Effect of Sn on Pt Electrode for Planar CO Sensor

Feng-hsiang Hsiao and Ming-Chang Yang
Department of Chemical Engineering,
National Cheng Kung University
1 Ta-Hsueh Rd., Tainan, Taiwan 701, ROC

Carbon monoxide (CO) is one of the major atmosphere pollutants mainly resulting from combustion of fuel in vehicles and power plants [1]. Its threshold limit value is 50 ppm. For the safety concerns, it is important to have a CO sensor with high sensitivity, fast response time and high reliability. Many researchers has used platinum as the sensing electrode material to detect several gases (such as NO_2, H_2, etc.) [2,3]. Platinum is also a good catalyst for sensing CO but it is easy to be poisoned by CO itself to cause poor sensitivity and short lifetime of the sensor. Addition of tin into platinum has been tried to solve this problem[4]. Recently, the electrochemical planar sensors have attracted much attention for potential of miniaturization [5]. The sening behavior on Pt and Sn-modified Pt (Sn/Pt) on planar CO sensors will be reported.

The structure of the planar sensor is shown in Fig. 1. Platinum was sputtered on the alumina substrate for the working and counter electrodes. The reference electrode was fabricated by Au sputtering. The areas of the working, counter and reference electrode were calculated 1.0, 1.0 and 0.2 cm^2, respectively. Then, the Sn/Pt electrode was prepared by electrodeposition in $SnCl_4$/3M H_2SO_4 at 0V(vs. Ag/AgCl). A solution containing 5% Nafion (Du pont) was cast on the alumina substrate and dried at ambient conditions. The substrate with Nafion was then placed in a vacuum oven and heated from room temperature to 120 ℃ in 2 hours. The thickness of the Nafion film was measured 2.5 μm with a profilometer.

The Fig. 2 shows the net current for 800 ppm CO at different applied potential with Pt electrode (curve A) and with Sn/Pt electrode (curve B). The maximum net current was observed at 0.3V for both kinds of electrodes. For The planar sensor, the Sn/Pt electrode had larger net current than the Pt electrode in the potential region of 0.1 ~ 0.5V(vs. Au). The Fig. 3 is the current response under different concentrations of CO (0-1000ppm) for the Pt electrode. According to Fig. 3, the final background current returned to the same value with that in the beginning. This suggested a stable Pt electrode during the measurement and Sn/Pt electrode had the same stability with Pt electrode. The sensitivity of the Sn/Pt was 3 nA/ppm CO, about 1.72 times of that at the Pt electrode (1.74nA/ppm CO), as shown in Fig. 4.

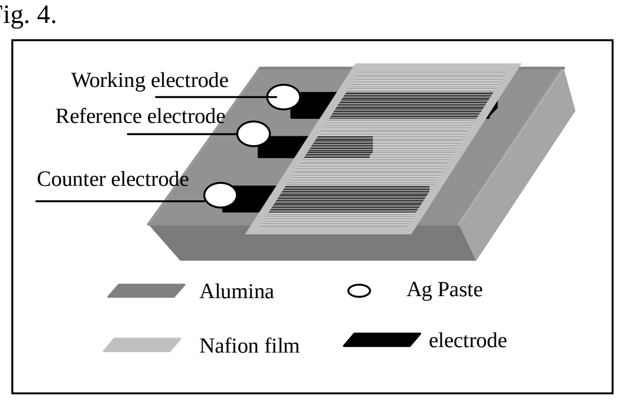

Fig. 1 The schematics of the planar CO sensor.

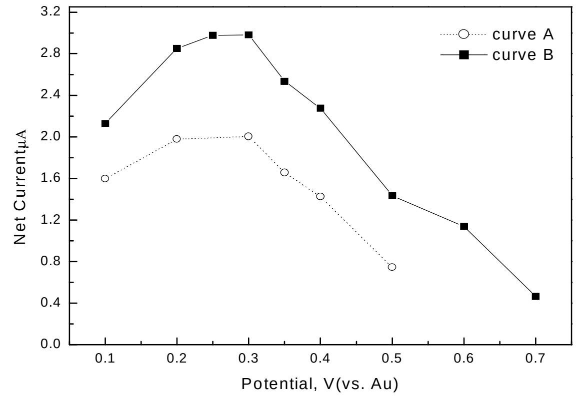

Fig. 2 Polarization curves of 800ppm CO. Curve A for Pt electrode; curve B for Sn/Pt electrode.

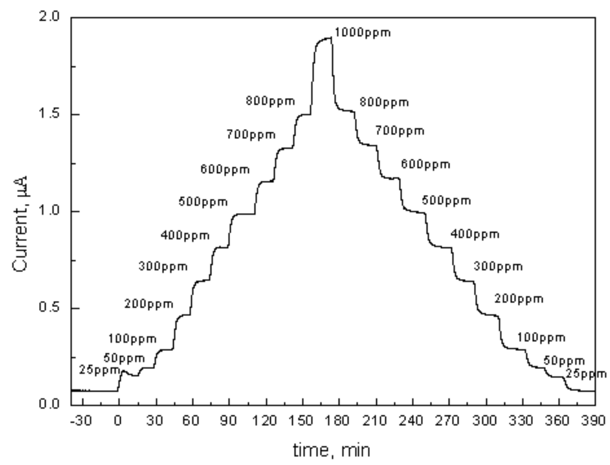

Fig. 3 The sensing response in the different CO concentration in N_2 at room temperature and 100% RH.

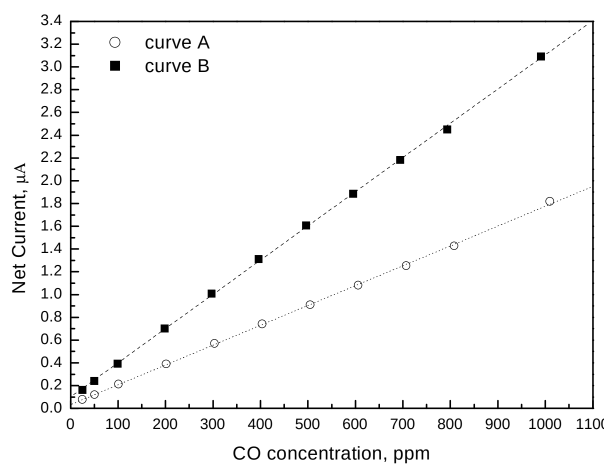

Fig. 4 The relationship between the net current and CO concentration in N_2 at 0.3V (vs. Au), room temperature and 100% RH. Curve A for Pt electrode; curve B for Sn/Pt electrode.

Reference

1. k. Wark and C.F. Warner, Air Pollution-Its Origin and Control. 2nd Ed., Harper & Row Publishers, NY, U.S.A (1981).
2. K.C. Ho, W.T. Hung, Sensors and Actuators B 79(2001) 11-16.
3. Z. Samec, F. opekar, G.J.E.F. crijns, Electroanaysis 7 (1995) 1054.
4. K.I Tsceng and M.C. Yang, the 200th Meeting of the Electrochemical Society, Abstrat No. 937 (2001).
5. A. Yasuda, T. Shimidzu, Reavtive & Functional Polymers 41 (1999) 235-243.