

Routes to Useful Products and Processes

Insights into Speciality Inorganic Chemicals

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The needs of graduates contemplating industrial research are addressed in this important book covering the major industrial applications of inorganic chemicals. Its eighteen chapters are written by authors with wide experience of their topics. About half the chapters feature the platinum group metals, giving a fair indication of their relevance to industry.

In the chapter on refining J. Hill describes the occurrence of the platinum group metals, their extraction, including chemical processes based on precipitation/filtration, and improved processes using solvent extraction and ion exchange. There is a good critique of the drawbacks to the classical processes, and it is emphasised that a major disadvantage to all the processes is that rhodium is extracted last.

A chapter on the medical applications of inorganic chemicals, by C. F. J. Barnard, S. P. Fricker and O. J. Vaughan describes platinum anti-cancer drugs and the development of cisplatin and carboplatin. Structure activity studies and the mechanism of action of these drugs are considered, but there is still much to find about the molecular basis of their action.

Heterogeneous catalysis is considered by G. C. Bond in a chapter on inorganic materials as catalysts for chemical processes. This subject is extensive, but refers to the importance of the platinum group metals only in hydrogenation, dehydrogenation, dehydrocyclisation, hydrogenolysis and Fischer-Tropsch chemistry.

The use of homogeneous catalysts in large scale industrial processes is described by A. Parkin. He discusses three processes employing platinum group metal complexes: the carbonylation of methanol by rhodium iodide based catalysts, the hydroformylation of alkenes by rhodium carbonyl phosphine complexes and the Wacker process for alkene oxidation to acetaldehyde using palladium where the catalyst is regenerated by a copper redox system.

The increasingly important topic of catalysts for stereospecific synthesis is examined by J. M. Brown. Here platinum group metals find particular use in reductive processes. There is reference to rhodium catalysts used for the preparation of L-DOPA, and rhodium systems based on bis(phospholane) designed by Du Pont. The versatility of ruthenium binap complexes in alkene double bond hydrogenations is shown in the syntheses of citronellol and vitamin E, and in a potential route to isoquinoline alkaloids. These ruthenium catalysts can also hydrogenate ketones with a high enantioselectivity; the rhodium analogues have commercial potential in vitamin B5 synthesis. Osmium tetroxide is mentioned for Sharpless dihydroxylations.

Automobile catalysis, a major use for platinum and rhodium, is addressed by M. Bowker and R. W. Joyner. The development of three-way catalytic converters, the principles of catalyst operation and surface chemistry are described. Future developments include enhanced durability, which can be provided by palladium only catalysts. The inventiveness of industrial scientists will be challenged by legislation imposed to reduce carbon dioxide emissions; when the zero emission legislation comes into force non-carbonaceous fuels may be necessary.

Other applications which involve the platinum group metals include the electronics industry, where ruthenium dioxide and bismuth ruthenate are used as thick film resistors and where palladium is used as a leaching inhibitor of silver from thick film conductors. Additionally, tris(bipyridyl)ruthenium catalysts are being used in solar energy conversion.

This volume thus provides a valuable overview of the industrial applications of inorganic materials. Each chapter has a useful list of specific and general references and key journals, thus providing the reader with an easy means to acquire further information. M.J.H.R.