The Application of Polyester Microchip to Capillary Electrophoresis

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Inexpensive disposable polyester microchip was fabricated through well-known photolithographic and wet-chemical etching procedure. Laboratory-scale laser induced fluorescence equipment was employed in this work to evaluate the separation performance of the polyester chip by using two laser dyes as samples. The polyester chip exhibited much higher separation efficiency than traditional fused silica capillary under the same miceller electrokinetic chromatographic condition.

Miniaturization of analytical separation setup has attracted much attention in the last decade because of its well-known advantages—high efficiency, time effectiveness and cost performance. Though microchip capillary electrophoresis (CE) has undergone rapid development within a very short time, it is still considered to be in its developing stage. A number of problems such as the choice of support materials, injection and detection of sample components, etc. have been inevitably encountered during its development. Furthermore, these problems are assumed to hinder further progress in this field thereby rendering many areas unexplored.

Recently inexpensive disposal polymer microchip is becoming another charming research field. We have developed a method capable of fabricating a polymer chip at typical laboratory level, which can save time and cost.[1] This work is the first report using unsaturated polyester co-polymerized with styrene as a polyester microchip for electrophoresis. The preparation of polyester microchip was performed through photolithographic and wet-chemical etching procedure, and followed by duplication. A serpentine channel design (Figure 1) was transferred to form a positive surface relief on a glass plate. From this glass plate with convex channel, the polyester microchip was duplicated (~15 µm in depth and ~100 µm in width). The microscopic uniformity of the convex channel on the glass plate and the channel on the polyester microchip was examined by scanning electron microscopy (SEM).

Laser induced fluorescence (LIF) method was employed for the detection in this work. A He/Ne laser was used to generate an excitation light of 543 nm which was modulated by a mechanical chopper (~800 Hz) and then was focused by a lens, and reflected by a mirror onto the polyester microchip. The fluorescence was collected by an optical fiber, and transferred into an electric signal which was then magnified by a photo multiplier tube. The signal was then input to a lock-in amplifier (NF Circuit Design Block Co. Ltd., Japan). The electropherogram was obtained using an integrator (Chromatopac CR-4A of Shimadzu Co. Ltd., Kyoto, Japan). The polyester microchip was evaluated by the separation of two fluorescence laser dyes (Sulforhodamine B and 101, Kanto Chemicals Co. Ltd., Japan). The samples with the concentration of ~1 × 10^{-4} M in 50 mM borate buffer solution were injected by applying –300 V to the sample waste reservoir with the other three reservoirs electrically grounded. In the separation mode, −7.0 kV was applied to the waste reservoir while the voltages at the sample and sample waste reservoirs were kept at –300 V, respectively. The injection method could avoid sample leakage from the side channels to the separation channel.[2] The separation was performed at room temperature under the electric field of 200 V/cm by employing 10 mM boric acid–sodium chloride / sodium hydroxide containing 12 mM sodium dodecyl sulfate (SDS) as a running buffer at pH 8.1. To make a comparison, the separation was also carried out under the same condition by using a fused silica capillary tube (the inner diameter was 50 µm) having the same separation length with the microchannel. Figure 2 showed the electropherogram of sulforhodamine B and 101 by miceller electrokinetic chromatography (MEKC) using the fused silica capillary tube and the polyester chip. The peak identification was made by injecting a mixture of samples spiked with sulforhodamine B. It was noticed that the signal/noise (S/N) ratio in Figure 2B is bigger than that in Figure 2A, which was ascribable to the LIF detection system we used in this experiment. The data from the polyester chip was compared with that from the fused silica capillary tube in Table 1. The column efficiency obtained by the polyester chip, which was expressed as a theoretical plate number, was three times greater than that of the fused silica tube, consequently

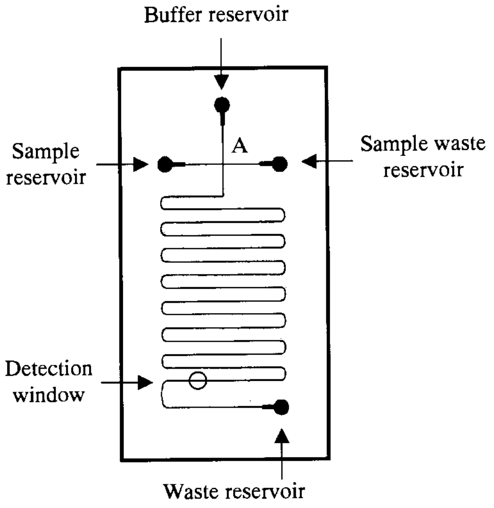

Figure 1. Design of microchannel. The length from buffer reservoir to waste reservoir was 35 cm, from cross section A to detection point was 32 cm, and from sample reservoir to sample waste reservoir was 2 cm. The height and the width of the channel was about 15 µm and 100 µm, respectively.

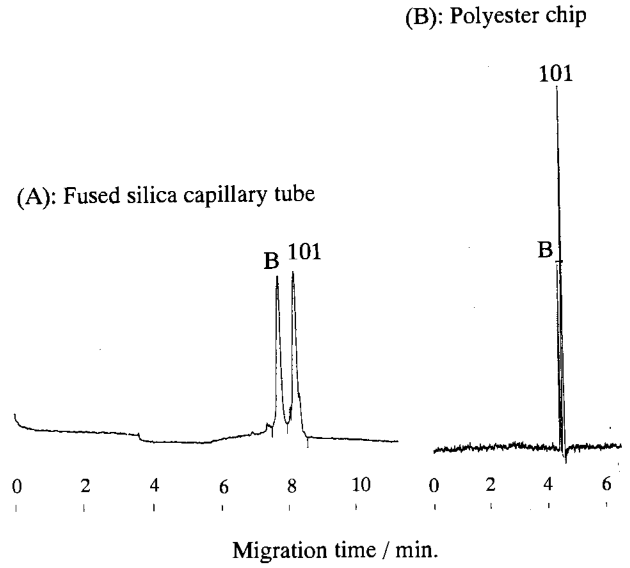

Figure 2. Electropherograms of separation of sulforhodamine B and 101 using 10 mM H_3BO_3-NaCl / NaOH containing 12 mM SDS as running buffer at pH 8.1 under the electric field of 200 V/cm. Different peak heights in Fig.2B resulted from the different fluorescence strength of the two samples induced by the laser of 543 nm.

resulting in a better separation performance—faster analysis speed and better resolution.

Table 1. Comparison of polyester chip with fused silica capillary tube

	Fused silica tube	Polyester chip
Total channel length	50 cm	35 cm
Effective channel length	32 cm	32 cm
Electric field	200 V/cm	200 V/cm
Inner diameter	50 μm	-
Channel width	-	100 μm
Channel height	-	15 μm
Detection	UV (215 nm)	LIF (543 nm)
Plate number	3.342×10^4/m	1.392×10^5/m
Migration time	8.204 min.	4.609 min.
Resolution	1.523	1.992

Running buffer: 10 mM H_3BO_3-NaCl / NaOH containing 12 mM SDS at pH 8.1.

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