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CNT microelectrodes for flexible electrochemical sensor applications

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Carbon nanotubes have shown promising properties as electrochemical electrodes such as the high sensitivity, rapid electron transfer kinetics, wide potential window, biocompatibility, and manufacturing versatility [1]. CNT-based flexible devices have been investigated extensively for varieties of application in gas sensors [2], pH sensor [3] and electronics devices, but there are few reports on electrochemical applications (chemical and bio sensors) to our knowledge [4-6]. In addition, the previously reported CNT electrodes has a dimension of mm, and the fabrication based on solution process causes the nonuniform in electrochemical activity on the electrode surface [7].

In this study, we demonstrate the fabrication of high-performance flexible microelectrodes based on CNT thin film, using the dry transfer method, and apply them to detect dopamine, an important neurotransmitter.

The CNT microelectrodes were fabricated on a PEN substrate by dry transfer method, and standard microfabrication technique [8]. In our electrode structure, only CNT surface is exposed to electrolyte and perform electrochemical reaction. The microfabrication process was used to minimize the contamination of CNT surface from photoresists and other organic compounds and could enable to obtain better reproducibility of electrode activity. Figure 1 shows the photograph of fabricated CNT microelectrodes. An array of 35 microelectrodes were fabricated on the substrate.

The electrochemical properties of CNT microelectrodes were characterized by cyclic voltammetry with $K_4[Fe(CN)_6]$ as a benchmark. The results show that $|E_{3/4} - E_{1/4}| = \triangle E \sim 60$ mV, close to the ideal value (59 mV). It mean the fabricated CNT microelectrodes have high electron transfer rate. We also confirmed the uniform in electrochemical activity of the CNT surface, especially after activation process. These CNT microelectrodes exhibited high sensitivity in detection of dopamine.

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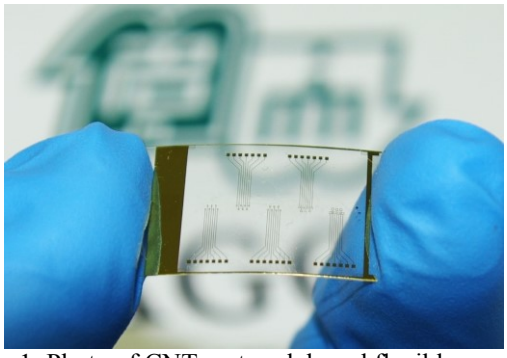

Fig 1: Photo of CNTs network based flexible microelectrodes.

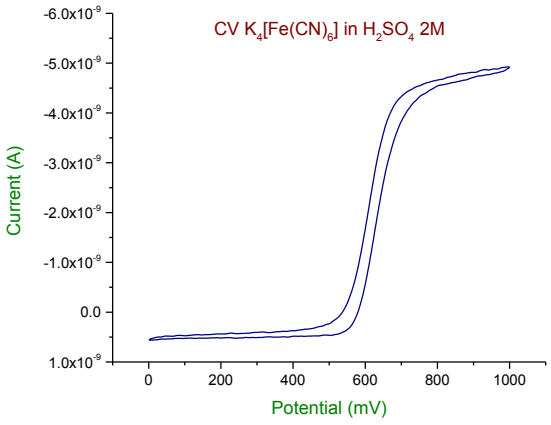

Fig. 2: CV of CNT microelectrode in Ferro cyanide at concentration of 250 µM in H_2SO_4 2M solution at scan rate 10 mV/s.