High throughput screening test of electrocatalyst and proton conductor for direct methanol fuel cells

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Combinatorial chemistry, while most popularly used in the discovery of biochemicals and pharmaceuticals, has also for many years been used to identify and optimize inorganic materials of complex compositions [2,3]. The combinatorial method entails the synthesis of large libraries of compounds, in which composition or processing conditions are systematically varied, followed by screening for a particular property of interest. Recently, this approach has been used with some success in the discovery of a new electrocatalyst [4], and sophisticated methods for rapid screening of catalyst libraries have now been developed [5].

The direct methanol fuel cell (DMFC) is a very promising electrochemical membrane reactor concept for environmentally benign power supply in transportation application. Some considerable efforts have been made in search for a DMFC electrocatalyst, especially for methanol electro-oxidation. As DMFCs require platinum (Pt) or platinum alloy catalysts as an active material in their electrodes, it is important to discover the new electrocatalyst in order to improve electrode performance. Since the proton-conductor should be added in the electrode to transfer the proton to membrane, the various proton conductors should be evaluated.

In this study, we introduced combinatorial method for the high throughput screening test. And the results were re-confirmed by single cell test. We performed the high throughput screening test of the CO-tolerant electrocatalyst and solid proton-conductor by using the combinatorial method.

HTS test was carried out in experimental condition of previous report [6]. In CO stripping experimental, a conventional three-electrode cell was used. In the measurement of CO stripping, the CV was performed till a reproductive curve was required. Electrode arrays were prepared by dispersion of PtRu/C, Au/TiO_2 onto a Teflon-coated carbon sheet, using manually prepared solution mixture.

The activity compositions of PtRu/C : Au/TiO_2 secondary array electrodes for methanol electro-oxidation were shown as the fluorescence images at different potential. The activity of methanol electro-oxidation was measured by the intensity of fluorescence and onset potential. The most active composition was PtRu/C : Au/TiO_2 = 9:1, 8:2, 7:3 and 6:4 in which the initial activation potential was started from 0.15V vs Ag/AgCl. However, the initial potential of PtRu/C without Au/TiO_2 was started at 0.3V. In HTS test of PtRu-$AuTiO_2$ secondary array made of metal ion precursor also showed most active composition at PtRu : Au/TiO_2 = 9:1, 8:2 and 7:3

CV background and CO oxidation performance of most active compositions are shown in figure 1. PtRu/C 100% catalyst started to oxidize at ca 0.147mV. However, PtRu/C – Au/TiO_2 showed negatively shifted potential. CO oxidation peak was also shifted, and CO oxidation charge was decreased with Au/TiO_2. It indicated that PtRu/C with Au/TiO_2 have higher CO oxidation performance than that of PtRu/C without Au/TiO_2. This result suggested that the Au/TiO_2 is helpful for oxidation of CO According to our result, the optimal composition was PtRu/C : Au/TiO_2 = 7:3. Single cell performance was also well agreed the combinatorial and CV results.

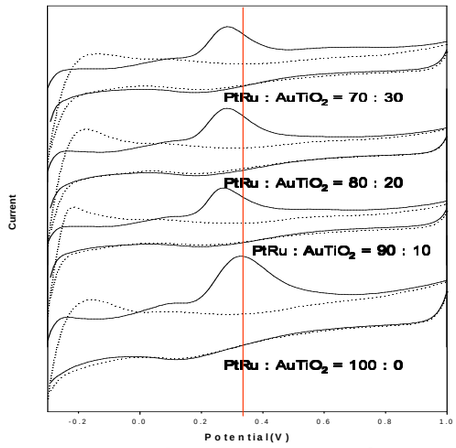

Figure 1. Cyclic voltammogram of CO stripping experiment in 0.25M H_2SO_4 electrolyte
Dashed line is base CV background curve

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