

## Transient XAS measurement on platinum water-gas-shift catalysts

Thursday, 22 May 2014 15:00 (30 minutes)

The water-gas-shift reaction is a promising route to increase H<sub>2</sub>/CO ratio of reformer gas in order to produce extremely pure H<sub>2</sub> gas stream for other applications, such as fuel cells.



Among all the supported catalysts containing nanoparticles of different noble metals, Pt exhibits great activity for water-gas-shift conversion [1]. Though supported noble metal nanoparticles catalysts have been widely investigated for decades, there are still competing models about the nature of the active sites. Supported by the fact that leached samples (without metallic Pt) had similar activity as unleached samples, it was suggested that non-metallic Pt species are responsible for the activity [2]. In contrast, other groups argued that metallic Pt was the only active sites [3]. It is our aim to resolve this discrepancy by in situ characterization under catalytic conditions, thus determining the structure-activity relationship of Pt catalysts. The experiments were carried out using the setup shown in Fig.1 (a) for XAS and simultaneous kinetic measurements with an on-line mass spectrometer. Samples were tested under water-gas-shift condition both with and without pre-treatments for reliable comparisons. QEXAFS enabled acquisition of spectra with time resolution of 1s and the structure of Pt nanoparticles was monitored during transient experiments.

Figure 1(a) 6.8% CO, 22% H<sub>2</sub>O, 37% H<sub>2</sub> and 8.5% CO<sub>2</sub> were co-fed to the samples in a capillary; water vapor was generated by flowing He through a water bubbler. Exit gas content was monitored by a mass spectrometer. Perpendicular to the gas flow, the X-ray beam passed through the samples and transmitted beam was detected by an ion chamber. Pt foil was used as a reference in this case; (b) XAS spectra of 1.5wt% Pt supported on Al<sub>2</sub>O<sub>3</sub> at room temperature (red), 95°C (blue) and 200°C (green) under water-gas-shift condition. The spectra suggested that Pt nanoparticles were reduced at elevated temperatures under water-gas shift condition.

Reference:

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2. Fu, Q., H. Saltsburg, and M. Flytzani-Stephanopoulos, Active Nonmetallic Au and Pt Species on Ceria-Based Water-Gas Shift Catalysts. *Science*, 2003. 301(5635): p. 935-938.
3. Pazmiño, J.H., et al., Metallic Pt as active sites for the water-gas shift reaction on alkali-promoted supported catalysts. *Journal of Catalysis*, 2012. 286(0): p. 279-286.

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**Session Classification:** Student Sessions