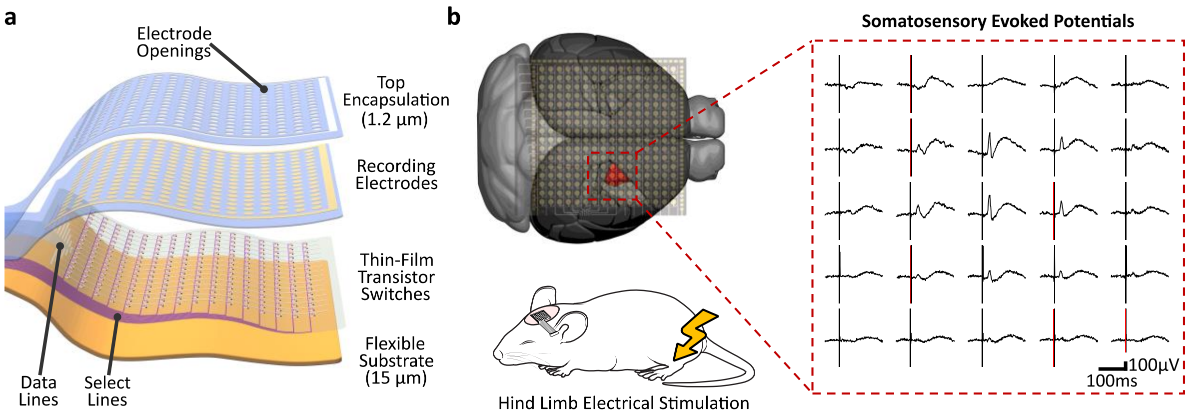

Figure 1. *Actively multiplexed µECoG array based on metaloxide thin-film transistors. a) Exploded-view illustration of the 256-electrode array, b) in vivo validation by recording somatosensory-evoked potentials.*

Discussion: By combining TFT multiplexing with newly proposed bulk-DAC feedback in the readout channel, we can integrate and address more electrodes than other passive arrays, achieve >10x less noise than existing active arrays, and obtain >2x effective channel area reduction in the ROIC, while maintaining comparable electrical performance over state-of-the-art ECoG readouts.

Significance: Our neuroelectronic interface platform overcomes the wiring bottle neck that limits many neural acquisition systems and has application potential as a tool for better mapping the cerebral cortex or as an enabling technology of future brain-machine interfaces.

References

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