Electrochemical Response with Composition of Parallel Opposed Dual Electrode and Flow Rate in a Microchannel

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We proposed an electrochemical microsystem based on a parallel opposed dual electrochemical detector in a microchannel and studied its properties using potassium ferrocyanide for flow analysis with dual mode cyclic voltammetry (CV) and chronoamperometry (CA). Dual electrode system is known as a high sensitive electrochemical detector [1-2]. High selectively and sensitivity were achieved since redox cycling enhances the current for electrochemically reversible species by using dual electrode and interdigitated array (IDA) electrode [3-4]. However, the fabrication of IDA electrode is difficult because the electrode has a line and space of a few micrometers. On most of the reports about the micro Total Analysis Systems (μ-TAS) with dual electrode [5-6], the electrode was fabricated on the same plate. We prepared a relatively large size dual electrode in which one electrode was on the bottom and the other was on the top of the microchannel. In this report, we studied the effect of the parallel opposed dual electrode composition under the flow rate of 0-5 $\mu dm^3 min^{-1}$.

Microchip was composed of three layers, two glass wafers and a microchannel layer made of a photo definable adhesive film (thickness: 50μm) as shown in fig.1. All the electrodes on the glass wafers were made by vacuum vapor deposition and patterned by the photolithography techniques. Electrode combination on electrochemical measurement was described in table 1.

Cyclic voltammograms depended on the configuration of a generator (*G)* and a collector (*C)* and the flow rates. When the flow rate was equal to or faster than 1 $\mu dm^3 min^{-1}$, the limiting current was stable. High collection efficiency up to 99 % was achieved without using the dual microelectrode such as a micro–band array or IDA electrode at the lowest sweep rate of 10 mVs^{-1} under non–flow condition. We also obtained the higher collection efficiency of nearly 100 % with a quicker response time of around a few seconds on CA. Collection efficiency decreased on flow rates, and depended on the composition of dual electrode as shown in fig.2. The limiting current agreed with theoretical value based on a channel flow double electrode (CFDE). Current amplification contributed to redox cycling was observed. These results make it possible to provide a highly sensitive on–chip electrochemical detector based on current amplification by redox cycling without using the high–resolution lithographic technique.

References
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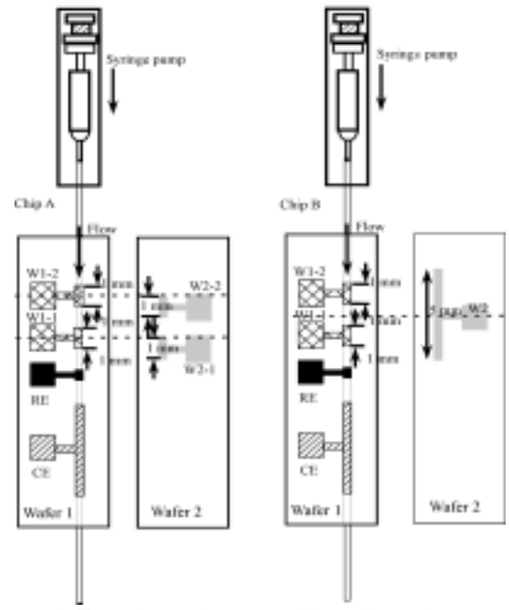

Figure 1. Experimental composition of parallel opposed dual electrode.

	Chip A (Generator)			Chip B (Generator)		
	Single		Double	Single		Double
Collector	W1-1	W1-2	W1 & W2	W1-1	W1-2	W1 & W2
W2-1	A			------	------	------
W2-2		B	C	------	------	------
W2	------	------	------	A	B	C

Table 1. Combination of electrode in experiment.

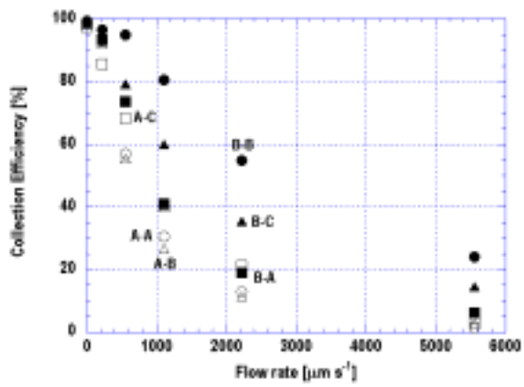

Figure 2. Collection efficiency versus flow rate on chronoamperometry measured at chip A and B. Open circles, squares and triangles are at the combination of A. B and C, respectively.