CE-AD기반의 Microfluidic chip을 이용한 Simazine과 Atrazine 그리고 Ametryn Herbicides 의 검출

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Detection of Simazine, Atrazine and Ametryn Herbicides on a Microfluidic Chip Based on CE-AD

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Abstract - A simple and rapid capillary electrophoresis method was developed for the quantitative analysis of common triazine herbicides. Cyclic voltammetry was employed to clarify the detection voltage which showed characteristic irreversible cathodic peaks. For the analysis, the mixture of triazine herbicides was applied in a microfluidic chip to determine the CE-separated peaks. Soil sample extracts were analyzed directly after drying and redissolution with the supporting electrolyte but without other pretreatment. The results were comparable to those obtained by HPLC with UV detection. Therefore, this method can be used in the rapid determination of pesticide/herbicide residues.

1. Introduction

Triazines are important herbicides used in weed control. They are ubiquitous environmental pollutants in soil and water. Their use has caused great concern because of their mobility and solubility in water and they strongly sorb onto soil [1]. Triazines and their degradation products are toxic and persistent in water, soil and organisms. Moreover, atrazine is a member of the triazine family and has been classified as human carcinogen [2].

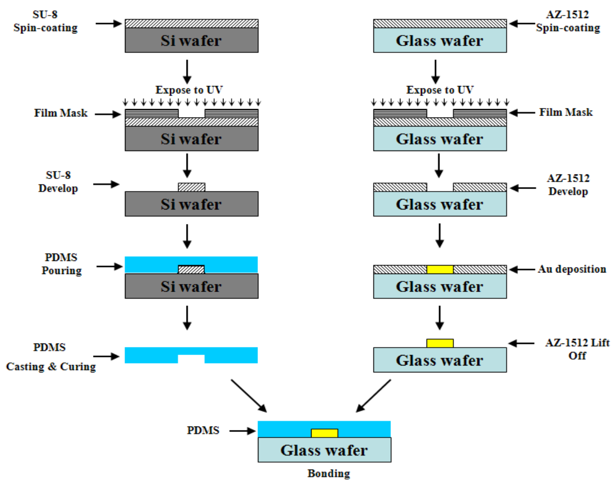
Analysis of pesticides is generally carried out by gas chromatography (GC) [3] or liquid chromatography (LC) coupled to different detectors, especially to mass spectrometer (MS) [4,5]. These procedures are tedious, time consuming and expensive. However, alternative and/or complementary methods, using capillary electrophoresis (CE), have emerged recently [6,7]. The prospects for CE in pesticide analysis are very promising because of its advantages, such as higher separation efficiency, shorter analysis times and very small consumption of expensive reagents and toxic solvents. In addition, its capability to conduct analysis in a miniaturized format (microchip technology) is interesting for the routine analysis of samples containing hazardous pesticides [8].

In this paper, we demonstrated an application of capillary electrophoresis-amperometric detection on a microfluidic chip to detect three triazine herbicides: simazine, atrazine and ametryn.

2. Experimental

2.1 Fabrication of the chip

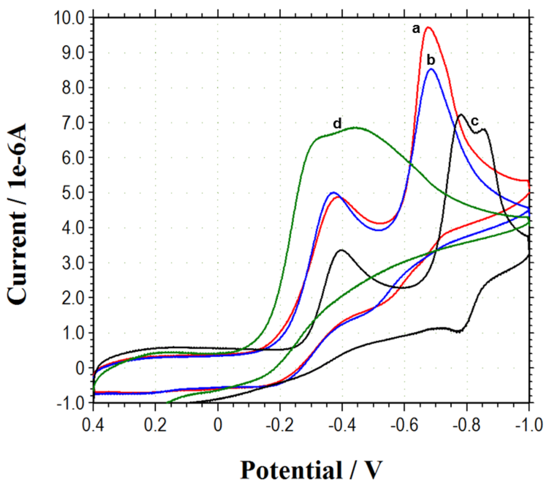
In this study, Microfluidic channels were fabricated in PDMS using soft lithography [9,10]. As masters, we patterned epoxy-based photoresist (SU8) on silicon wafers using conventional photolithography. Channels were typically 200 µm in diameter. PDMS prepolymer was cast on silicon masters and cured thermally (65℃). The PDMS layer containing microfluidic channels was peeled away from the silicon wafer, and inlet and outlet holes were drilled. Au/Ti electrodes were deposited by thermal evaporation. Ti layer was used to enhance adsorption of Au electrodes on the glass. The layer of PDMS containing microfluidic channels was oxidized by UV-Ozone and sealed irreversibly to a glass slide (Fig. 1)



<Fig 1> Fabrication process for Microchip.

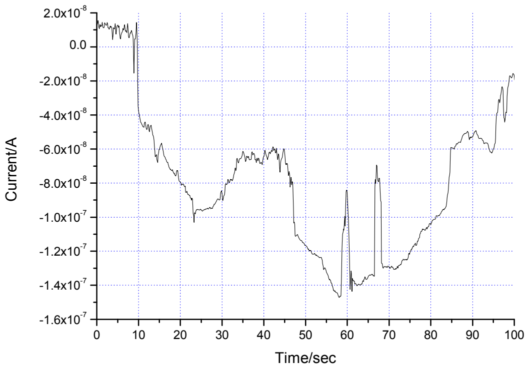
2.2 Resut and discussions

Cyclic voltammetry was conducted which exhibits a characteristic cathodic peak at -0.70V for both simazine and atrazine, and -0.80V for ametryn, without any anodic peak at reverse scan, indicating that the cathodic peaks were due to irreversible electron transfer processes (Fig. 2).



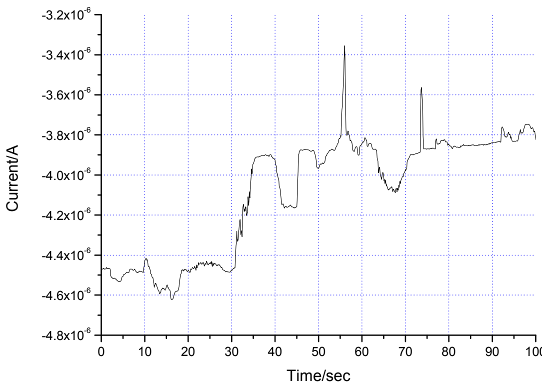
<Fig 2> Cyclic voltammogram of atrazine (a), simazine (b), ametryn (c), and 200mM KCl in (1:1) MtOH:H2O. They showed a characteristic cathodic peak at -0.70V for both simazine and atrazine, ant -0.80V for ametryn, without any anodic peak at reverse scan between a potential range -1.0 to 0.40V at scan rate 100 mV s-1.

For CE-AD separation of triazine complex, the capillary was filled with 1.5% agarose. In separate electropherograms, simazine, atrazine and ametryn showed clear single peaks at 59, 65 and 70.75 seconds of migration time respectively. A mixer of simazine and atrazine showed separated peaks 59 and 67 seconds respectively (Fig. 3).



<Fig 3>. CE-AD of simazine and atrazine in 200mM KCl . The electrophoregram shows separated peaks at 59 and 63 seconds.

Similarly, a mixer of simane and ametryne also showed separated peaks 56 and 73.50 seconds respectively in the electropherogram (Fig. 4). These results indicates effective separation of herbicides & their simultaneous detection on a microchip platform.



<Fig. 4> CE-AD of simazine and ametryn in 200mM KCl . The electrophoregram shows separated peaks at 56 and 73.50 seconds.

3. Conclusion

In this study, the determination of simazine, atrazine and ametryn herbicides by CE-AD was carried out. The results showed that triazine can be separated and analyzed within 30 min. The CE-AD technique on a microfulidic chip as such may prove to be a useful qualitative and quantitative tool for similar environmental pollutants.

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