micrux
CLINICAL

Application Notes

www.micruxfluidic.com

Separation and detection of neurotransmitters by ME-ED

empresa innovadora de base tecnológica reconocida por ANCES e!bt

Separation and detection of Neurotransmitters by ME-ED

» INTRODUCTION

Microfluidic electrophoresis chips offer several advantages in the separation of small molecules such as catecholamines, a group of neurotransmitters. Thus, the miniaturization of the electrophoretic process brings features such as low cost, high speed, high throughput, small sample and reagent requirements as well as integration and compactness.

In the same way, **electrochemical approaches** have demonstrated to be a very effective system for microfluidic devices. Electrochemical detection, besides the inherent miniaturization, provides portability, low cost, low power requirements, easy integration and high sensitivity.

Neurotransmitters and related compounds such as dopamine, epinephrine, norepinephrine or L-DOPA, have an important physiological role in the transmission of nerve impulses. Thus, for example, dopamine plays a critical role in the reward system, and its dysfunction is implicated in Parkinson's disease and schizophrenia. L-DOPA, a precursor of dopamine that crosses the blood–brain barrier, is used in the treatment of Parkinson's disease. So, analysis and control of neurotransmitters is of paramount importance in **neuroscience field**.

» EXPERIMENTAL

Samples: Catecholamaines standard solutions.

Injected sample: < 100 pL.

Instrumentation: MicruX® HVStat / iHVStat. Holder DC series.

Microfluidic devices: SU8/Pyrex microchips with integrated single electrodes or interdigitated array (IDA).

Conditioning: 0.1 M NaOH – 20 min
Deionized water – 15 min
Buffer solution – 10 min

» RESULTS

Microfluidic electrophoresis platform has been used in the separation and detection of *dopamine* (DA) and *L-DOPA* (dopamine precursor).

The platform enables the use of three- or four-electrode approaches.

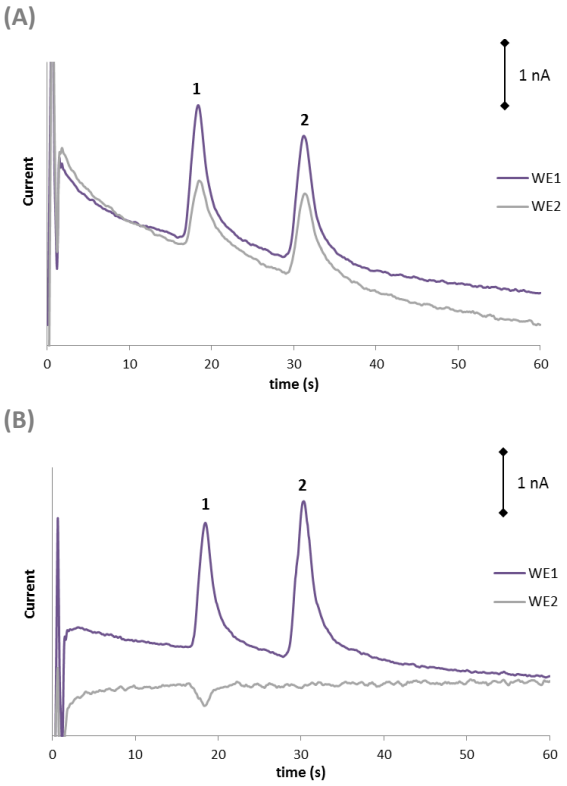

***Figure 1**. Electropherograms for a mixture of **(1)** DA 50 µM and **(2)** L-DOPA 100 µM carried out in a SU8/Pyrex microfluidic chip with integrated Pt IDA electrode. Conditions: V_{inj} = +0.75 kV, V_{sep} = +1.0 kV, t_{inj} = 5 s, E_d (WE1) = E_d (WE2) = +0.8 V **(A)**, E_d (WE1) = +0.8 V / E_d (WE2) = -0.1 V **(B)**, 20 mM MES pH = 6.0.*

The separation of the two compounds is accomplished in less than **40 s**. Moreover, the use of an *interdigitated array* (IDA) electrode detector improves the benefits of microfluidic systems. In this case, each set of microelectrodes can be potentiostated individually, so that two analytical signals can be simultaneously recorded.

Thus, when the two microelectrodes arrays are working at the same oxidation potential (***Figure 1A***) the addition of faradaic currents generated in both working electrodes is carried out, enhancing the analytical parameters.

The possibility of controlling individually each set of microelectrodes also allows the application of different detection potentials (***Figure 1B***) performing a redox cycling. Thus, the oxidation products of the analytes generated in the first microelectrode diffuse and become the source of the reaction at the adjacent electrode where reduction is performed. The use of redox cycling improves the selectivity and led to enhance the sensitivity (***Table 1***).

Therefore, IDA detectors could be used to perform two electrochemical measurements from the same sample. Moreover, it could be used for specific detection of compounds that show a reversible redox process in the same analysis.

Automated electrophoresis systems using microfluidic chips with integrated electrochemical detection bring a promising tool for the resolution of several analytical problems in neuroscience and other analytical fields.

Advances in microfluidic technologies are going to provide new features that enhance the analytical parameters demanded in most of the clinical applications.

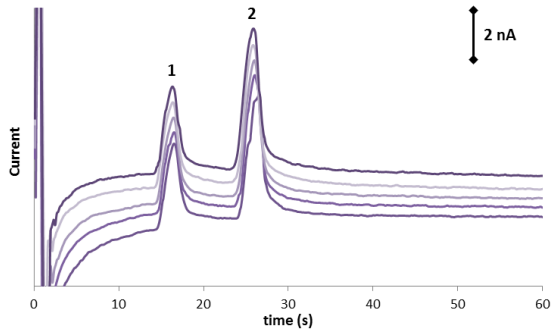

Figure 2. Successive electropherograms for a mixture of **(1)** DA 50 µM and **(2)** L-DOPA 100 µM carried out in a SU8/Pyrex microfluidic chip with integrated Pt electrode. Conditions: V_{inj} = +750 V, V_{sep} = +1000 V, t_{inj} = 5 s, E_d = +0.8 V (vs. Pt), 20 mM MES pH = 6.0.

Table 1. *Analytical parameters for a single-channel SU8/Pyrex microchip with integrated Pt electrode or interdigitated Pt microelectrode array*

	Single Pt Electrode		Pt IDA†		Pt IDA (redox)‡	
	DA	***L-DOPA***	***DA***	***L-DOPA***	***DA***	***L-DOPA***
» ***Precision - RSD (i_p)***	5%	2%	5%	2%	7%	4%
» ***Precision - RSD (t_m)***	1%	0.5%	0.5%	1%	0.5%	0.5%
» ***Lineal Range (µM)***	10 – 250	20 - 500	10 – 500	20 – 500	10 – 250	20 – 200
» ***Sensitivity (pA·µM^{-1})***	71	37	110	41	98	54
» ***LOD (µM)****	3	8	2	6	2	4
» ***Resolution - R_s***	1.1		1.0		0.9	
» ***Efficiency - N (m^{-1})***	10.000	20.000	15.000	33.000	16.000	37.000
» ***Noise (pA)***	100	100	<75	<75	<75	<75

†Pt IDA: data for WE1+WE2.
‡Pt IDA redox: data for WE1 with a redox cycling.
**Limit of detection considers a signal-to-noise ratio, S/N = 3.*
Conditions: 20mM MES, pH 6.0; V_{inj} = +750 V, t_{inj} = 3 s, V_{sep} = +1000 V. DA (50 µM), DOPA (100 µM).
Precision experiments: n = 10.

micrux
TECHNOLOGIES

Severo Ochoa Building · Floor -1 – Room 4 & 6
Julián Clavería s/n · 33006 · Oviedo (Asturias) · SPAIN

Phone/FAX: +34 984151019

E-mail: info@micruxfluidic.com
Web: www.micruxfluidic.com

Smart Microfluidic and Electrochemistry
olutions for Research Science