

Chemical Conversion of Carbon Dioxide

Catalytic Activation of Carbon Dioxide, ACS Symposium Series 363

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Carbon dioxide build-up in the atmosphere, the resulting warming of the world's climate and the widespread disruption that could result, have all been very much in the news recently. This monograph is thus very timely in as much as it discusses some of the recent practical and theoretical work on the chemical conversion of carbon dioxide, which turns out to be quite chemically reactive despite being so thermodynamically stable. Regrettably it has not been possible to review here all the work reported.

Six of the fourteen chapters in the book deal explicitly with electrocatalytic reduction. Depending upon the catalyst and the conditions, a wide range of products have been obtained.

M. H. Miles and A. N. Fletcher summarise their review of carbon dioxide reduction on metal electrodes which shows the formation of methane on ruthenium and copper, methyl alcohol on ruthenium and molybdenum, carbon monoxide on ruthenium, palladium, platinum, cobalt, iron, gold and silver, and formate on cadmium, indium, tin or lead electrodes.

A contribution by a large group of researchers at the University of North Carolina (B. P. Sullivan, M. R. M. Bruce, T. R. O'Toole, C. M. Bolinger, E. Megehee, H. Thorp and T. J. Meyer) reviews the overall problems of designing suitable electrocatalysts and the energetics of the carbon dioxide conversion reaction. More detailed information is given of their own work on polypyridine complexes of the second and third row transition metals.

K. W. Frese and D. P. Summers, SRI International workers interested in photoelectrochemical conversion, used semiconductor electrodes which gave a

methanol product; later they used plated ruthenium electrodes giving methane.

The natural reluctance of carbonate and bicarbonate anions to adsorb on a negatively charged cathode was overcome by W. M. Ayers and M. Farley of Electron Transfer Technologies Inc., who employed a two cell electrochemical reactor separated by a palladium membrane acting as a bipolar electrode. Methanol and formic acid with lesser amounts of formaldehyde were the result.

Attempts by S. D. Worley and C. H. Dai of Auburn University to make higher molecular weight oxygenates over supported rhodium catalysts resulted in methane formation, while further addition of potassium apparently poisoned the catalyst completely.

More information on gas phase reduction over heterogeneous catalysts would have been welcome, particularly the commercially very important methanol synthesis which is now generally believed to be a case of carbon dioxide, rather than carbon monoxide, hydrogenation.

One purpose of a symposium is to review the current state of the science in a particular area, and point out areas where more work is required. This symposium and this publication certainly achieve these objectives. Clearly we are still a long way removed from the level of sophistication and expertise of the natural plant world which seemingly has no difficulty in using carbon dioxide as a basic carbon containing raw material.

This book should prove to be particularly useful to people who are interested in photoelectrochemical carbon dioxide fixation and the reverse, that is organically powered fuel cells.

J.W.J.