

A New Conductivity Detector for Capillary Electrophoresis

Zuan Guang CHEN^{1,2*}, Jin Yuan MO², Tian Yao XIE², Li Shi WANG²,
Xiao Yun YANG², Kong ZHANG³, Min Sheng ZHANG¹

¹Department of Chemistry, Sun Yat-sen University of Medical Sciences, Guangzhou 510089

²College of Chemistry and Chemical Engineering, Zhongshan University, Guangzhou 510275

³First Attached Hospital, Sun Yat-sen University of Medical Sciences, Guangzhou 510080

Abstract: A new conductivity detector for capillary electrophoresis consisting of an electrochemical cell and a conductive meter was developed. In the cell, the microelectrode and capillary were inserted through the cell wall and fixed by screws and sealing ring, the ends of microelectrode and capillary were located by a guide with two cross holes. LOD for K⁺ was 1.5×10^{-5} mol/L.

Keywords: Capillary electrophoresis, conductivity detector.

Introduction

High performance capillary electrophoresis (HPCE) is a new analytical technique and has been applied in various fields. In the detection modes for HPCE, conductivity detection is a rather universal one, including on-column¹, end-column² and suppressed conductivity³ detection. In the first two, there is a yielded potential between two conductive electrodes, which is interfered by the separation voltage. The yielded potential may easily destroy the general conductivity meter. For the detector with suppressor, it is difficult in manufacture and its dead volume is increased.

In this work, a new end-column conductivity detector was designed. The detector has eliminated the yielded potential between conductive electrodes. It is convenient in installation of electrodes and capillary.

Experimental

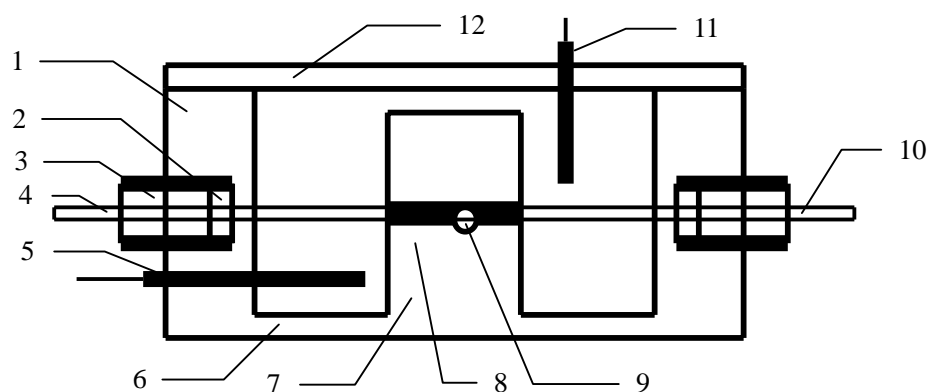
Instruments and Reagents

High voltage source has been described in former report⁴. Fused-silica capillary (100 μ m-inner diameter) was obtained from Yongnian Optical Fiber Factory, Hebei. Data working station (CES 98) was made by College of Chemistry and Chemical Engineering of Zhongshan University, Guangzhou, China. Tris(hydroxymethyl)aminomethane (abbreviation tris) and boric acid were of AR grade. All solutions were prepared in re-distilled water.

Electrochemical cell

The structure of electrochemical cell is given in **Figure 1**. The cell was made by organic glass or plastic, in which the micro-electrode and capillary were inserted through the cell wall and fixed by screws and sealing rings. The ends of micro-electrode and capillary were located by a guide with two cross holes. The micro-electrode was used as one of conductivity electrodes, pairing electrode (the other conductivity electrode) and ground electrode of high voltage source were placed or fixed in the cell.

Figure 1 Structure of electrochemical cell



1.cell wall, 2.sealing rings, 3.screws, 4.capillary, 5.ground electrode, 6.organic glass body, 7.guide, 8.hole A, 9.hole B, 10. micro-electrode, 11.pairing electrode, 12.cover

Micro-electrode

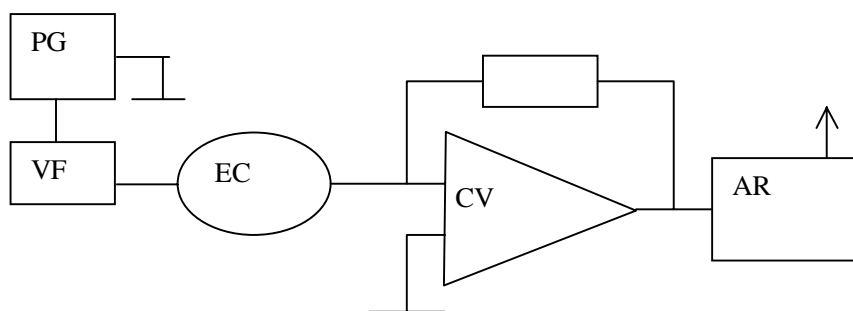
Micro-electrode was made from platinum. The platinum wire of $80\ \mu\text{m}$ diameter was inserted into a silica capillary of $150\ \mu\text{m}$ -id and $360\ \mu\text{m}$ -od (same as the outer diameter of separation capillary), then sealed by resin. It was better to cover the electrode with a metal tube to protect it.

Conductivity meter

Figure 2 is the basic electronic circuit of conductivity meter which consisted of pulse generator (PG), voltage follower (VF), current-voltage transformer (CV) and absolute rectifier (AR). The pulse frequency of pulse generator was set at 1000 Hz.

Testing condition

The length of capillary was 70 cm ($100\ \mu\text{m}$ -id), buffer was Tris- H_3BO_3 (10.0:10.0 mmol/L). The sample was 0.1mmol/L of KNO_3 and NaCl in buffer. The sample was introduced by gravitation at 20 cm height for 10.0 seconds, separated at 18.0 kV and detected by the conductivity meter.

Figure 2 Basic electronic circuit of conductivity meter

PG: pulse generator, VF: voltage follower, CV: c-v transformer,
EC: electrochemical cell, AR: absolute rectifier

Results and Discussion

Analysis of mixed inorganic ions

The mixture solution of K^+ , Na^+ , NO_3^- and Cl^- was determined. The limits of detection were 1.5×10^{-5} , 2.0×10^{-5} , 2.5×10^{-4} and 1.0×10^{-4} mol/L for K^+ , Na^+ , NO_3^- and Cl^- , respectively. The linear concentration for the ions ranged over three orders of magnitude.

Position of each electrode in electrochemical cell

It was found that the relative position of the pairing electrode and ground electrode in the cell affected the ratio of signal to noise remarkably. The reason may be that there is a strong electric field in the interval between outlet of capillary and ground electrode, when the pairing electrode was placed close to this interval, a potential was yielded between the micro-electrode and pairing electrode, which was affected by the separation voltage. When the two electrodes were placed in opposite sides of the outlet of capillary, the yielded potential was zero, the best ratio of signal to noise was obtained.

Conclusion

In the electrochemical cell of this detector, locating the micro-electrode at the capillary outlet was very easy and convenient. The micro-electrode was not broken in installation and operation. The yielded potential between conductivity electrodes was eliminated, which would be suitable to most conductivity meters.

Acknowledgments

This research was supported partially by the National Natural Science Foundation of China (Grant No.29675033). We also thank engineer Hexian SITU for his help.

References

1. X. Huang, T. Pang, M. J. Gordon, R. N. Zare, *Anal. Chem.*, **1987**, *59*, 44.
2. X. Huang, T. Pang, M. J. Gordon, R. N. Zare, *Anal. Chem.*, **1991**, *63*, 189.
3. N. Avdalovic, C. A. Pohl, R. D. Rocklin, J. R. Stillian, *Anal. Chem.*, **1993**, *65*, 1470.
4. Z.G. Chen, J.Y. Mo, X.Y. Yang, L.S. Wang, X.T. Mei, M.S. Zhang, *Chin. Chem. Lett.*, **1999**, *10*(3), 231.

Received 13 October 1999

Revised 2 February 2000