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# SMART CARBON DIOXIDE GAS SENSOR BASED ON SOLID ELECTROLYTES

Toru Maekawa, Kengo Suzuki, Hiroshi Ishikawa,
Shinji Tamura[a], Nobuhito Imanaka[a] and Gin-ya Adachi[b]
R&D Center, New Cosmos Electric Co., Ltd.
[a]Department of Applied Chemistry, Faculty of Engineering
Osaka University
[b]Juri Institute for Environmental Science and Chemistry,
College of Analytical Chemistry
2-5-4 Mitsuya-naka, Yodogawa-ku, Osaka 532-0036, Japan
[a]2-1 Yamadaoka, Suita, Osaka 565-0871, Japan
[b]2-1-8 Tenma, Kita-ku, Osaka 565-0043, Japan

## Introduction

Recently, the $CO_2$ monitoring has been becoming an urgent issue not only for the suppression of the "greenhouse effect", but also for the amenity in facilities. Among various sensing methods, all solid state type sensor is one of promising tools for in situ monitoring. From our previous researches on the $CO_2$ gas sensors based on solid electrolytes (Figure 1), rapid, continuous, and reproducible sensing performances have been demonstrated.[1-4]

In this study, the miniaturized sensor cell of the size in 2mm, was fabricated with the thin Pt film heater, and its practical sensing performance was investigated.

## Experimental

Figure 2 presents a schematic illustration of the miniaturized $CO_2$ gas sensor. The sensor consists of the detecting $La_2O_2SO_4$-$Li_2CO_3$ auxiliary electrode with Au sensing electrode, cationic/anionic conductor tip, Pt reference electrode and alumina substrate with a thin Pt film heater. After co-pressing the individual solid powder of the cationic/anionic conductor, the cationic/anionic conductor tip was sintered and then cut into pieces of 0.5mm$^2$. The tip was fixed to the $Al_2O_3$ substrate with a binder. The detecting and the reference electrodes were prepared by using the $La_2O_2SO_4$-$Li_2CO_3$ powder and the Pt pastes on each side of the tip, respectively. The operation temperature was controlled at 500℃ with electric power consumption of 0.5W and the $CO_2$ sensor output (EMF) was monitored in the $CO_2$ concentration range between 500ppm and 3%.

## Results and Discussion

Figure 3 depicts the variation of the sensor output (EMF) with the $CO_2$ gas concentration. A linear relationship was clearly observed between the sensor output and log($P_{CO_2}$). The slope obtained from the EMF output vs. log($P_{CO_2}$) relationship is n=1.92, which well coincides with that from the theoretical Nernst equation (solid line in Fig. 3). The above result explicitly indicates the fact that the $CO_2$ gas concentration can be quantitatively determined only by measuring the sensor output.

Figure 4 shows the long term stability of the present $CO_2$ sensor. A high stability was ensured after ca. 100 days, suggesting a satisfactory performance for in situ monitoring.

## References

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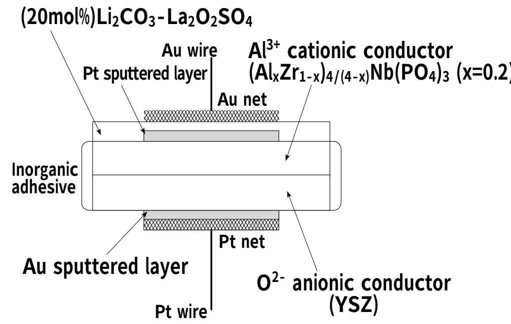


Fig. 1. The cross-sectional view of the sensor element based on Al3$^+$ and O$^{2-}$ ion conducting solids with $La_2O_2SO_4$-$Li_2CO_3$ auxiliary electrode.

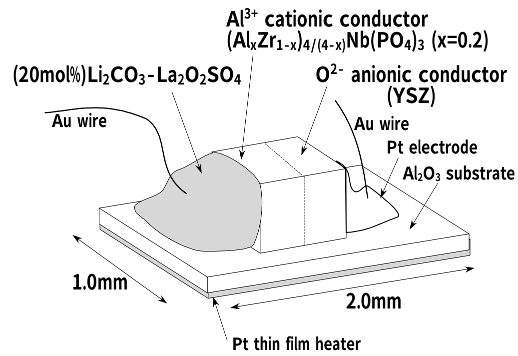


Fig. 2. A schematic illustration of the miniaturized $CO_2$ sensor element with thin Pt film heater.

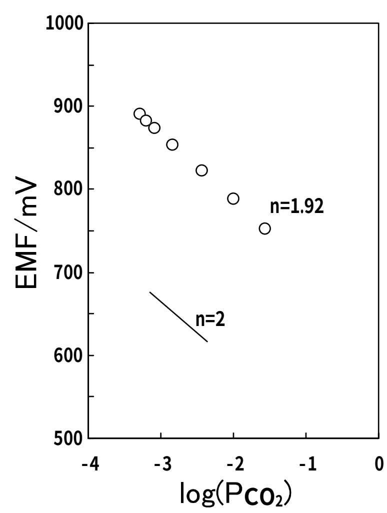


Fig. 3. The relationship between the sensor output(EMF) and the logarithm of the $CO_2$ concentration at 500℃.

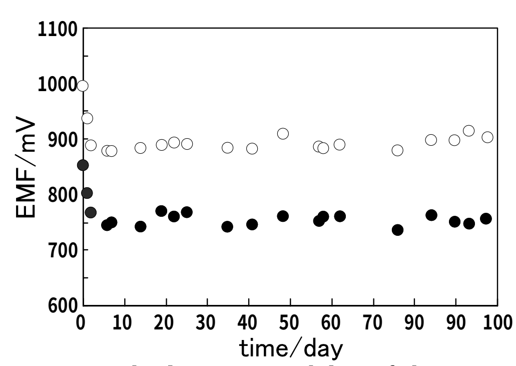


Fig. 4. The long term stability of the sensor output(EMF) for the $CO_2$ gas concentration of 500ppm(○) and 3% (●) .