

The Nature of Chemisorbed Species in Platinum Metal Catalysis

PAPERS AT THE AMERICAN CHEMICAL SOCIETY MEETING

One of the few established facts of catalysis is that chemisorbed species are formed on the surface of the catalyst during a reaction. Some species are simple—for example, hydrogen atoms—but some are novel and have no counterpart in ordinary chemical compounds. Some species formed may not participate at all in the reaction. A clear recognition of what species are formed in a given system would greatly assist our understanding of catalytic mechanisms. A symposium on this pertinent subject formed a useful part of the one hundred and fiftieth meeting of the American Chemical Society, held in Atlantic City in September.

A number of direct techniques for observing adsorbed species or the effects they cause are now available. The method of infra-red spectroscopy has been applied for some fifteen years, but still continues to yield helpful information. C. W. Garland (MIT) has obtained the infra-red spectra of carbon monoxide adsorbed on rhodium, palladium and platinum by flash-evaporation of these metals in the gas: in the case of platinum, new bands not revealed by previously used techniques have been observed at low frequencies. C. E. Meloan (Kansas State University) reported on the effect of electric fields on the infra-red spectrum of carbon monoxide on platinum. The application of 4,000 volts d.c. resulted in changes in intensity of the absorption bands and slight changes of frequency, and applying a Tesla coil (a.c. voltage) enhanced the extent of chemisorption.

Results obtained using three other techniques were described. R. W. Zuehlke (Lawrence University) has examined the adsorption of nitric oxide on palladium and

platinum using magnetic susceptibility combined with gravimetry. The physically-adsorbed state and at least one low energy chemisorbed state were recognised. Low-energy electron diffraction (LEED) is a powerful tool for recognising chemisorbed species. C. W. Tucker (General Electric, Schenectady) has observed the structures formed by oxygen and carbon monoxide on the (100), (110) and (111) faces of platinum and rhodium: the difference in behaviour of the two metals was rationalised in terms of a higher heat of adsorption shown by the latter. Finally John Turkevich (Princeton) reported on electron-spin resonance measurements of hydrogen, carbon monoxide, ethylene and oxygen on palladium/alumina.

The classical method of obtaining information on the structure of chemisorbed intermediates involves deductions from detailed studies of kinetics of reactions, especially those in which the isotopic tracer method is used. This has proved a very powerful method, and R. L. Burwell (Northwestern University) has added to our store of knowledge by studying the reaction of a number of cyclic hydrocarbons with deuterium over palladium/alumina in a flow system. G. V. Smith (Illinois Institute of Technology) contributed similar information on the reactions of unsaturated esters. A further contribution in this field is that of D. W. McKee on the methane-deuterium exchange on palladium-ruthenium alloys.

These papers represent steady progress in a particularly difficult field of study, and we must hope that before long a number of catalytic mechanisms will yield their secrets to these types of intensive study.

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