Science of Synthesis

Category 3 Cumulative Index

Compounds with Four and Three Carbon—Heteroatom Bonds

Indexers
J. Backes and
C. J. Drayton

Editorial Board
D. Bellus
E. N. Jacobsen
S. V. Ley
R. Noyori
M. Regitz
P. J. Reider
E. Schaumann
I. Shinkai
E. J. Thomas
B. M. Trost

Thieme
Organizational Structure of Science of Synthesis*

Classification is based on the product, with all products belonging to one of six broad-ranging categories. All products occupy a strict hierarchical position in Science of Synthesis, defined according to the classification principles*. Products in Categories 3–6 are organized according to oxidation state, with products containing the greatest number of carbon–heteroatom (C–X) or C–C π-bonds to a single carbon occupying the highest positions (e.g., carboxylates, enolates, and alcoholates are covered in Categories 3, 4, and 5, respectively).

Each category is subdivided into volumes (see opposing page), each of which is devoted to discrete groupings of compounds called product classes (e.g., “Thiophenes” is Product Class 10 of Volume 9). Product classes may be further subdivided into product subclasses, (e.g., “Thiophene 1,1-Dioxides” is Product Subclass 3 of Product Class 10 of Volume 9). Consequently, the relationship between heading name and heading number varies below product class level within individual volumes.

For each product class or subclass, a number of methods are described for synthesizing the general product type. Often there are variations on a method given. Both methods and variations contain experimental procedures with relevant background information and literature references. Selected products and reactions display the scope and limitations of the methods.

* A complete description of the full classification principles can be found in the Science of Synthesis Guidebook.
Volume Listing for Category 3: 4/3 C–X bonds

**CATEGORY**

1. Organometallics (Vols 1–8)

2. Hetarenes (Vols 9–17)

3. 4/3 C–X bonds (Vols 18–24)

4. 2 C–X bonds (Vols 25–33)

5. 1 C–X bond (Vols 34–42)

6. All C bonds (Vols 43–48)

**Category 3 4/3 C–X bonds (Volumes 18 – 24)**

- **Volume 18** Four Carbon–Heteroatom Bonds: X–C≡X, X≡C=X, X=C≡X, CX₄
- **Volume 19** Three Carbon–Heteroatom Bonds: Nitriles, Isocyanides, and Derivatives
- **Volume 20 a** Three Carbon–Heteroatom Bonds: Acid Halides; Carboxylic Acids and Acid Salts
- **Volume 20 b** Three Carbon–Heteroatom Bonds: Esters and Lactones; Peroxy Acids and R(CO)OX Compounds; R(CO)X, X = S, Se, Te
- **Volume 21** Three Carbon–Heteroatom Bonds: Amides and Derivatives; Peptides; Lactams
- **Volume 22** Three Carbon–Heteroatom Bonds: Thio-, Seleno- and Tellurocarboxylic Acids and Derivatives; Imidic Acids and Derivatives; Ortho Acid Derivatives
- **Volume 23** Three Carbon–Heteroatom Bonds: Ketenes and Derivatives
- **Volume 24** Three Carbon–Heteroatom Bonds: Ketene Acetals and Yne–X Compounds

* Detailed listings of product classes and subclasses, methods, and variations can be found in the Table of Contents sections of every volume.
Science of Synthesis

*Science of Synthesis* is the authoritative and comprehensive reference work for the entire field of organic and organometallic synthesis.

*Science of Synthesis* presents the important synthetic methods for all classes of compounds and includes:

- Methods critically evaluated by leading scientists
- Background information and detailed experimental procedures
- Schemes and tables which illustrate the reaction scope
Category 3

Compounds with Four and Three Carbon–Heteroatom Bonds

Cumulative Index

Editorial Board

D. Bellus                  P. J. Reider
E. N. Jacobsen            E. Schaumann
S. V. Ley                 I. Shinkai
R. Noyori                 E. J. Thomas
M. Regitz                 B. M. Trost

2008
Georg Thieme Verlag KG
Stuttgart · New York
List of All Volumes

Science of Synthesis, Houben–Weyl Methods of Molecular Transformations

Category 1: Organometallics
1. Compounds with Transition Metal–Carbon π-Bonds and Compounds of Groups 10–8 (Ni, Pd, Pt, Co, Rh, Ir, Fe, Ru, Os)
2. Compounds of Groups 7–3 (Mn…, Cr…, V…, Ti…, Sc…, La…, Ac…)
3. Compounds of Groups 12 and 11 (Zn, Cd, Hg, Cu, Ag, Au)
4. Compounds of Group 15 (As, Sb, Bi) and Silicon Compounds
5. Compounds of Group 14 (Ge, Sn, Pb)
6. Boron Compounds
7. Compounds of Groups 13 and 2 (Al, Ga, In, Tl, Be… Ba)
8a. Compounds of Group 1 (Li… Cs)
8b. Compounds of Group 1 (Li… Cs)

Category 2: Hetarenes and Related Ring Systems
9. Fully Unsaturated Small-Ring Heterocycles and Monocyclic Five-Membered Hetarenes with One Heteroatom
10. Fused Five-Membered Hetarenes with One Heteroatom
11. Five-Membered Hetarenes with One Chalcogen and One Additional Heteroatom
12. Five-Membered Hetarenes with Two Nitrogen or Phosphorus Atoms
13. Five-Membered Hetarenes with Three or More Heteroatoms
14. Six-Membered Hetarenes with One Chalcogen
15. Six-Membered Hetarenes with One Nitrogen or Phosphorus Atom
16. Six-Membered Hetarenes with Two Identical Heteroatoms
17. Six-Membered Hetarenes with Two Unlike or More than Two Heteroatoms and Fully Unsaturated Larger-Ring Heterocycles

Category 3: Compounds with Four and Three Carbon–Heteroatom Bonds
19. Three Carbon–Heteroatom Bonds: Nitriles, Isocyanides, and Derivatives
20a. Three Carbon–Heteroatom Bonds: Acid Halides; Carboxylic Acids and Acid Salts
20b. Three Carbon–Heteroatom Bonds: Esters and Lactones; Peroxy Acids and R(CO)X Compounds; R(CO)X, X = S, Se, Te
21. Three Carbon–Heteroatom Bonds: Amides and Derivatives; Peptides; Lactams
22. Three Carbon–Heteroatom Bonds: Thio-, Seleno-, and Tellurocarboxylic Acids and Derivatives; Imidic Acids and Derivatives; Ortho Acid Derivatives
23. Three Carbon–Heteroatom Bonds: Ketenes and Derivatives
24. Three Carbon–Heteroatom Bonds: Ketene Acetals and Yne–X Compounds
<table>
<thead>
<tr>
<th>Category 4: Compounds with Two Carbon–Heteroatom Bonds</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 Aldehydes</td>
</tr>
<tr>
<td>26 Ketones</td>
</tr>
<tr>
<td>27 Heteroatom Analogues of Aldehydes and Ketones</td>
</tr>
<tr>
<td>28 Quinones and Heteroatom Analogues</td>
</tr>
<tr>
<td>29 Acetals: Hal/X and O/O, S, Se, Te</td>
</tr>
<tr>
<td>30 Acetals: O/N, S/S, S/N, and N/N and Higher Heteroatom Analogues</td>
</tr>
<tr>
<td>31a Arene—X (X = Hal, O, S, Se, Te)</td>
</tr>
<tr>
<td>31b Arene—X (X = N, P)</td>
</tr>
<tr>
<td>32 X—Ene—X (X = F, Cl, Br, I, O, S, Se, Te, N, P), Ene—Hal, and Ene—O Compounds</td>
</tr>
<tr>
<td>33 Ene—X Compounds (X = S, Se, Te, N, P)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category 5: Compounds with One Saturated Carbon–Heteroatom Bond</th>
</tr>
</thead>
<tbody>
<tr>
<td>34 Fluorine</td>
</tr>
<tr>
<td>35 Chlorine, Bromine, and Iodine</td>
</tr>
<tr>
<td>36 Alcohols</td>
</tr>
<tr>
<td>37 Ethers</td>
</tr>
<tr>
<td>38 Peroxides, Inorganic Esters (RO—X, X = Hal, S, Se, Te, N)</td>
</tr>
<tr>
<td>39 Sulfur, Selenium, and Tellurium</td>
</tr>
<tr>
<td>40 Amines, Ammonium Salts, Haloamines, Hydroxylamines, and Hydrazines</td>
</tr>
<tr>
<td>41 Nitro, Nitroso, Azo, Azoxy, and Diazonium Compounds, Azides, Triazenes, and Tetrazenes</td>
</tr>
<tr>
<td>42 Organophosphorus Compounds (incl. RO—P and RN—P)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category 6: Compounds with All-Carbon Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>43 Polynes, Arynes, Enynes, and Alkynes</td>
</tr>
<tr>
<td>44 Cumulenes and Allenes</td>
</tr>
<tr>
<td>45 Arenes, Annulenes, and Conjugated Polynes</td>
</tr>
<tr>
<td>46 1,3-Dienes</td>
</tr>
<tr>
<td>47 Alkenes</td>
</tr>
<tr>
<td>48 Alkanes</td>
</tr>
</tbody>
</table>
Science of Synthesis

Houben–Weyl Methods of Molecular Transformations

Category 3

Compounds with Four and Three Carbon–Heteroatom Bonds

Cumulative Index

Indexers

J. Backes and C. J. Drayton

2008

Georg Thieme Verlag KG
Stuttgart · New York
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

D. Bellus (Basel, Switzerland)  P. J. Reider (New Jersey, USA)
E. N. Jacobsen (Cambridge, USA)  E. Schaumann (Clausthal-Zellerfeld, Germany)
S. V. Ley (Cambridge, UK)  I. Shinkai (Tsukuba, Japan)
R. Noyori (Nagoya, Japan)  E. J. Thomas (Manchester, UK)
M. Regitz (Kaiserslautern, Germany)  B. M. Trost (Stanford, USA)

October 2000
Category 3 (Compounds with Four and Three Carbon—Heteroatom Bonds):
Cumulative Index

Preface ................................................................ IX
Product Class Overview .............................................. 1
Structure Index .......................................................... 21
Name Reaction Index .................................................. 151
Keyword Index ............................................................ 165
Author Index ............................................................. 571
Abbreviations ............................................................. 945