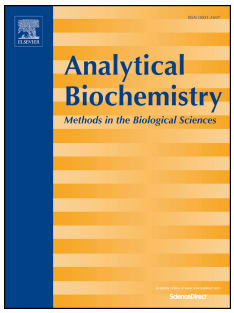
Accepted Manuscript



Bio-electrochemical microelectrode arrays for glutamate and electrophysiology detection in hippocampus of temporal lobe epileptic rats

Ziyue Li, Yilin Song, Guihua Xiao, Fei Gao, Shengwei Xu, Mixia Wang, Yu Zhang, Fengru Guo, Jie Liu, Yang Xia, Xinxia Cai

PII: S0003-2697(18)30316-6

DOI: 10.1016/j.ab.2018.04.023

Reference: YABIO 13003

To appear in: *Analytical Biochemistry*

Received Date: 24 March 2018

Revised Date: 21 April 2018

Accepted Date: 23 April 2018

Please cite this article as: Z. Li, Y. Song, G. Xiao, F. Gao, S. Xu, M. Wang, Y. Zhang, F. Guo, J. Liu, Y. Xia, X. Cai, Bio-electrochemical microelectrode arrays for glutamate and electrophysiology detection in hippocampus of temporal lobe epileptic rats, *Analytical Biochemistry* (2018), doi: 10.1016/j.ab.2018.04.023.

Bio-electrochemical Microelectrode Arrays for Glutamate and Electrophysiology Detection in hippocampus of Temporal Lobe Epileptic Rats

Ziyue Li [a,b], Yilin Song [a,b], Guihua Xiao [a,b], Fei Gao [a,b], Shengwei Xu [a,b], Mixia Wang [a,b], Yu Zhang [a,b], Fengru Guo [c], Jie Liu [c], Yang Xia [c], Xinxia Cai [a,b*]

[a] State Key Laboratory of Transducer Technology, Institute of Electronics, Chinese Academy of Sciences, Beijing 100190, China.
[b] University of Chinese Academy of Sciences, Beijing 10090, China.
[c] University of Electronic Science and Technology of China, Chengdu, 611731, China
*Corresponding Email: xxcai@mail.ie.ac.cn

Abstract

Temporal Lobe Epilepsy (TLE) is a chronic neurological disorder, characterized by sudden, repeated and transient central nervous system dysfunction. For better understanding of TLE, bio-nanomodified microelectrode arrays (MEA) are designed, for the achievement of high-quality simultaneous detection of glutamate signals (Glu) and multi-channel electrophysiological signals including action potentials (spikes) and local field potentials (LFPs). The MEA was fabricated by Micro-Electro-Mechanical System fabrication technology and all recording sites were modified with platinum black nano-particles, the average impedance decreased by nearly 90 times. Additionally, glutamate oxidase was also modified for the detection of Glu. The average sensitivity of the electrode in Glu solution was $1.999\pm0.032\times10^{-2}$ pA/μM·μm^2(n=3) and linearity was R=0.9986, with a good selectivity of 97.82% for glutamate and effective blocking of other interferents. In the in-vivo experiments, the MEA was subjected in hippocampus to electrophysiology and Glu concentration detection. During seizures, the fire rate of spikes increases, and the interspike interval is concentrated within 30ms. The amplitude of LFPs increases by 3 times and the power increases. The Glu level (4.22μM, n=4) was obviously higher than normal rats (2.24μM, n=4). The MEA probe provides an advanced tool for the detection of dual-mode signals in the research of neurological diseases.

Keywords: implantable microelectrode array, dual-mode detection, glutamate, electrophysiology, hippocampus CA1, temporal lobe epilepsy

1. Introduction

Epilepsy is one of the most important central nervous system disorder caused by abnormally high synchronizing discharges of the brain neurons. Epilepsy is a common chronic clinical syndrome in neurology, and approximately 1%~2% of people will have had one or more seizures during their life [1,2]. It is well recognized that approximately one-quarter of epilepsy is drug-resistant epilepsy, and temporal lobe epilepsy (TLE) is one of the commonest drug-resistant epilepsies [3]. TLE is characterized by recurrent seizures that originate from the hippocampus, amygdala or entorhinal cortex. Antiepileptic drugs and surgery are the traditional