

C. N. R. S., Villeurbanne, France. In particular, macroscopic techniques such as Extended X-ray Adsorption Edge Fine Structure (EXAFS) and Radial Electron Distribution (RED) were compared and contrasted. While EXAFS has been used to determine metal aggregate morphology in catalysts, RED has been used to show the flexibility of aggregates in the presence of adsorbates. This was illustrated for the adsorption of hydrogen and oxygen on platinum aggregates on graphite. Field-Emission Gun Scanning Transmission Electron Microscopy (FEG-STEM) equipped with Electron Energy Loss Spectrometry (EELS) can be used to probe the nanostructure of catalysts. The application of EXAFS was expanded upon by R. Prins of the Technical University of Eindhoven, The Netherlands, specifically in the characterisation of metal-support interactions. The importance of the method of data analysis was stressed and exemplified by the study of the strong metal support interaction (SMSI) of rhodium on titania. It was concluded that, in the SMSI state, the rhodium particles rest on a reduced suboxide of titania. Oxygen admission at 100K resulted in adsorption on, but not oxidation of, rhodium, in contrast to the rhodium/alumina system where rhodium was oxidised. It was concluded that the electronic

influence from the titania support was responsible for the properties of rhodium in the SMSI state. The use of surface EXAFS to aid comparison of the C-C distances in acetylene, ethylene and ethane in the gas phase, and when adsorbed on a Pt(111) surface, was described by D. Chandresis of the Université de Paris-Sud, Orsay, France.

## Conclusions

Much of the discussion during the conference was concerned with bridging the gap between surface physics/chemistry and "real" catalysis. The debate was, perhaps, best summarised by R. Burch of the University of Reading, England, who reviewed the relationship between high-vacuum low-temperature techniques and industrial processes, which often occur at high temperature and pressure. The rôle of ensembles in structure sensitive reactions and the influence of electronic effects were discussed in relation to catalyst additives, promoters and poisons.

It is clear that much still needs to be done in reconciling studies on "model" catalysts with those on "working" catalysts. It is also clear that meetings such as this Paul Sabatier Conference provide a valuable forum for catalysing this process.

B.H.

## Palladium in Low Alloy Steels

Palladium has been examined as a possible alloying addition to various grades of iron-based alloys, particularly medium strength non-stainless ferritic steels, to decrease susceptibility to hydrogen embrittlement. Although the mechanism by which palladium alters the characteristics of these materials is still uncertain, the benefits achieved by this alloying technique have been observed recently in high strength steels, and reported by B. E. Wilde, I. Chatteraj and T. A. Mozhi of the Fontana Corrosion Centre, Ohio State University ("The Influence of Palladium on the Resistance of Low Alloy Steels to Hydrogen Embrittlement", *Scr. Metall.*, 1987, 21, (10), 1369-1373), their work receiving financial support from the General Motor Corporation and Sandia National Laboratory.

In the case of high strength low alloy steels,

resistance to hydrogen embrittlement can be achieved with quite low levels of palladium addition and in less severe hydrogen charging environments. A particular application for such improved material is said to be for automobile spring fasteners, where failures caused by hydrogen embrittlement from corrosion in de-icing salts can be a problem.

The introduction of palladium into the surface of heat treated steel by ion implantation also resulted in the elimination of hydrogen embrittlement, when 6.5 atomic per cent palladium was implanted to a depth of 11 nm below the surface. Clearly this developing technology could have major implications on the performance of other steel structures. Further studies are being undertaken to provide information on the palladium/hydrogen interaction at the atomic level.

I.R.M.