Spotlight

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

Introduction

Although molybdenum(VI) dichloride dioxide (MoO$_2$Cl$_2$) has been known for a long time,$^1$ it is still exploited as a catalyst for versatile organic transformations.$^2$ It is an oxo-transfer catalyst, displaying its ability to promote oxidation as well as reduction reactions. In many reactions, it is also used as a Lewis acid.

Preparation

MoO$_2$Cl$_2$ is a pale-yellow solid, highly reactive and corrosive. It is commercially available$^3$ and can be prepared by a method reported by Colton and Tomkins.$^4$ MoO$_2$Cl$_2$L$_2$ (where L = dmf, dmso, and thf) are more frequently used because of their thermal and chemical stability. The preparation of MoO$_2$Cl$_2$(dmf)$_2$ is simple, efficient, and almost quantitative using readily available Na$_2$MoO$_4$·2H$_2$O.$^5$

Abstracts

(A) Using catalytic MoO$_2$Cl$_2$(dmf)$_2$, arylindazoles are accessible by reductive cyclisation of o-nitrobenzylidene amines with triphenylphosphine in refluxing toluene or under microwave conditions. Similarly, o-nitrostyrenes and nitrobiphenyls gave indoles and carbazoles, respectively. Benzothiazines, benzoazaines, and tetrahydroquinolines were obtained by the reductive cyclisation of o-nitroalkenes via an Alder-ene reaction.$^6$

(B) Selective deoxygenation of sulfoxides to sulfides was carried out with triphenylphosphate or boranes using MoO$_2$Cl$_2$(dmf)$_2$ or MoO$_2$Cl$_2$. Catalytic MoO$_2$Cl$_2$(dmf)$_2$ and pinacol as a benign reducing agent were used for the reduction of sulfoxides to sulfides. The same system was explored for the reduction of nitroaromatic compounds to anilines.$^5,7$

(C) Aromatic and aliphatic esters were reduced to alcohols using silanes and catalytic MoO$_2$Cl$_2$. Imines were efficiently reduced to amines using the same system.$^8$

(D) Using MoO$_2$Cl$_2$, dimethylphenylsilanes were added to aldehydes and ketones to give dimethylphenylsilyl ethers.$^9$

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(E) MoO₂Cl₂(dmoso)₂ is a mild oxidation catalyst and oxidizes primary benzyl alcohols to aldehydes and secondary alcohols to ketones using oxygen.₁⁰

(F) Sulfides were selectively oxidized to sulfoxides and sulfones using MoO₂Cl₂(dmf)₂ as a catalyst and hydrogen peroxide in varying concentrations. Similarly, aliphatic and aromatic thiols were oxidized to disulfides.₁¹

(G) Epoxidation of various internal and terminal alkenes was achieved with high selectivity and good yields using an oxo-Mo catalyst. Challenging substrates like styrenes were selectively and efficiently epoxidized.₁²

(H) Thioglycosylation of O-acetylated glycosides with functionalized thioles led to exclusive 1,2-thioglycoside diastereomers using catalytic MoO₂Cl₂-catalyzed condensation of ethyl diazoacetate and aldehydes. Acetylation, pivalation, and benzoylation of alcohols, amines, and thiols was achieved by nucleophilic acyl substitution using amphoteric MoO₂Cl₂ catalyst.₁³

(I) Carbamates were prepared from primary, secondary, or tertiary alcohols and aliphatic or aromatic isocyanates using low concentrations of MoO₂Cl₂(dmf)₂ catalyst. Optically active substrates were also explored with retention of configuration.₁⁴

(J) Methanolation of epoxides to β-alkoxy alcohols is carried out by MoO₂Cl₂-catalyzed ring opening. Similarly, acetonidation or conversion of epoxides into α-alkoxyketones was also achieved.₁⁵

References

(3) CAS No. 13637-68-8.