

# Science of Synthesis

## Compounds with Four and Three Carbon— Heteroatom Bonds

Four Carbon—Heteroatom Bonds:  
 $X-C\equiv X$ ,  $X=C=X$ ,  $X_2C=X$ ,  $CX_4$

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## Science of Synthesis

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# Science of Synthesis

Houben-Weyl Methods of Molecular Transformations

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# Science of Synthesis

Houben-Weyl Methods of Molecular Transformations

Category 3

## Compounds with Four and Three Carbon–Heteroatom Bonds

Volume 18

### Four Carbon–Heteroatom Bonds: $X-C\equiv X$ , $X=C=X$ , $X_2C=X$ , $CX_4$

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## Preface

As our understanding of the natural world increases, we begin to understand complex phenomena at molecular levels. This level of understanding allows for the design of molecular entities for functions ranging from material science to biology. Such design requires synthesis and, as the structures increase in complexity as a necessity for specificity, puts increasing demands on the level of sophistication of the synthetic methods. Such needs stimulate the improvement of existing methods and, more importantly, the development of new methods. As scientists confront the synthetic problems posed by the molecular targets, they require access to a source of reliable synthetic information. Thus, the need for a new, comprehensive, and critical treatment of synthetic chemistry has become apparent. To meet this challenge, an entirely new edition of the esteemed reference work **Houben-Weyl Methods of Organic Chemistry** will be published starting in the year 2000.

To reflect the new broader need and focus, this new edition has a new title, **Science of Synthesis, Houben-Weyl Methods of Molecular Transformations**. **Science of Synthesis** will benefit from more than 90 years of experience and will continue the tradition of excellence in publishing synthetic chemistry reference works. **Science of Synthesis** will be a balanced and critical reference work produced by the collaborative efforts of chemists, from both industry and academia, selected by the editorial board. All published results from journals, books, and patent literature from the early 1800s until the year of publication will be considered by our authors, who are among the leading experts in their field. The 48 volumes of **Science of Synthesis** will provide chemists with the most reliable methods to solve their synthesis problems. **Science of Synthesis** will be updated periodically and will become a prime source of information for chemists in the 21st century.

**Science of Synthesis** will be organized in a logical hierarchical system based on the target molecule to be synthesized. The critical coverage of methods will be supported by information intended to help the user choose the most suitable method for their application, thus providing a strong foundation from which to develop a successful synthetic route. Within each category of product, illuminating background information such as history, nomenclature, structure, stability, reactivity, properties, safety, and environmental aspects will be discussed along with a detailed selection of reliable methods. Each method and variation will be accompanied by reaction schemes, tables of examples, experimental procedures, and a background discussion of the scope and limitations of the reaction described.

The policy of the editorial board is to make **Science of Synthesis** the ultimate tool for the synthetic chemist in the 21st century.

We would like to thank all of our authors for submitting contributions of such outstanding quality, and, also for the dedication and commitment they have shown throughout the entire editorial process.

### The Editorial Board

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## Volume Editor's Preface

This volume concerns the synthesis of functional groups in which carbon has four bonds to heteroatoms. This represents an enormously diverse range of chemistry, and a correspondingly wide variety of functionality, from highly unsaturated systems such as heterocumulenes (e.g., carbon dioxide) to compounds with no  $\pi$ -bonds, such as carbon tetrafluoride. Despite this diversity, much of the chemistry is dominated by that of the carbonyl group and its direct heteroatom analogues, such as the imino and thiocarbonyl groups. A central role is played by phosgene ( $\text{COCl}_2$ ) which, despite its toxicity, is a useful precursor to many of the other functional groups in Volume 18. While most of the compound classes have been known for a very long time, some have proven more elusive and have only recently been prepared and identified, through advances in synthetic methodology and spectroscopic techniques. Such compounds include phosphalkene and phosphalkyne derivatives, and several selenium- and tellurium-based functional groups.

The structure of this volume follows that established in the other volumes of **Science of Synthesis**, i.e. the material is organized into methods for the synthesis of the product class in question, with each method usually including a discussion of the scope of the method, examples, and an experimental procedure. Occasionally, this structure has been modified in order to present the material in a more succinct and reader-friendly way. The product classes are ordered according to the **Science of Synthesis** guidelines. When the product subclass is employed as a reagent or catalyst in organic transformations, a further section titled *Applications [of the Product Class] in Organic Synthesis* is included.

Finally, I would like to thank everyone who has been involved in the creation of this volume. In particular, I thank the authors for the very considerable time and effort that they devoted to producing a series of thorough and well-written sections, Dr Joe P. Richmond for valuable help in planning the volume, Dr M. Fiona Shortt de Hernandez, Dr Christabel Carter, Dr Karen Muirhead, Leigh Murray, and the other members of the team at Thieme for their hard work, patience, and attention to detail throughout.

**Volume Editor**

Newcastle, March 2005

J. G. Knight



**Volume 18:**  
**Four Carbon–Heteroatom Bonds:**  
 **$X-C\equiv X$ ,  $X=C=X$ ,  $X_2C=X$ ,  $CX_4$**

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