

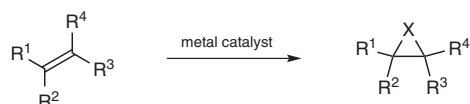
Abstracts

p 1

2.1 Epoxidation and Aziridination Reactions

F. Xia and S. Ye

Due to the strain associated with three-membered rings, epoxides and aziridines react with various nucleophiles to give 1,2-difunctionalized products. This makes them valuable intermediates in organic synthesis, including in the synthesis of bioactive natural and nonnatural compounds. This chapter summarizes recent advances in metal-catalyzed epoxidation and aziridination reactions of alkenes, as well as their synthetic applications.



X = O, NR¹

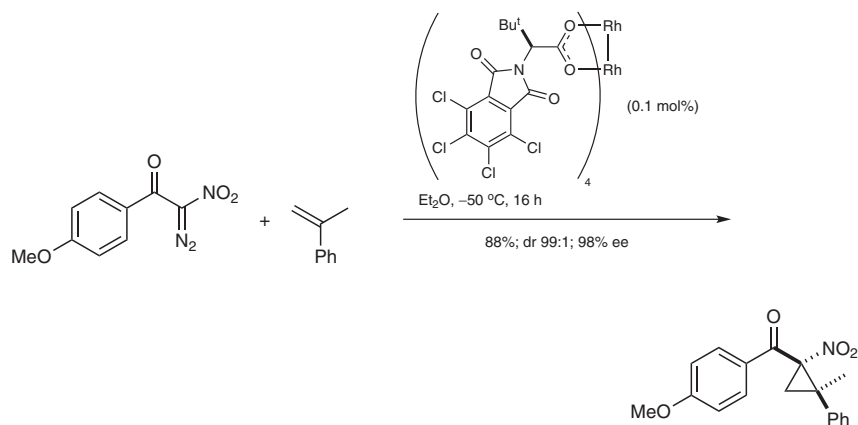
Keywords: epoxidation · aziridination · epoxides · aziridines · alkenes · metal catalysis · cyclization · enantioselectivity · diastereoselectivity · asymmetric synthesis

p 49

2.2 Metal-Catalyzed Cyclopropanation

L. K. B. Garve and D. B. Werz

This chapter describes the most important metal-catalyzed methods to generate cyclopropanes, the smallest class of cycloalkanes. In the past fifty years, the use of metals in combination with chiral ligands for diastereo- and enantiodiscrimination in cyclopropane synthesis has been intensively studied. Two main approaches have emerged. Utilizing carbenes in the form of metal-carbene complexes has led to a renaissance of three-membered-rings in organic synthesis. In another approach, metal cations such as gold(I) and platinum(II) interact with alkynes, forming novel cyclopropane motifs. Finally, further metal-catalyzed cyclopropanations are mentioned.



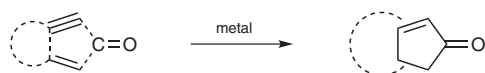
Keywords: cyclopropanes · three-membered rings · metal-catalyzed cyclopropanation · asymmetric cyclopropanation · carbenes · metal–carbene complexes · Kulinkovich cyclopropanation · enynes · copper · rhodium · cobalt · iridium · ruthenium · iron · palladium · gold · platinum · titanium · bicyclic molecules

p 99

2.3 Pauson–Khand Reactions

G. Domínguez and J. Pérez-Castells

The Pauson–Khand (2+2+1) cycloaddition (PKR) is one of the best ways to construct a cyclopentenone. In this review, standard procedures to perform both stoichiometric and catalytic Pauson–Khand reactions are presented. These include the use of homo- and heterogeneous catalysts as well as different promoters. Asymmetric versions are described, as are cascade processes where the Pauson–Khand reaction is combined with other transformations. The chapter ends with a summary of representative total syntheses of natural products where a Pauson–Khand reaction is used as the key step.



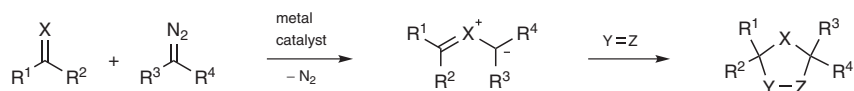
Keywords: Pauson–Khand · cycloaddition · transition-metal catalysis · stereoselectivity · asymmetric synthesis · cobalt · rhodium · iridium · heterogeneous catalysis · cascade synthesis · total synthesis

p 167

2.4 1,3-Dipolar Cycloadditions Involving Carbonyl or Azomethine Ylides

X. Xu and W. Hu

Carbonyl ylides, which behave as active 1,3-dipole species, have found numerous applications in organic synthesis, especially in the formation of five-membered heterocycles. Among the versatile transformations of carbonyl ylides, 1,3-dipolar cycloadditions with π -bonds, including (3+2)-cycloaddition reactions with carbon–carbon π -bonds, aldehydes, and imines, are ubiquitous and important reactions. This chapter focuses on recent advances in these catalytic (3+2)-cycloaddition reactions and the examples presented emphasize the chemo-, diastereo-, and enantiocontrol that can be achieved. Also described are selected examples of cycloaddition reactions with azomethine ylides, which behave with similar reactivity to carbonyl ylides, to give the corresponding N-heterocycles. In addition, some selected applications of these (3+2)-cycloaddition reactions in natural product synthesis are highlighted.



$X = O, NR^5$; $Y = Z =$ aldehyde, ketone, alkene, alkyne, imine, etc.

Keywords: (3+2) cycloaddition · carbonyl ylides · azomethine ylides · 1,3-dipoles · diazo compounds · chiral dirhodium carboxylates · heterocycles · five-membered rings · natural product synthesis · asymmetric catalysis

2.5 Metal-Catalyzed Asymmetric Diels–Alder and Hetero-Diels–Alder Reactions

H. Du

This chapter focuses on asymmetric Diels–Alder, oxa-Diels–Alder, and aza-Diels–Alder reactions promoted by various chiral, Lewis acidic metal catalysts. As well as describing the different approaches and catalysts, selected examples of these reactions in the synthesis of natural products and drug molecules are presented.



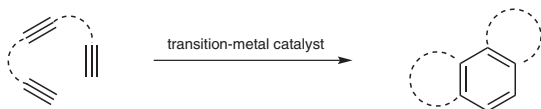
X = CHR⁶, O, NR⁶

Keywords: asymmetric synthesis • aza-Diels–Alder reactions • Diels–Alder reactions • Lewis acid catalysis • metal-catalyzed reactions • oxa-Diels–Alder reactions

2.6 Metal-Catalyzed (2 + 2 + 2) Cycloadditions

K. Tanaka and Y. Shibata

The transition-metal-catalyzed (2+2+2) cycloaddition is a useful and atom-economical method for the synthesis of substituted six-membered-ring molecules. In this chapter, standard procedures for the transition-metal-catalyzed (2+2+2) cycloaddition involving not only alkynes but also nitriles, heterocumulenes, alkenes, and carbonyl compounds are presented. Applications in the synthesis of chiral aromatic molecules (biaryls, cyclophanes, and helicenes) and biologically active molecules are also described.

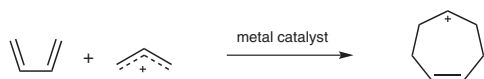


Keywords: alkenes • alkynes • asymmetric catalysis • benzenes • biaryls • carbocycles • carbodiimides • carbon dioxide • carbonyl compounds • cycloaddition • cyclophanes • helicenes • heterocumulenes • heterocycles • isocyanates • metallacycles • nitriles • pyridines • pyridones • transition metals

2.7 Metal-Catalyzed (4 + 3) Cycloadditions Involving Allylic Cations

D. E. Jones and M. Harmata

The (4+3)-cycloaddition reaction is a reaction between an allylic cation and diene. It is a powerful process and one of the few reactions that directly generates seven-membered ring systems. This reaction exhibits high levels of diastereoselectivity and regioselectivity, which makes it attractive for the rapid construction of complex targets. Several select, reliable, and reproducible methods for the generation and capture of allylic cations by 1,3-dienes using metal catalysis or mediation are presented in this review along with some representative examples of the use of (4+3) cycloadditions in the synthesis of natural products.

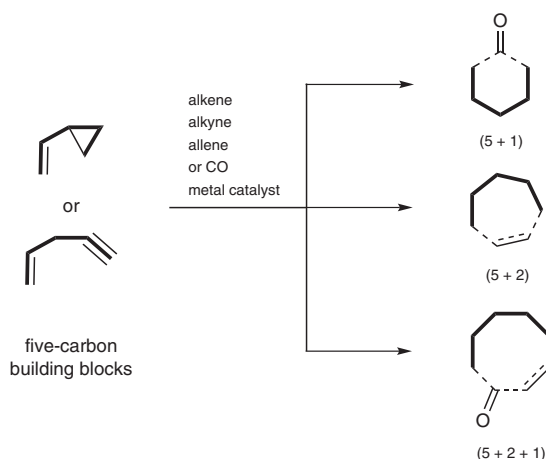


Keywords: (4+3) cycloaddition · intramolecular · intermolecular · allylic cations · oxallylic cations · chiral cations · 1,3-dienes · regioselective · diastereoselective · stereoselective · asymmetric · enantioselective · metal-catalyzed · metal-mediated

2.8 Metal-Catalyzed (5+1), (5+2), and (5+2+1) Cycloadditions

X. Li and W. Tang

Metal-catalyzed (5+n) cycloaddition is a powerful strategy for the synthesis of six-, seven-, and eight-membered carbocycles and heterocycles. These cycloadditions usually involve oxidative cyclization to a metallacycle; insertion into the C–M bond (e.g., by carbon monoxide, an alkene, alkyne, or allene, or a combination thereof); and reductive elimination. Vinylcyclopropanes and 3-acyloxy-1,4-enynes are the most common five-carbon synthons. Recent advances in transition-metal-catalyzed (5+1), (5+2), and (5+2+1) cycloadditions including their development, mechanistic studies, and applications are reviewed in this chapter.

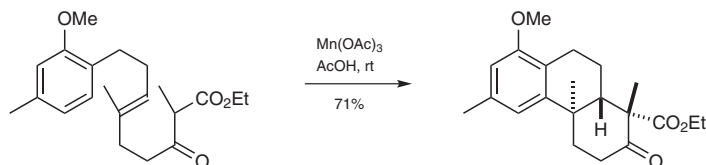


Keywords: cycloaddition · transition metals · catalysis · vinylcyclopropanes · propargylic esters · (5+1) cycloaddition · (5+2) cycloaddition · (5+2+1) cycloaddition · carbocycles · heterocycles · seven-membered rings · alkenes · alkynes · allenes · imines · cyclopropanes · epoxides · rhodium · ruthenium · nickel · iron · dictamnol · aphanamol · allocyathin B₂ · tremulenediol A · tremulenolide A · pseudolaric acid B · frondosin A · rameswaralide · hirsutene · desoxyhyppophilin · asteriscanolide

2.9 Intramolecular Free-Radical Cyclization Reactions

M. Mondal and U. Bora

Over the past five decades, the metal-mediated intramolecular free-radical cyclization strategy has developed into a widely applicable synthetic methodology. With properties including wide functional-group tolerance, selectivity, and spatial retention, radical chemistry has attracted considerable attention from chemists dealing with the synthesis and functionalization of diverse organic compounds. The coverage of this chapter is limited to the best methods available for the metal-mediated synthesis of cyclic organic and biomolecular species for practical use in both an academic setting and in industry.

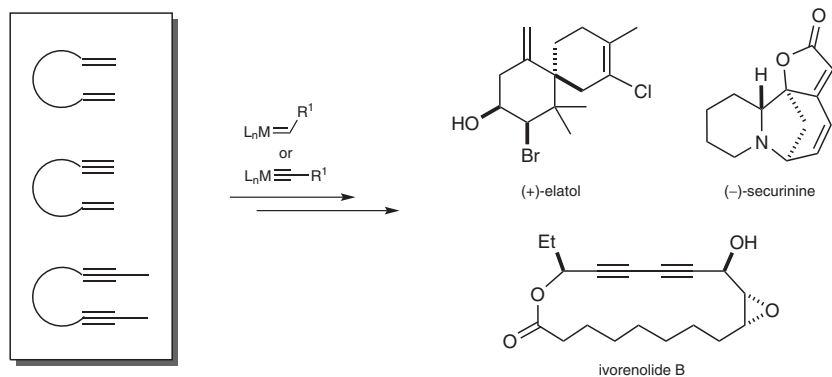


Keywords: intramolecular · free-radical · cyclization · manganese(III) acetate · titanocenes · samarium(II) iodide · copper · tandem · cascade · pyrroles · alkylidenes · indoles · azaindoles · indolinones · oxindoles · lactams · quinolines · furans · lactones · phthalides · pyrans · benzopyrans · piperidines · cycloalkanes · cycloalkanols · allyl alcohols · amino alcohols · cyclic ketones · amino ketones · phenanthridines · benzothiazoles · thiophenes · total synthesis

2.10 Ring-Closing Metathesis

D. Lee and V. Reddy Sabbasani

Ring-closing metathesis (RCM) has emerged as a powerful synthetic tool. Depending on the unsaturated functional groups involved, ring-closing-metathesis reactions are classified into three categories: diene ring-closing metathesis, enyne ring-closing metathesis, and diyne ring-closing metathesis. These are mediated/catalyzed by metal alkylidenes or alkylidyne to form cyclic alkenes or alkynes, with ring sizes ranging from small to large, and including both carbocycles and heterocycles. Mechanistically, diene and diyne ring-closing metathesis involves an exchange reaction between the participating alkenes or alkynes, whereas enyne ring-closing metathesis involves a formal addition reaction between an alkene and an alkyne. This chapter summarizes the distinctive features of these different ring-closing metathesis processes in terms of the advancement of mechanistic understanding and the development of effective catalyst systems and their application to natural product synthesis.



Keywords: diene metathesis · diyne metathesis · enyne metathesis · ring-closing metathesis · ring rearrangement · ruthenium alkylidenes · metallotropic shift · molybdenum alkylidenes · molybdenum alkylidynes