NW10A/2012G680

Micro XAFS Analysis of Micro Gas Sensor

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1 Introduction

Wide spread of natural gas home sensor has been desired for safety reason. Conventional gas sensor requires AC100V electric source which prevent its spread because of the bad appearance and the limitation of installation. If a gas sensor can be driven by battery, larger number of gas sensors are used at home. Suzuki et al. developed a SnO_2 thin film by a microelectromechanical system (MEMS) method to achieve miniaturization of the gas sensor and reduce the power consumption. The operating life of a battery-driven sensor reached average 5 years over[1, 2]. The life time of co catalyst should be elongated. We have investigated structure of catalyst and its change using micro XAFS. We found the catalyst structure changes from place to place in a few tens μm level and the result has accelerated the gas home sensor development.

2 Experimental

Micro gas sensors were prepared as described elsewhere [1, 2]. They were used under the household environment. Three typical examples were measured according to the degradation degrees such as high, medium and low degradation degree and denoted as H, M, L respectively.

Pd K-edge micro-XAFS experiments were performed at the NW-10A beamline at the Photon Factory. The original beam size of this beam line was 1×1 mm^2. The X-ray beam was focused by a polycapillary lens (XOS Inc., USA) having a focal distance of 9.5 mm and transmission efficiency of about 8 % at 25 keV. The incident X-ray beam intensities were monitored by 170 mm long ionization chambers. The X-ray fluorescence was detected by a 19 elements Ge-SSD (Ortec, USA). A focal spot was about 25 μm in diameter (FWHM) measured by knife-edge scan of 50 μm Pd wire. The sample was placed on the X-Y-Z stage (Sigma koki, Japan). And figure 1 shows measured alignments of X-ray and samples.

3 Results and Discussion

Table. 1 shows Pd ratio on each positions of each gas sensors from linear combination least square fitting of XANES at each position using Pd foil and PdO standard spectra. Fresh micro gas sensor had a homogeneous structure consistent of PdO nanoparticle As the degradation degree increased, the component of metallic Pd increased and the distribution became inhomogeneous. Especially, in H and M, about 85% PdO at edge position is reduced to Pd. And at the most degraded micro gas sensor (H), there is a correlation Pd distribution and temperature distribution. It indicates that the reduction of PdO is more easily with lower temperature under the operating atmosphere.

Our work suggests that the homogenous heating must be necessary to elongate the life-time.

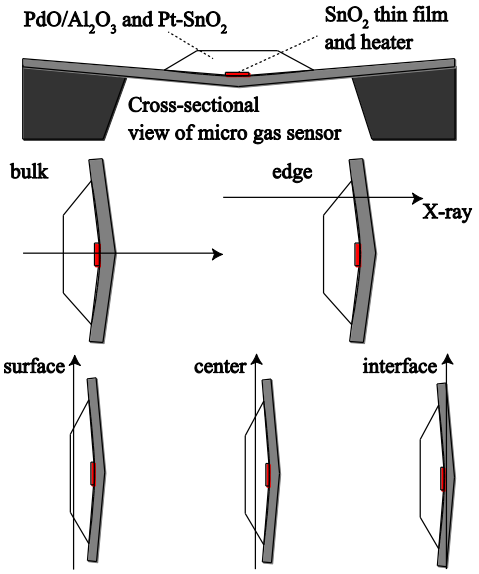

Figure 1 The diagram of micro gas sensors and alignments of x-ray and samples.

Table 1 Pd ratio of each samples from liner combination fitting results of XANES.

	bulk	edge	surface	center	interface
Fresh	0 ± 5	0	0	2 ± 3	0 + 2
L	18 ± 3	18 ± 9	0	14 ± 3	9 ± 4
M	5 ± 4	86 ± 4	13 ± 4	23 ± 4	13 ± 5
H	12 ± 3	83 ± 4	48 ± 5	38 ± 5	20 ± 4

References

[1] Suzuki T *et al*., Sensors and Actuators B Chem. **109**, 185 (2005).
[2] Tabata S *et al*., Sensors and Actuators B Chem. **109**, 190 (2005)

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