A Study on Carbon Monoxide Sensor Based on Lanthanum Fluoride Electrolyte

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Carbon monoxide (CO), mainly generated from the incomplete combustion of fuel is a typical component in the air pollution, and needs to be detected in the atmosphere.

Many types of sensors has been operated at high temperature to detect CO[1,2]. Some solid electrolytes operated at low temperature, consist mostly of metal halide, including β-PbF_2[3], $PbSnF_4$[4],and LaF_3 [5,6]. Previous researches revealed that lanthanum fluoride could be used to detect fluoride ion [7] and oxygen at room temperature [5,6]. LaF_3 solid electrolyte has been found to applicable at room temperature due to high conductivity. Kuwata reported that a solid electrolyte cell with LaF_3 electrolyte was able to detect 1.3% H_2 or 1000ppm CO in air at 100 ℃, but the sensing response was independent of the partial pressure of CO at 50 ℃[8]. Therefore it is our objective to develop a CO sensor with solid electrolyte operated at room temperature.

In this report, an assembly of electrode/solid electrolyte/electrode has been constructed. Powder of LaF_3 mixed with PVA (polyvinyl alcohol) was pressed into a compact pellet. After sintering of the pellet at 700 ℃, platinum films were sputtered on the both sides of the pellet for electrodes. The sputtered pellet was then immersed into water for 1 hr prior to measuring the potential difference at room temperature. Sample gases were prepared by mixing CO with N_2, and the reference gas was the air at a gas flow of 100ml/min.

The potential response to the step changes of various concentration of CO from 900 to 200 ppm at 21 ℃ are shown in Figure 1. Kuwata [8] reported that a cell using LaF_3 had a sensitivity to CO, but needed to be operated at 100 ℃. The difference of the potential response between with and without CO decreased with the concentration CO. The relationship between the potential difference and CO concentrations was linear, as shown in Figure 2. The slope, namely the sensitivity, was $5.5x10^{-2}$mV/ppm. From the calibration curve, potential response is not linear to the logarithm of CO concentration according to the Nernst equation. The sensing performance in the air would be also reported.

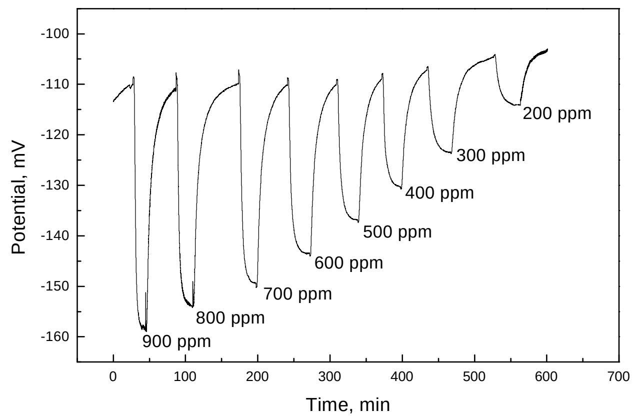

Fig. 1. The potential response to the step changes of various concentration of CO at 21 ℃

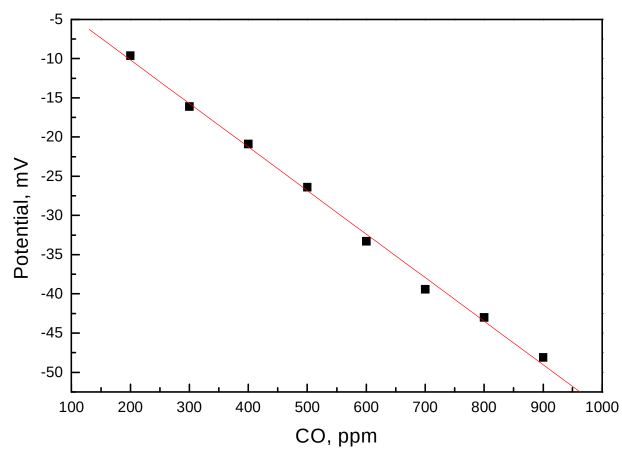

Fig. 2. The calibration curve in the CO concentration range of 900 ~ 200 ppm.

References

[1] A. M. Azad, S. A. Akbar, and K. S. Goto, J. Electrochem. Soc., 139 (1992) 3690-3704.
[2] N. Mira, T. Raisen, G. Lu, and N. Yamazoe, Sensors and Actuators, 47 (1998) 84-91.
[3] G. Couturier, Y. Danto, R. Gibaud, and J. Salardenne, Solid State Ionics, 5 (1981) 621-624
[4] E. Siebert, J. Fouletier and S. Vlminot, Solid State Ionics, 9/10 (1983) 1291-1294.
[5] N. Yamazoe, J. Hisamoto, S. Kuwata, and N. Miura, Sensors and Actuators, 12 (1987) 415-423.
[6] N. Yamazoe, J. Hisamoto, S. Kuwata, and N. Miura, Sensors and Actuators, 16 (1989) 301-310.
[7] W. Moritz, and Muller, Analyst, 116 (1991) 589-593.
[8] S. Kuwata, N. Mura, N. Yamazoe and T. Seiyama, Chemistry Letters, 8 (1984) 1295-1296.