

Hand-Held Automated Instrument For Microchip Electrophoresis With Amperometric Detection

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INTRODUCTION

Microchips electrophoresis (ME) in combination with electrochemical detection (ED) can bring a new generation of point-of-care (POC) analysis systems in which would be integrated the main steps of an analytical process. However, the use of these miniaturized devices also requires the development of a new instrumentation in concordance with the features of ME-ED, specially, relative to miniaturization and portability.

Thus, a second-generation of a battery-powered portable electrophoresis instrument (iHVStat) for using microchips electrophoresis with electrochemical detection has been developed. The main unit of the instrument (150x165x95mm) consists of four-outputs high voltage power supply (HVPS) and a bipotentiostat (Bipot) with 2-channels for dual electrochemical detection. The use of an electrochemical transduction system simplifies the instrument developments, since non-optical elements are required.

Furthermore, a new reusable microfluidic platform has been also designed for using the microchips with the portable instrument. The platform with the ME-ED is directly inserted in the main unit of the instrument making easier the use of the complete system. It is controlled with a user-friendly PC software developed for microchip electrophoresis.

The performance of the electrophoresis platform has been evaluated using single- and dual-channel SU-8/Pyrex microchips with different models of integrated electrodes including microelectrode and interdigitated arrays. The successful performance of the complete system has been demonstrated in different analytical applications such as separation of neurotransmitters, chloro-phenols, purine-derivatives, vitamins, polyphenol acids and flavones.

MICROFLUIDIC ELECTROPHORESIS SYSTEM

MICROFLUIDIC PLATFORM

- Top part
- Bottom part
- Microchip
- Buffer reservoir
- Waste reservoir
- Sample reservoir
- Detection reservoir
- Dimensions: 100 x 65 x 15 mm (L x W x H)
- Integrated wells with standard fluidic parts
- Integrated Pt/HV electrodes
- Electrical contacts for HV and EC detection

MICRUX® iHVSTAT INSTRUMENT

- More Safety
- More Compact
- More Integrated
- Without cables
- Battery-powered (LiPo – 3300 mAh)
- Control PC software - Micrux® Manager v2.0
- Bluetooth® PC connection

Specifications:

- Dimensions: 165 x 150 x 95 mm (L x W x H)
- HVPS:
 - 1 channel/4 outputs
 - Max. output voltage: $\pm 3000V$
 - Max. output current: 0.34 mA
- BIPOT:
 - DC-potential range: $\pm 2.0 V$
 - Current range: 1 nA to $1 \mu A$
 - EC techniques: DC-AD & PAD

MICROFLUIDIC CHIPS – ELECTROCHEMICAL DETECTOR

SINGLE-CHANNEL SUB/PYREX MICROCHIPS

- ME1
- ME2
- Dimensions: 30 mm x 13 mm x 5 mm

ELECTROCHEMICAL DETECTORS

- Electrodes: 50/150 nm Titanium/platinum thin-film
- Microelectrode Array (MEA)
 - ME-SUB-PHD01T (ME1)
 - ME-AE: 150 μm
 - ME-SUB-PHD02T (ME2)
 - ME-AE: 100 μm
- Microelectrode Array (MEA)
 - ME-SUB-NEA-PHD04T (ME4)
 - ME-AE: 150 μm
 - ME-AE: 250 μm
- Interdigitated Array (IDA)
 - ME-SUB-IDA-PHD05T (ME5)
 - ME-AE: 250 μm
 - ME-AE: 250 μm
- Parallel dual-working electrode
 - ME-SUB-PHD03T (ME3)
 - ME-AE: 100 μm
 - ME-AE: 100 μm

DUAL-CHANNEL SUB/PYREX MICROCHIPS

- ME1
- ME2
- Dimensions: 30 mm x 13 mm x 5 mm

ANALYTICAL APPLICATIONS

NEUROTRANSMITTERS

- DA – Dopamine (50 μM)
- DDPA (100 μM)
- Buffer: 20 mM MES-NaOH pH 6.0
- ME1: $V_{app} = +750 V, t_{app} = 3 s$
- ME2: $V_{app} = +1000 V, t_{app} = 3 s$
- $E_{det} = +0.8 V$

phenols / purines / vitamins

- ME5 – Interdigitated Array
- EP – Epinephrine (50 μM)
- pAP – p-Aminophenol (50 μM)
- APAP – Acetaminophen (100 μM)
- UA – Uric Acid (125 μM)
- AA – Ascorbic Acid (250 μM)
- Buffer: 20 mM MES-NaOH pH 6.0
- ME1: $V_{app} = +750 V, t_{app} = 3 s$
- ME2: $V_{app} = +1000 V, t_{app} = 3 s$
- $E_{det} = +0.8 V$
- $E_{det} = -0.25 V$

FLAVONES / POLYPHENOLIC ACIDS

- ME5 – Interdigitated Array
- Flavones: Rutin + Quercetin (50 μM)
- RA – Rosmarinic Acid (100 μM)
- CA – Caffeic Acid (100 μM)
- GA – Gallic Acid (100 μM)
- Buffer: 20 mM MES-NaOH pH 5.0
- $V_{app} = +850 V, t_{app} = 5 s$
- $V_{app} = +900 V, t_{app} = 5 s$
- $E_{det} = +0.8 V$
- $E_{det} = -0.25 V$

CONCLUSIONS

- A more compact, robust and easy-to-use instrument was achieved in the second-generation of automated microfluidic electrophoresis system.
- The new microfluidic system enables the use of a wide variety of single- and dual-channel microchips electrophoresis with integrated electrodes.
- The automated analytical system is going to bring the use of microfluidic chips more routine in research laboratories and industry for "in-situ" analysis of diverse matrices, including clinical, environmental and food samples.

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ACKNOWLEDGEMENTS:

