Electrolytic Formation of Pt-Li Alloy and Its Excellent Electrocatalysis for Formic Acid Oxidation

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Numerous reports have demonstrated the use of Pt alloy to enhance electrocatalytic activities of Pt. Commonly, alloying Pt with early and late transition metals (Pt-M) is utilized for accelerating oxygen reduction reaction activity in which electronic and geometric effects are suggested to play an essential role in modifying Pt [1-4]. Pt-Ru based catalysts are well known to be a state of the art of catalyst for methanol oxidation by serving hydroxyl (OH) groups to Pt [5]. Meanwhile, Wang et al. found that Pt-Au alloy is an active catalyst for formic acid oxidation (FAO) due to an ensemble effect by which adjacent Pt sites required to produce CO from formic acid are blocked by Au [6]. However, among many metals which have been alloyed with Pt, to the best of our knowledge, no one has attempted to use the alkaline group metals, e.g., Li as alloys with Pt for electrocatalysts. Early finding by Nash et al. [7] indicated a remarkable ability of Li atoms to penetrate into the platinum lattice. Some reports mentioned that Pt-Li alloys are produced by mixing the elements at a high temperature (1550°C) [8] and by electrodeposition in aprotic solvents [9, 10]. However, those reports do not demonstrate the characteristic of Pt-Li alloys, particularly for their electrocatalytic activities.

In this paper, we will present the electrolytic formation and unique properties of Pt-Li alloy and also its excellent electrocatalytic activity for FAO: The electrodeposition of Li on Pt electrode in propylene carbonate leads to a formation of Pt-Li alloy in which Li atoms deeply penetrate into Pt lattice structure. Its electrocatalysis for FAO is superior to that of pure Pt electrode, which originates from its geometric and electronic peculiarities[11].

Acknowledgement

The present research was financially supported by Grant-in-Aid for Scientific Research from the Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan.

References

1) H. A. Gasteiger, S. S. Kocha, B. Sompalli, F. T. Wagner, *Appl. Cat. B: Enviromental*, **9**, 56 (2005).
2) T. Toda, H. Igarashi, M. Watanabe, *J. Electrochem. Soc.*, **145**, 4185 (1998).
3) V. Stamenkovic, T. J. Schmidt, P. N. Ross, N. M. Markovic, *J. Phys. Chem. B*, **106**, 11970 (2002).
4) V. Jalan, E. J. Taylor, *J. Electrochem. Soc.*, **130**, 2299 (1983).
5) T. Yajima, N. Wakabayashi, H. Uchida, M. Watanabe, *Chem. Commun.*, 828 (2003).
6) S. Wang, N. Kristian, S. Jiang, X. Wang, *Electrochem. Commun.*, **10**, 961 (2008).
7) C. P. Nash, F. M. Boyden, L. D. Whitting, *J. Am. Chem. Soc.*, **82**, 6203 (1960).
8) O. Loebich, Ch. J. Raub, *Platinum Metals Reviews*, **25**, 113 (1981).
9) D. Aurbach, M. Daroux, P. Faguy, E. Yeager, *J. Electroanal. Chem.*, **297**, 225 (1991).
10) A. N. Dey, *J. Electrochem. Soc.*, **118**, 1547 (1971).
11) Z. Awaludin, T. Okajima, T. Ohsaka, *Electrochem. Commun.*, **31**, 100 (2013).