

XAFS analysis of PtIn catalysts: effect of support and reduction temperature

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Introduction

Supported PtIn catalysts are interesting for several petrochemical reactions. As in general, the activity and selectivity depends on the structure of the active phase, that in this case must consider the existence of independent Pt and In phases and PtIn alloys.

In previous research [1,2] we have analysed the state of PtIn supported on activated carbon and on SiO₂, regarding mainly the preparation method (successive impregnation and coimpregnation) and the support surface chemistry. In our recent measurements we have analysed the effect of a higher reduction temperature (773 K) in both activated carbon and silica supported PtIn catalysts.

Experimental

The catalysts were prepared by successive impregnation in excess volume (followed by solvent evaporation). Aqueous solutions of In(NO₃)₃ and H₂PtCl₆ were used in the indicated order. The Pt loading is about 1 wt.% and the atomic Pt/In ratio is 1. Drying and reduction were carried out at 383K (overnight) and at 623K or 773K (in H₂ flow, 2h), respectively. The Pt L_{III}-edge absorption spectra were recorded in the transmission mode at RT (E=11300-12700 eV). A FT was performed on k³-weighted oscillations over the range of 3-12 Å⁻¹.

Results and discussion

Figure 1 compares the FT-EXAFS obtained for activated carbon and SiO₂ supported PtIn catalysts after reduction at 623 and 773K.

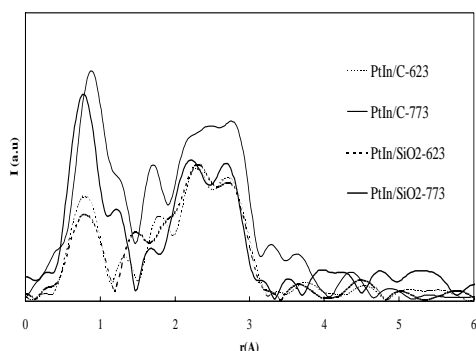


Figure 1. FT-EXAFS of reduced PtIn catalysts.

A preliminary and qualitative analysis of these data shows a very important effect of the support when the reduction temperatures 623 and 773 K are compared.

In general terms, the increase in the temperature of reduction from 623 to 773K has a minor effect in the structure of Pt in SiO₂ supported bimetallic catalysts. However, when the support is carbon a substantial change is observed, probably as a consequence of a weaker metal-support interaction.

Such an effect of the support is also revealed by the analysis of the XANES region, shown in Figure 2.

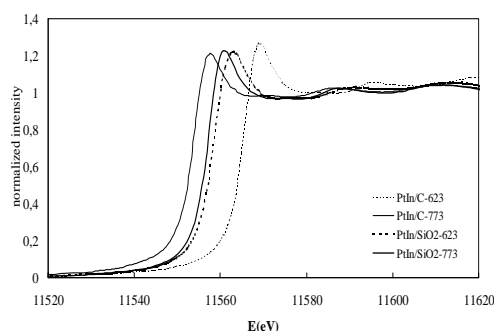


Figure 2. XANES region corresponding to reduced PtIn supported catalysts.

Also as a first observation, there is a large similarity between the results obtained for SiO₂-based catalysts reduced at 623 and 773K, while in the case of carbon supported samples noticeable differences are observed.

In relation to the effect of the support commented here it should be also mentioned that, as previously reported [2], the reduced monometallic Pt/SiO₂ catalysts shows a FT-EXAFS with a maximum at around 1.7 Å and a weaker signal in the region corresponding to Pt foil. It has been interpreted [2] as an important Pt-O interaction due to small particles of metallic platinum bonded to the support surface through Pt-O-Si bonds. The increase in the reduction temperature from 623 to 773 K does not modify the FT-EXAFS of the Pt/SiO₂ catalyst. In the case of reduced Pt/C the features of Pt foil are clearly observed [1].

References

- [1] D. Cazorla et al., PF user's report, 2001.
- [2] M.C. Román et al., PF user's report, 2002.

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