Hypervalent Iodine Chemistry

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Preparation, Structure and Synthetic Applications of Polyvalent Iodine Compounds

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Preface

Iodine is the heaviest non-radioactive element in the Periodic Table that is classified as a nonmetal and it is the largest, the least electronegative and the most polarizable of the halogens. It formally belongs to the main group p-block elements; however, the bonding description, structural features and reactivity of iodine compounds differ from the light main-group elements. The electronic structure of polyvalent iodine is best explained by the hypervalent model of bonding and, therefore, in modern literature organic compounds of trivalent and pentavalent iodine are commonly named as hypervalent iodine compounds. The reactivity pattern of hypervalent iodine in many aspects is similar that of transition metals – the reactions of hypervalent iodine reagents are commonly discussed in terms of oxidative addition, ligand exchange, reductive elimination and ligand coupling, which are typical of transition metal chemistry.

Since the beginning of the twenty-first century, the organic chemistry of hypervalent iodine compounds has experienced an unprecedented, explosive development. Hypervalent iodine reagents are now commonly used in organic synthesis as efficient multipurpose reagents whose chemical properties are similar to derivatives of mercury, thallium, lead, osmium, chromium and other metals, but without the toxicity and environmental problems of these heavy metal congeners. One of the most impressive recent achievements in the field of iodine chemistry has been the discovery of hypervalent iodine catalysis.

This book is the first comprehensive monograph covering all main aspects of the chemistry of organic and inorganic polyvalent iodine compounds, including applications in chemical research, medicine and industry. The introductory chapter (Chapter 1) provides a historical background and describes the general classification of iodine compounds, nomenclature, hypervalent bonding, general structural features and general principles of reactivity of polyvalent iodine compounds. Chapter 2 gives a detailed description of the preparative methods and structural features of all known classes of organic and inorganic derivatives of polyvalent iodine. Chapter 3, the central chapter of the book, deals with the applications of hypervalent iodine reagents in organic synthesis. Chapter 4 describes the most recent achievements in hypervalent iodine catalysis. Chapter 5 deals with recyclable polymer-supported and nonpolymeric hypervalent iodine reagents. Chapter 6 covers the “green” reactions of hypervalent iodine reagents, including solvent-free reactions, reactions in water and reactions in ionic liquids. The final chapter (Chapter 7) provides an overview of important practical applications of polyvalent iodine compounds in medicine and in industry.

This book is aimed at all chemists interested in iodine compounds, including academic and industrial researchers in inorganic, organic, physical, medicinal and biological chemistry. It will be particularly useful to synthetic organic and inorganic chemists, including graduate and advanced undergraduate students. The book also covers the green chemistry aspects of hypervalent iodine chemistry, including the use of water as solvent, reactions under solvent-free conditions, recyclable reagents and solvents and catalytic reactions, which makes it especially useful for industrial chemists. The last chapter provides a detailed summary of practical applications of polyvalent iodine compounds, including various industrial applications, biological activity and applications of iodonium salts in PET (positron emission tomography) diagnostics; this chapter should be especially useful for medical and pharmaceutical researchers. Overall, the book is aimed at a broad, multidisciplinary readership and specialists working in different areas of chemistry, pharmaceutical and medical sciences and industry.