Electronic Supplementary Material (ESI) for Analytical Methods.

Supporting Information for:

A fully disposable paper-based electrophoresis microchip with integrated pencil-drawn electrodes for contactless conductivity detection

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Experimental

1. Chemicals

All chemicals were used without further purification, in analytical grade, and purchased from Sigma-Aldrich, St. Louis, Missouri, USA. The artificial serum was purchased from Doles Reagents (Goiânia, GO, Brazil).

2. Instrumentation for Electrophoresis and Contactless Conductivity Detection

For the experiments with paper-based microchip, it was used a bipolar two-channel high voltage sequencer from eDAQ (model ER230, Denistone East, NSW, Australia) and a labmade system developed based on the electronics described by da Silva and co-workers.[1] A function generator (model GV-2002, ICEL, Manaus, Brazil) was used to apply the high-frequency sinusoidal wave. The measured current was converted to voltage, rectified, filtered, amplified, and monitored using an A/D interface (model NI USB-6009) from National Instruments. The data acquisition was performed with 1ms of resolution by using a software written in LabVIEW^{TM} v. 2010.

Experiments of zone electrophoresis on glass microchips were performed using a Quad HV microchip electrophoresis system (model ER455) supplied by eDAQ (Denistone East, NSW, Australia). The system comprises two high-voltage sequencers model ER230 and a C^4D model ER225. This system is coupled with microfluidic platform model ET-225 (Micronit Microfluids Enschede, Netherlands). Electrophoretic separations were performed using commercial glass microchips model ET190 with integrated sensing electrodes from Micronit Microfluids (Enschede, Netherlands). Glass microchips comprise two channels (100 µm width × 10 µm depth) arranged in double-T geometry with gap of 100 µm and the electrophoresis chip consisted of a 40 mm long separation channel, 0.7 cm long side arms and effective length equal to 33 mm. Two parallel electrodes measuring 200 µm wide × 500 µm long × 200 nm thick spaced by 250 µm were used for C^4D

measurements. PowerChrom software (version 2.7.9) was used for the acquisition, display, and analysis of electropherograms. All the sequences of high voltages were controlled using either the eDAQ Sequencer software (version 1.3.3).

3. Results

3.1 Ohm plot

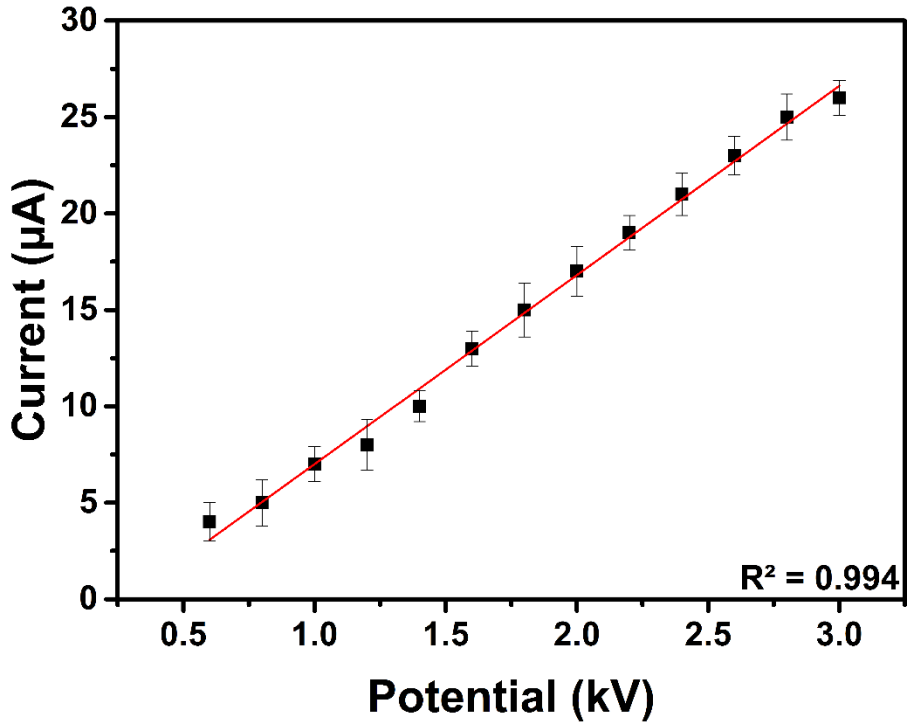

Figure S1. Plot of current versus voltage for paper-based microchannels filled with running buffer composed of MES/His (20 mM, each), pH 6.1.

3.2. Evaluation of different electrode arrangements and injection-to-injection repeatability

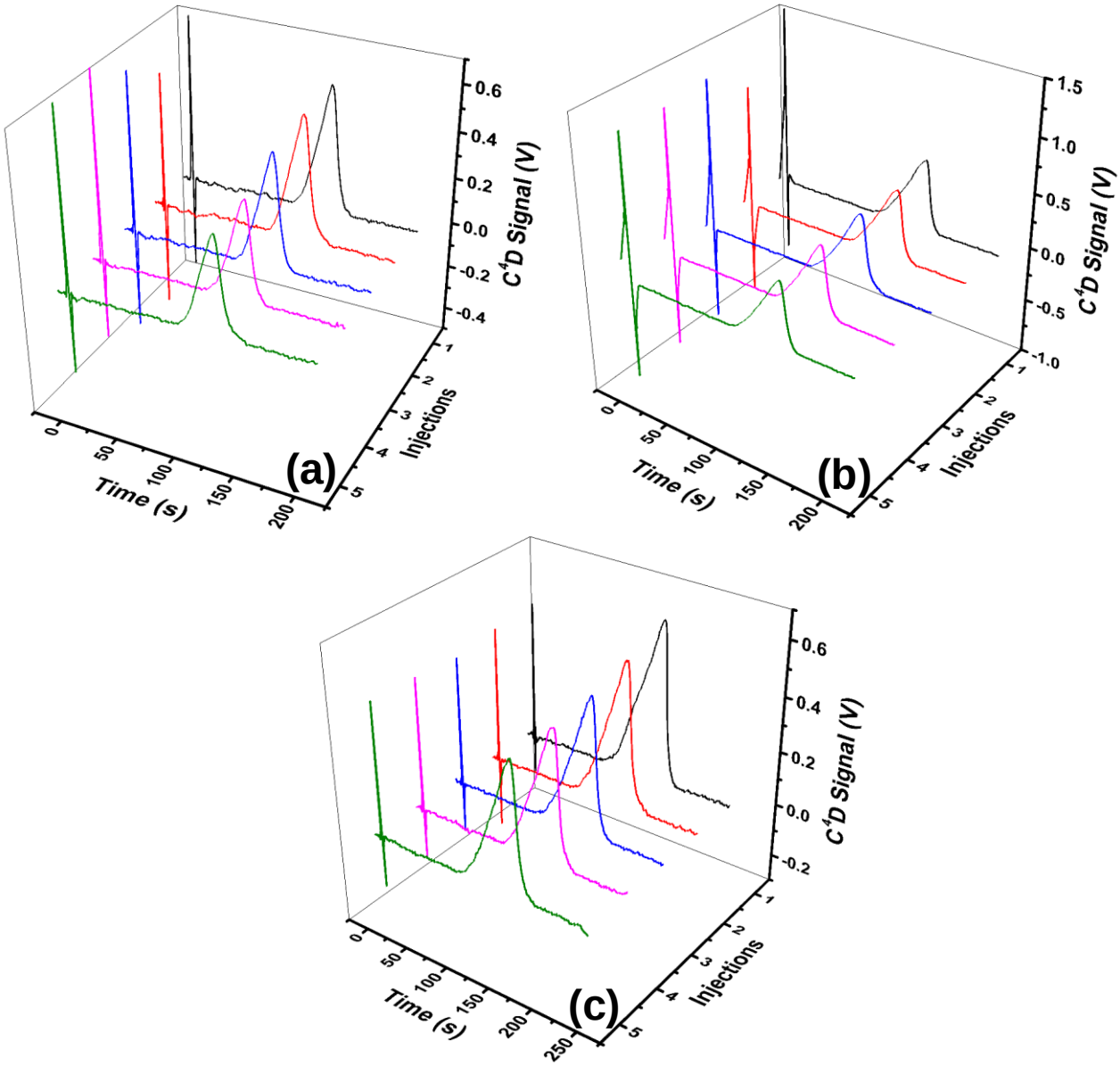

Figure S2. Electropherograms showing five consecutive injections of a standard solution containing 500 µmol L^{-1} Na^{+} for electrode cell attached on (a) top, (b) bottom, and (c) top-bottom sides.

Table S1. Comparison of the analytical performance for the different electrodes arrangements (n = 5).

Electrode Arrangement	Intensity (V)	Area (V.s)	Migration Time (s)	Efficiency ($N.m^{-1}$)	Asymmetry
Top	0.48 ± 0.06	9.89 ± 1.24	134.2 ± 1.6	3959 ± 167	0.52 ± 0.04
Bottom	0.62 ± 0.03	16.64 ± 1.05	153.6 ± 2.1	9161 ± 419	0.30 ± 0.02
Top-Bottom	0.52 ± 0.04	17.93 ± 1.80	167.8 ± 1.0	3871 ± 300	0.25 ± 0.02

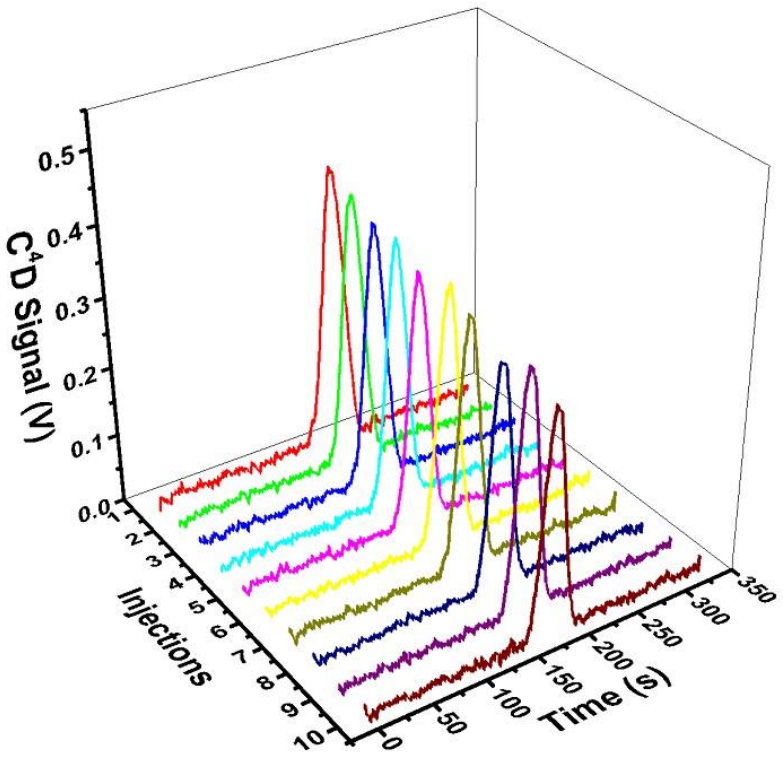

Figure S3. Electropherograms of ten consecutive injections for a Na^+ standard solution (250 µmol L^{-1}).

3.3. Analytical Curves

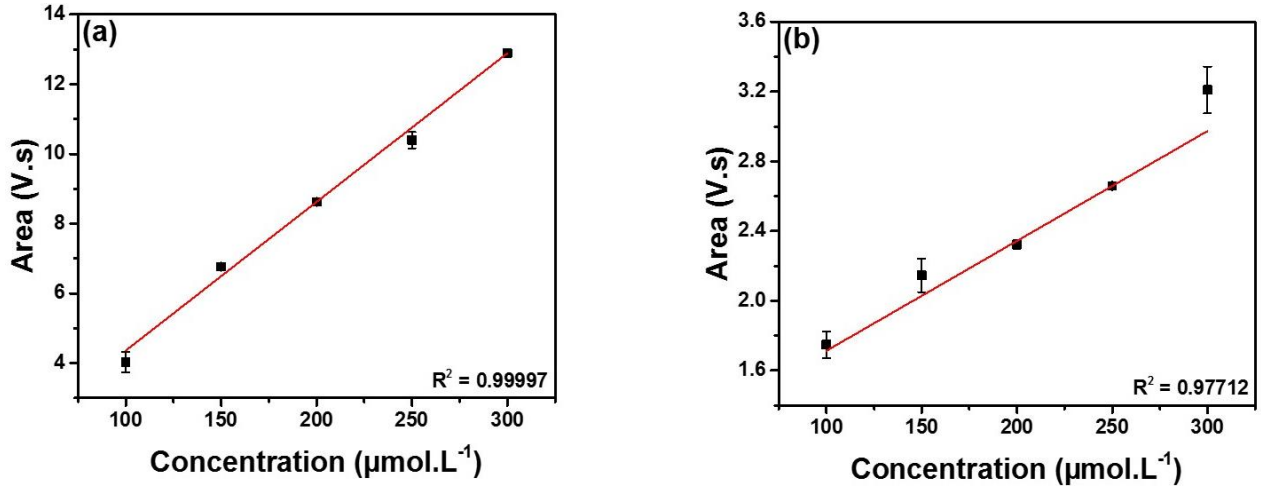

Figure S4. Calibration curves for (a) BSA and (b) creatinine on paper-based electrophoresis microchips.

3.4. Detection of BSA and creatinine in artificial serum samples

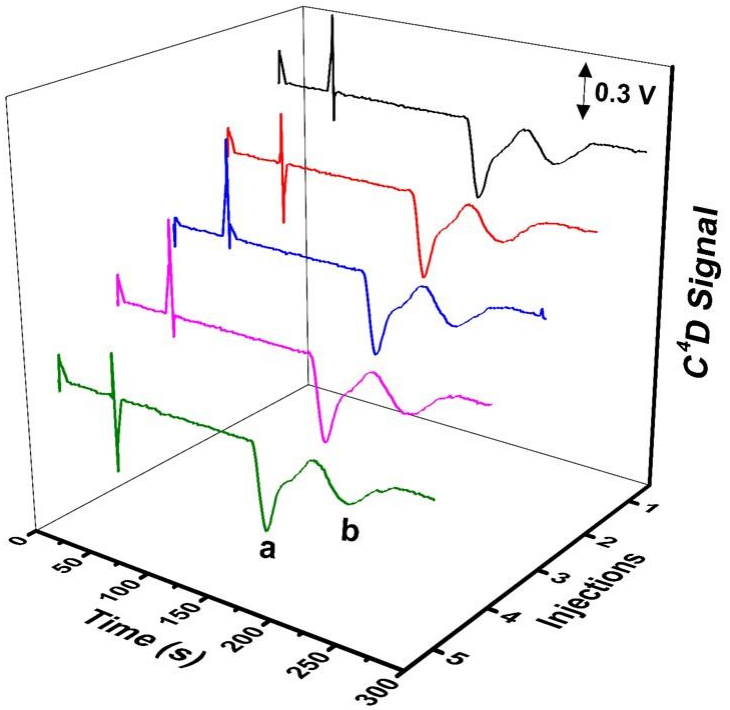

Figure S5. Electropherograms showing five analysis of (a) BSA and (b) creatinine in artificial serum sample using paper-based electrophoresis microchips.

Table S2. Chemical composition of artificial serum sample.

Analyte	Average Concentration
Uric Acid	4.08 mg/dL
Albumin	2.06 g/dL
Alanine aminotransferase / Glutamic-pyruvate transaminase	55 IU/L
Amylase	234 U/dL
Aspartate aminotransferase/Glutamic-oxaloacetic transaminase	63 IU/L
Billirubin	0.79 mg/dL
Calcium	8.96 mg/dL
Total Iron Binding Capacity	228 µg/dL
Chloride	91 mmol/L
Total Cholesterol	125 mg/dL
HDL Cholesterol	64 mg/dL
LDL Cholesterol	39 mg/dL
Creatinine	1.04 mg/dL
Lactate dehydrogenase	260 IU/L
Iron	84 µg/dL
Alkaline Phosphatase	144 U/L
Phosphate	3.71 mg/dL
γ-glutamiltranspeptidase	56 IU/L
Glucose	90 mg/dL
Magnesium	1.62 mg/dL
Potassium	3.46 mmol/L
Total protein	3.69 g/dL
Triglycerides	89 mg/dL
Urea	33 mg/dL

3.5. Detection of BSA and creatinine on commercial glass electrophoresis chips

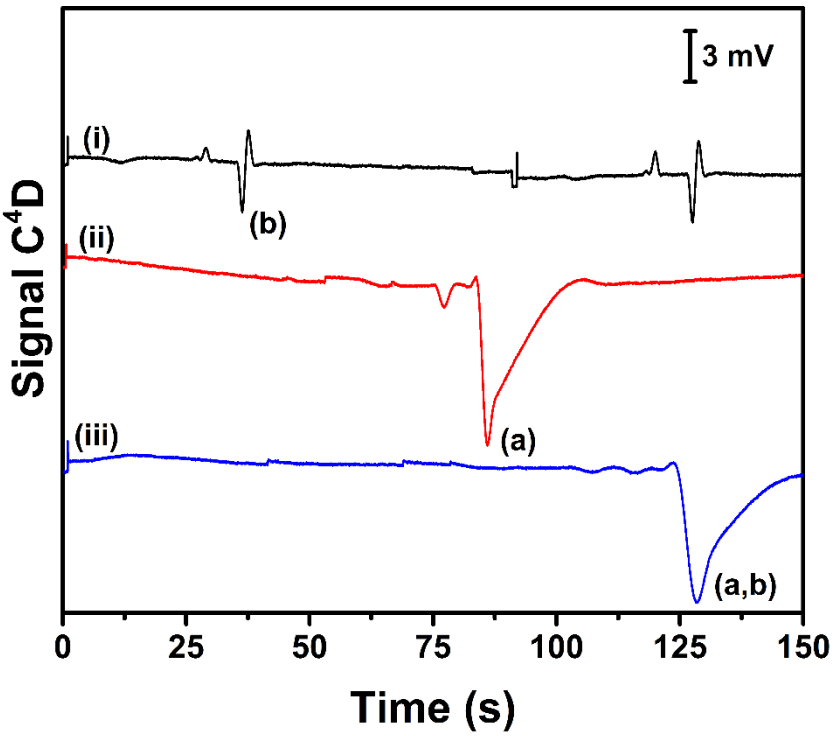

Figure S6. Electropherograms showing the individual analysis of (a) BSA and (b) creatinine solutions as well as a mixture of both analytes on commercial glass electrophoresis devices.

4. References

(1) da Silva, J. A. F.; Guzman, N.; do Lago, C. L. *J. Chromatogr. A* **2002**, *942*, 249-258.