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Spotlight 119

This feature focuses on a reagent chosen by a postgraduate, highlighting the uses and preparation of the reagent in current research

Molybdenum Hexacarbonyl

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Introduction

Molybdenum hexacarbonyl [Mo(CO)_6] is a stable crystalline solid with an octahedral geometry (Figure 1). It is generally prepared by reductive carbonylation of molybdenum halides, or is obtained from commercial sources. Mo(CO)_6 finds use as catalyst or reagent in several processes, by itself or tuning its reactivity by ligand exchange. Replacement of the carbonyl ligands by both p and s donors affords a large number of different molybdenum complexes which have found use in organic synthesis. The use of chiral ligands allows high levels of regio- and enantioselectivity to be attained.

Abstracts

(A) The use of a thermostable catalytic system in combination with Mo(CO)_6 allowed the synthesis of benzofuranones starting from bromobenzyl alcohols. Indanones were obtained under similar conditions using ortho-bromo(chloro)styrenes. A variant was performed by using polymer-supported amines for the synthesis of amides from aryl halides. A convenient synthesis of α-methyl-γ-butyro lactones from allenyl carbonyls was performed by a DMSO-promoted carbonylation. These reactions enlighten the role of Mo(CO)_6 as a source of CO.

(B) ‘Instant’ catalysts formed from Mo(CO)_6 and phenols have been developed for alkyn metathesis. Pre-heating activation of catalytic systems consisting of Mo(CO)_6 and 4-chlorophenol has increased the yields of productive enyne metathesis. This procedure was used to dimerize ortho-alkyloxypropynylbenzenes and to afford ring-closing alkyn metathesis (RCAM) products from dipropynyls. The use of 2-fluorophenol in place of 4-chlorophenol led to a more reactive and friendly catalyst, which has been employed not only in RCAM, but also in alkyn homodimerizations (HD) and cross metatheses (CM).

(C) Mo(CO)_6 was reported to effect Pauson–Khand reactions of enynes to afford cyclopentenones. Chiral alkynyl allenes afforded enantioenriched α-alkylidene cyclopentenones. Under the same conditions, functionalized difluoroallenes underwent intramolecular [2+2] cycloaddition to afford gem-difluoro bicyclo[4.2.0] systems, instead of the expected Pauson–Khand products. A tandem Pauson–Khand reaction of biscyclo-bisallenenes to [5.5.5.5] tetracycles has been reported by Cook, who used a saturated solution of Mo(CO)_6.

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(D) Mo(CO)$_3$ has catalyzed the cycloisomerization of 1-alkyn-4-ols to 2,3-dihydrofurans and the isomerization of epoxalkynes to furans.$^{16}$ Cyclizations of allylphenylethers with skeletal rearrangement to benzopyrans have also been performed.$^{16}$ Friedel–Crafts alkylations have been reported, too.$^{16}$

(E) Mo(CO)$_3$ has been used to reduce the N–O bonds of isoxazoles,$^{7c}$ isoxazolines,$^{7c}$ isoxazolidines$^{7e}$ and 1,2-oxazines,$^{7d}$ Variants employed sub-stoichiometric amounts of Mo(CO)$_3$ in the presence of NaBH$_4$,$^{7b}$ or a decomplexing work-up on silica gel.$^{7j}$ The selective reduction of azides,$^{7h}$ nitro compounds$^{7b}$ and hydroxylamines$^{7i}$ to amines and deoxygenation of epoxides$^{7j}$ have also been accomplished.

(F) Mo(CO)$_3$ behaved as a catalyst for the mild oxidation of 2,5-dialkylfurans to $E$ or $Z$ (depending on the use of a base) enediones using cumyl hydroperoxide (CHP).$^{6b}$ Diones gave peroxypyrazolidines,$^{45}$ whereas, for other oxidations with Mo(CO)$_3$, see: (a) Barluenga, J.; Fañanás, F. J. Tetrahedron 2000, 56, 4597. For the synthesis of different carbonyl complexes, see: (c) Bertolini, T. M.; Nguyen, Q. H.; Harvey, D. F. Tetrahedron Lett. 2002, 43, 3744 and references therein. For imine cyclizations of allylphenylethers with skeletal rearrangement to amines and deoxygenation of epoxides$^{7j}$ have also been accomplished.

References


