Book Review

D.J. Cardin, M.F. Lappert and C.L. Raston, *Chemistry of Organo-Zirconium and -Hafnium Compounds*, Ellis Horwood, Chichester, 1986, 452 pages, £59.50. ISBN 0-85312-475-2.

Zirconium was first isolated early in the nineteenth century, but the rapid development of the chemistry of this element with organic ligands was delayed until the 1960's, when it grew in the wake of the great explosion of interest in the organometallic chemistry of the transition metals initiated by the success of the Ziegler polyethylene catalysts and the discovery and structural characterization of ferrocene. Hafnium, as the rarer and more expensive element, has followed a parallel though lesser expansion. The incentives for developing hafnium chemistry are small, as the similarity of these elements has required the chemist to look very carefully for the subtle differences which do exist.

The two important advances in organo-transition metal chemistry alluded to above have had particular significance for zirconium and hafnium. In the case of the Ziegler reaction, their periodic relationships with titanium undoubtedly initiated early interest in the alkyl derivatives, whereas the stabilizing effect of the cyclopentadienyl ligand, as exemplified in ferrocene, has permitted the development of a vast range of bis(cyclopentadienyl) derivatives of Group 4. This facet of zirconium and hafnium chemistry dominated the literature when the previous comprehensive monograph (by Wailes, Coutts and Weigold) was published in 1974, and that is still the case today. However, the intervening years have seen a number of significant developments which illustrate the unique reactivity and structural diversity of the heavier Group 4 elements. Against this background of burgeoning activity in a technically difficult area of chemistry, this volume has been written by three authors who are, or have been, active researchers in the field.

The book is organized in chapters according to the ligand types, with mono- and bis-(cyclopentadienyl) chemistry contributing almost three hundred pages to a volume of four hundred and fifty pages. There are also chapters on homoleptic and heteroleptic σ-bonding ligands, neutral and anionic π-bonding ligands (other than cyclopentadienyls), and on the applications of organo-zirconium and -hafnium complexes in organic synthesis and catalysis.

Chapter one is of most general interest, and defines the scope of the book and reviews the systematic basis of the chemistry: parameters such as

mean bond dissociation enthalpies are set in a periodic context, and their consequences discussed.

The authors also take an historical perspective and select eighteen key topics (with the most prominent researchers) which have contributed most to the surge in interest in organo-zirconium and -hafnium chemistry,

Within the subsequent chapters, the emphasis is on the properties of individual molecules, with much of the physical data collected or referenced in thirty-seven tables, and the chemical relationships presented in sixty-nine schemes. The text is liberally illustrated with eighty ORTEP diagrams and numerous displayed formulae. Unfortunately, a few of the figures have not reproduced well, though this hardly distracts the reader from the content. Another minor criticism concerns the referencing of footnotes in the tables, which reach as far as *aaaaaaag* in one table: surely a more economical notation could have been employed?

Long production times tend to devalue books which cover rapidly developing subjects. The literature is reviewed in this volume to the end of 1982 in the main text, and addenda to each chapter update the work to the end of 1984, when the book was in proof. One wonders why it took a further eighteen months to reach publication.

This book is, nevertheless, a most valuable contribution to the literature of Group 4, and undoubtedly will be appreciated as much by those who are deeply involved in the subject as by those who wish to browse casually in this exciting field of chemistry.

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