A CO Sensor Consisted of Ion Plated Au Film and Neutral Buffer Solution

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INTRODUCTION

A toxic CO gas has been detected in working environments such as chemical plants and steel making for a long time¹⁾. So, many electrochemical CO sensors consisted of a platinum black working electrode and H₂SO₄ solution have been widely used to detect the CO gas²⁻⁵⁾. The sensor of this type, however, is hard to handle, because it includes a strong acid and oxide layer may be formed on the electrode to lower its catalytic activity.

In this study, we attempted to make a CO sensor which consisted of a thin layer gold electrode and a neutral buffer solution, and its performance was investigated.

EXPERIMENTAL

A schematic of the CO gas sensor made by us is shown in Figure 1. This Au working electrode was formed on a gas permeable Teflon membrane (PTFE) by ion plating method. The Au plating was carried out under following conditions: substrate bias voltage of -0.5kV, RF-power of 600W and Ar gas atmosphere of 1.3×10^{-2} Pa. The platinum black printed on the PTFE was served as the counter electrode. The reference electrode is a Ag/AgCl(saturated KCl). Three kinds of buffer solution, pH3[C₆H₄(COOK)(COOH)+HNO₃], pH7[KH₂PO₄+Na₂B₄O₇] and pH11[Na₂HPO₄+NaOH], were prepared as the electrolyte. CO with a flow rate of 0.2dm³/min diluted with N₂ or pure AIR was fed to the sensor to evaluate the

Fig.1 Schematic of a CO sensor.

Fig.2 Response of a CO sensor with a solution of pH7 at +0.3V vs. Ag/AgCl(sat. KCl). CO concentration was 260ppm(N₂-balance).

functional characteristic. The potential of the working electrode was controlled by a conventional potentiostat. All measurements were carried out at $25 \pm 0.5^\circ\text{C}$.

RESULTS AND DISCUSSION

First, the current response of the sensor was investigated under various potentials by feeding an inert gas(N₂) and a diluted CO gas (CO+N₂) in turn, to determine the most suitable constant potential which gives a stable and re-

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Fig. 3 Dependence of $i(\text{N}_2)$ and $i(\text{CO}+\text{N}_2)$ on the electrode potential using each pH solution. CO concentration was 260ppm.

Fig. 4 Relationship between CO concentration and $i(\text{CO})$ at +0.3V vs. Ag/AgCl(sat. KCl) solution of pH7.

producible current for electrochemical oxidation of CO. Figure 2 is an example of the current response obtained at +0.3V(vs. Ag/AgCl) in a buffer solution of pH7. It is found from Fig. 2 to be excellent in the response, that is, the background

current under N₂ flow is also reproduced before and after CO feeding along with the sharp increase and decrease of current. In Fig. 2, the current corresponding to CO concentration, $i(\text{CO})$, is the value which subtracted the background current $i(\text{N}_2)$ from $i(\text{CO}+\text{N}_2)$.

Figure 3 shows dependence of $i(\text{N}_2)$ and $i(\text{CO}+\text{N}_2)$ on electrode potential in different buffered pH solutions. It is desirable for the sensor that the background current is small and the current susceptible to CO is large. It can be seen from Fig. 3 that there is no difference between $i(\text{N}_2)$ and $i(\text{CO}+\text{N}_2)$ over whole potential range in the pH3 solution, and the background current is too large in the pH11 solution. In the buffer solution of pH7, it was found that there was significant difference between $i(\text{N}_2)$ and $i(\text{CO}+\text{N}_2)$ as well as the smaller background current. Therefore, we chose the potential value of +0.3V as the setting potential of the sensor, along with adopting the solution of pH7.

Other two kinds of buffer solutions of pH3 and 7 prepared by mixing Na₂HPO₄ and citric acid were also compared with the performance in above mentioned solutions(pH3 and 7). There was no essential difference so far as adopting pH7, even in the solution containing citric acid.

Using such conditions in the pH and the potential, dependence of $i(\text{CO})$ on the CO concentration was investigated, as shown in Fig. 4. The output current $i(\text{CO})$ was found to have a good linearity to the CO concentration over the wide range, independent of the kinds of the dilution gas. It could be considered that the newly developed CO gas sensor working at +0.3V in the buffer solution of pH7 was promising to detect quantitatively the CO gas in various working environments.

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