


Experiment title:

High resolution XANES of Pt nanoparticles during photocatalytic production of H₂

Experiment number:
30-02- 1066

Beamline:
Date of experiment:

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Shifts:

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Report: The objective of the present run was to investigate , through preliminary experiments considering the number of shifts, the HR XANES at Pt edge of Pt/TiO₂ catalyst (Pt loading 1 wt%, dispersion 60%) during the photocatalytic reduction of methanol to produce hydrogen at room temperature under UV radiation. A new in-situ cell has been designed fort this puspouse with a wide kapton window for imporving the solid angle. The spectrometer of beamline BM30B was composed of three single crystals, but only two could be used. Conventional fluorescence detection was previously used (see report 30-02 1039) and evidences the d band population of Pt (XANES at Pt LIII edge) under illumination and methanol flow thanks to the high dispersion of the catalysts on TiO₂ semiconductor. We were able to relate the importance of the electron transfer to the power of the UV lamp and the excitation wavelength. However, the questions remained on the origin of this phenomena which can be either attributed to electrons or hydrogen adsorbed at the surface of the noble metal particles.

In fact, it is well known that the Pt L₃ XANES is sensitive to the adsorption of H₂ [1,2]. This latter contribution induces a braodening of the white line intensity which is well observed

with highly dispersed systems [2]. Considering the small partial pressure of H_2 produced during the photoreduction of methanol, we wished to use HR XANES in order to enhance the resolution of the XANES spectra and evidence in a better way the contribution of surface hydrogen, adsorbed on Pt, to the signal. Therefore, a prereduced Pt/TiO₂ sample was registered with and without UV illumination. The figure 1. illustrates the variation of white line intensity and its broadening during the photoreduction process evidencing that both contributions namely d band occupation form electron transfer from SC to noble metal and white line broadening from H adsorbed on Pt surface atoms. HR Xanes allowed us to demonstrate the electronic and chemical effects induced during the photocatalytic reaction. Further work are needed (effect of power, wavelength) to quantify in a better way these effects.

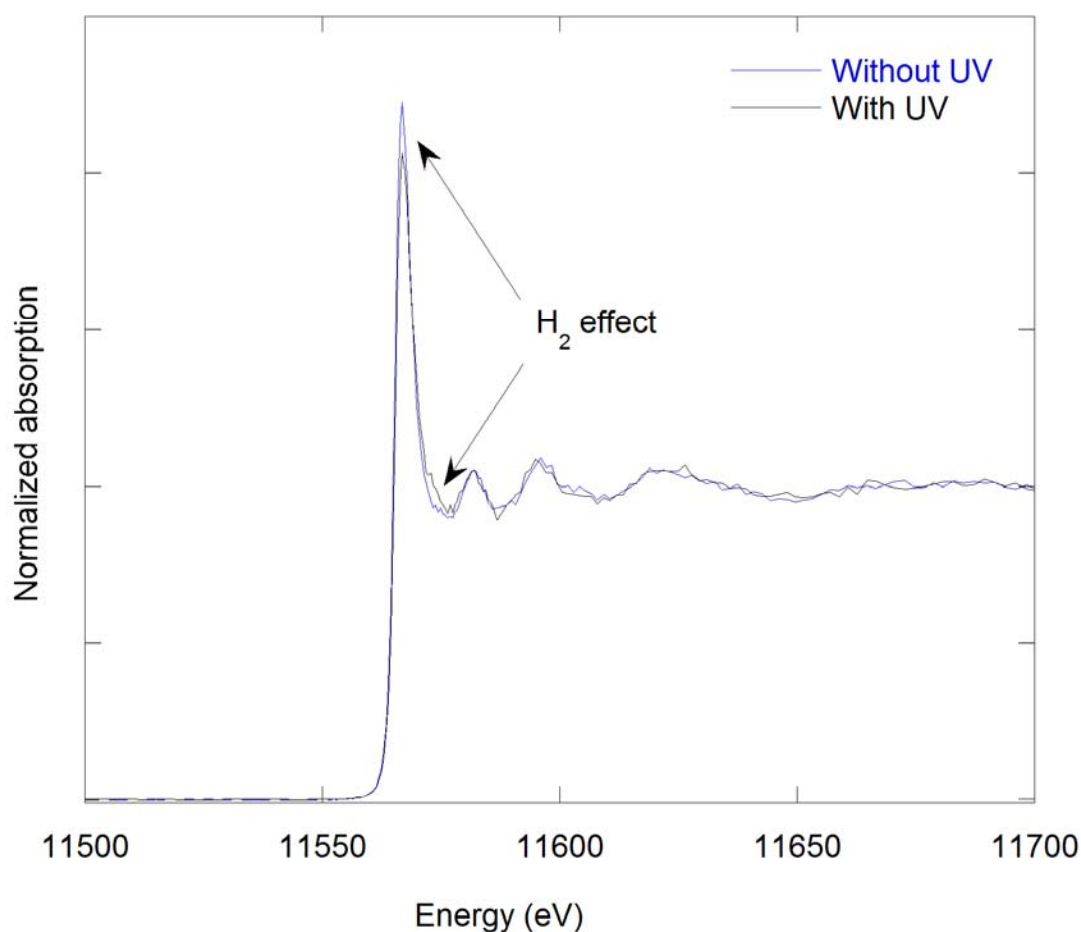


Figure 1 : HR XANES spectra of 1 wt % Pt/TiO₂ under dark and UV illumination in the presence of methanol.

References

- [1] T. Kubota, K. Asakura, N. Ichikuni, Y. Iwasawa, Chem. Phys. Lett. 256 (1996) 445.
- [2] D.C. Koningsberger et al., J. Catal. 216 (2003) 178–191 191.