

## Synthesis of surfactant-stabilized Pt/C and Pt-Ru/C nanoparticles for H<sub>2</sub>/CO electro-oxidation

Chiu L. Hui<sup>1</sup>, J. Prabhuram, and I-Ming Hsing\*

Department of Chemical Engineering and Environmental Engineering Graduate Program<sup>1</sup>, Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong SAR

\*Corresponding author (kehsing@ust.hk)

### Abstract

State-of-the-art fuel cell catalysts such as Pt and its alloys have particle sizes of 2-3 nm in diameter. Nevertheless, the preparation of such nano-scale particles seems to be difficult by using the conventional methods. Hence an alternative approach for producing small catalytic clusters with a well defined particle size and distribution would be desirable. The surfactant-stabilized catalytic clusters dispersed in aqueous solution or organic solvents with an ability to adsorb on the high surface area carbon supports are found to be promising towards this goal [1-4].

In this report, we have prepared thiolate-stabilized, water dispersible carbon (Vulcan XC-72) supported 20 wt % Pt and Pt-Ru (1:1) alloy nanoparticles by the reduction of appropriate amount of chloroplatinic acid and ruthenium chloride mixture with sodium borohydride, using mercaptosuccinic acid (MSA) as the stabilizer. High resolution transmission electron microscopy reveals the presence of well separated catalytic particles with diameter range of 2-3 nm, when the initial molar ratio of MSA to chloroplatinic acid (S/Pt) is maintained to 2.8. The S/Pt ratio is found to be the critical parameter in controlling the sizes of the catalytic particles. The XRD patterns of Pt/C and Pt-Ru/C exhibit the characteristics diffraction peaks responsible for the formation of fcc Pt and Pt-Ru alloy in the catalyst. In this

case, the protection of catalytic particles from aggregation is discussed mainly by electrostatic stabilization caused by the monolayer of thiolate molecule covering the metal clusters. The coverage of the thiolate molecules can be removed by treating the catalytic particles with excess of ethanol before using the catalysts for the electrochemical oxidation of H<sub>2</sub>/CO.

The electrocatalytic activity of these surfactant-stabilized Pt/C and Pt-Ru/C toward the oxidation of H<sub>2</sub>/CO is studied. The suitability of these surfactant-stabilized catalysts is evaluated by employing a combination of CO stripping voltammetry and the rotating disc electrode (RDE) technique. Finally, the activity of the surfactant-stabilized catalysts is compared with the commercial E-TEK catalysts.

### References:

- 1) H. Bonnmann, W. Brijoux R. Brinkmann, E. Dinjus, R. Fretzen, T. Jousen, B. Korell, J. Mol. Catal. 74 (1992) 323.
- 2) M. T. Reetz, S. A. Quaiser, Angew. Chem. 107 (1995) 2461.
- 3) S. Chen, K. Kimura, J. Phys. Chem. B 105 (2001) 5397.
- 4) X. Wang, I-Ming Hsing, Electrochim. Acta 47 (2002) 2981.