Abstract No. Schw0374

EXAFS Analysis of Bimetallic Catalysts

V. Schwartz (U. Del.), D. Mullins (ORNL), M. Zellner (U. Del.), and J.G. Chen (U.Del.)
Beamline: X10C

Introduction: It is well known from the literature that bimetallic systems often offer interesting properties and possibilities in designing catalysts with high activity and desirable selectivity. The Ni/Pt system is particularly interesting since both metals are important constituents of hydrogenation and reforming catalysts, but Pt and Ni exhibit very different catalytic and reductive properties [1,2]. The objective of our work is to investigate different synthesis techniques and support materials to prepare bimetallic Ni/Pt catalysts using the X-ray Absorption Fine Structure (EXAFS) technique.

Methods and Materials: Different methods and precursors were used during the preparation of the Ni/Pt bimetallic. In one case, a 5 wt% Pt/Al_2O_3 commercial catalyst (AlfaAesar 38318, 300m^2/g) was impregnated with nickel nitrate. In another case, γ-Al_2O_3 (AlfaAesar 39812, 120m^2/g) was used as support and the two metals were loaded on the support by wet impregnation of nickel nitrate and tetraamineplatinum (II) nitrate. In either case, two different catalyst compositions were prepared by varying the Ni/Pt ratio (Ni/Pt=1 and Ni/Pt=3). After the impregnation step, the catalyst precursors were dried in air and calcined at 290^{o}C. Pt L_3-edge EXAFS spectra were recorded in transmission mode at room temperature after reduction with H_2. The program XDAP – version 3.2 was used to analyze and fit the data as described in the literature [3].

Results: Figure 1 shows the absolute parts of the Fourier-transformed $\chi(k)\cdot k^3$ Pt L_3-edge EXAFS functions in the range of 3.0 Å< k <11.5 Å of the Pt foil (reference) and the bimetallic catalysts. The main peak at 2.77 Å (phase-corrected) corresponding to Pt-Pt contribution for the Pt foil shifts slightly to lower distances ($3Ni/1Pt/Al_2O_3$) and it is less intense for the catalysts prepared using the γ-Al_2O_3 support when compared to the ones prepared using the commercial Pt/Al_2O_3. The decrease of the magnitude of the Pt-Pt peak corresponds, in this case, to lower coordination numbers. Additionally, fitting analysis demonstrated that the Pt-Pt peaks for the catalysts prepared by impregnation of Pt and Ni metals on γ-Al_2O_3 are superimposed with a small Pt-Ni contribution located at 2.55 Å (phase-corrected), revealing the formation of bimetallic particles.

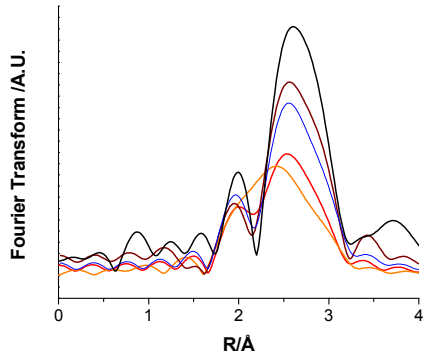

Figure 1: Pt L_{III}-edge k^3 weighted Fourier Transform of the EXAFS of:
- Pt foil
- $1Ni/1Pt/Al_2O_3$
- $3Ni/1Pt/Al_2O_3$
- $1Ni/1Pt\text{-}Al_2O_3$(commercial)
- $3Ni/1Pt\text{-}Al_2O_3$(commercial)

Acknowledgements: Research sponsored by the U.S. Department of Energy, Office of Basic Energy Sciences, Grant No. DE-FG02-00ER15014.

References:

[1] Dominguez, E.J.M., Vasquez, S.A., Renouprez, A.J., Yacaman, M.J. *J. Catal.* 75, 101 (1982).
[2] Wielers, A.F.H., Dings, M.M.M., van der Grift, C.J.G., Geus, J.W. *Appl. Catal.* 24, 299 (1986).
[3] M. Varkaamp, J.C. Linders, D.C. Koningsberger, Phys. Rev. B 209 (1-4), 159 (1995).