

SYNLETT
Spotlight 237Magtrieve™ (CrO₂): A Versatile
Oxidant in Organic Synthesis

Compiled by Yu-Heng Liu



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

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Introduction

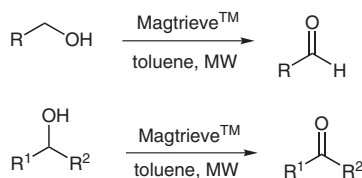
Magtrieve is a magnetically retrievable oxidant based on tetravalent chromium dioxide (CrO₂).¹ It is a selective, heterogeneous form of CrO₂, whose reduced form stays on the crystal surface. It is insoluble in most common organic solvents. Reactions with Magtrieve™ are typically performed in chlorinated solvents or toluene. Magtrieve has found wide application in organic synthesis, such as in the oxidation of allylic alcohols to allylic aldehydes,² the formation of benzyl from benzoin,³ the aromatization of imidazolines,⁴ the conversion of 2-hydroxymethyl-6,7-bis(pentylsulfanyl)tetrathiafulvalene into 2-formyl-6,7-bis(pentylsulfanyl) tetrathiafulvalene,⁵ oxidation of 2-

methoxyphenols to 1,4-benzoquinones,⁶ etc. This reagent is still ferromagnetic and can be conveniently removed after the reaction by a simple magnetic separation, because only the surface of the CrO₂ is reduced. This has significant environmental and cost advantages over traditional chromium reagents that require aqueous work-up and consequent appropriate disposal of the chromium waste. In addition, the reduced chromium surface can be simply reconverted into CrO₂ by heating in air, thus adding to its recyclability and cost-effectiveness. Magtrieve as an oxidant is a very well-suited reagent for microwave synthesis because it carries the benefit of efficient conversion of electromagnetic energy into heat according to the dielectric heating mechanism.⁷

Abstracts

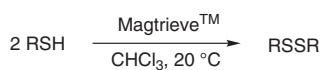
(A) Conversion of Alcohols into Carbonyl Compounds:

A convenient application of Magtrieve in organic synthesis is the oxidation of alcohols to carbonyl compounds.⁷ The reactions were carried out under microwave irradiation and in toluene as solvent. The primary alcohols were turned into the corresponding aldehydes without over-oxidizing them to carboxylic acids, while oxidation of secondary alcohols yielded ketones.



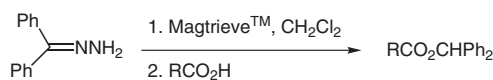
(B) Oxidation of Thiols to Disulfides:

An efficient procedure for the oxidation of thiols to disulfides using Magtrieve as oxidant was reported for the first time.⁸ For the aromatic thiols, the oxidation was complete within a few hours. The oxidation of aliphatic long-chain thiols required higher reaction temperatures and longer times. Tertiary thiols were inert under these conditions. The chemoselective oxidation of a thiol containing a primary hydroxyl group can be achieved by this method.



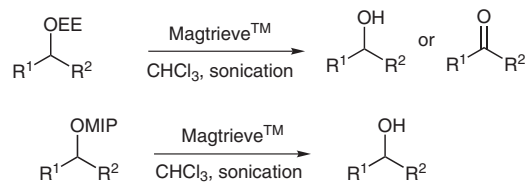
(C) Oxidation of Benzophenone Hydrazone to Diphenyldiazomethane:

A series of diphenylmethyl esters was obtained in moderate to good yields via oxidation of benzophenone hydrazone by Magtrieve to diphenyldiazomethane, followed by the reaction with carboxylic acids, enabling the one-pot protection of carboxylic acids including N-protected amino acids.⁹

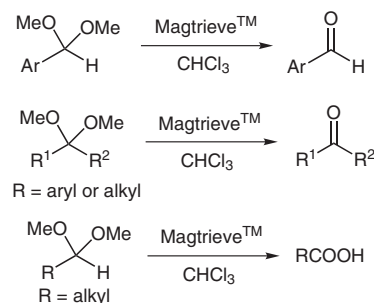


(D) *Chemoselective Deprotection/Oxidation of Protected Alcohols:*

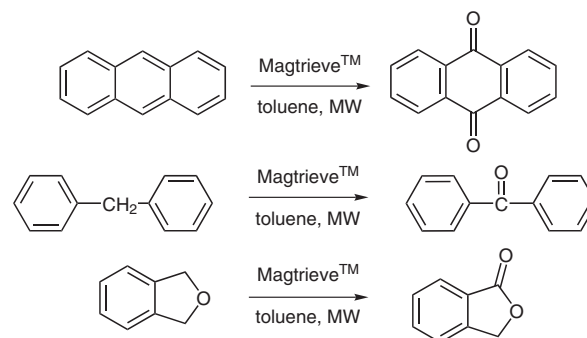
Using Magtrieve, 1-ethoxyethyl (EE) ethers of benzyl alcohol and allyl alcohols were converted into aldehydes under sonication conditions. EE ethers of aliphatic alcohols could be deprotected to give the corresponding alcohols without further oxidation. 1-Methyl-1-methoxyethyl (MIP) ethers of allyl, benzyl, or aliphatic alcohols were also deprotected to alcohols under these conditions. The selectivity of the method was demonstrated by the survival of other protecting groups such as tetrahydropyranyl (THP), methoxymethyl (MOM), 2-methoxyethoxymethyl (MEM), or *tert*-butyldimethylsilyl (TBDMS) ethers.¹⁰

(E) *Chemoselective Deprotection/Oxidation of Acetals and Ketals:*

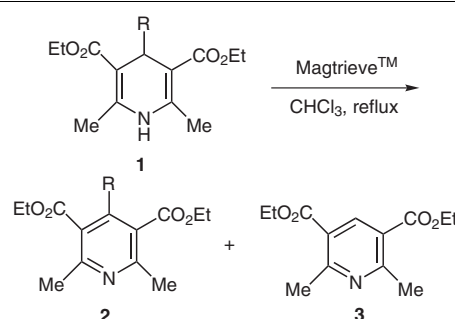
Magtrieve was also successfully used for the deprotection of acetals and ketals or for the direct oxidation to carboxylic acids.¹¹ The reaction proceeded at room temperature in chloroform. Dimethyl acetals of aromatic aldehydes and dimethyl ketals of ketones were converted into the corresponding carbonyl compounds in good yields. Dimethyl acetals of aliphatic aldehydes were oxidized to yield the corresponding carboxylic acids. The 1,3-dioxolanes were inert under these reaction conditions. This methodology is useful for the chemoselective deprotection of dimethyl acetals and ketals in the presence of dioxolanes.

(F) *Oxidation of Side-Chain Arenes:*

Lukasiewicz and co-workers¹² reported that Magtrieve was an efficient oxidant for the transformation of anthracene and side-chain arenes containing activated methylene groups into quinones, aryl ketones, or lactones. The reactions were carried out under microwave conditions using toluene as medium and gave the corresponding carbonyl compounds in high yields.

(G) *Aromatization of Hantzsch 1,4-Dihydropyridines:*

Ko and Kim found that Magtrieve can serve as mild oxidant for the aromatization of Hantzsch 1,4-dihydropyridines to pyridines using chloroform as solvent.¹³ Hantzsch 1,4-dihydropyridines bearing a benzyl group or an isopropyl group at 4-position underwent simultaneous dealkylation to give **3**.



References

- (1) Lee, R. A.; Donald, D. S. *Tetrahedron Lett.* **1997**, 38, 3857.
- (2) Vincent, F.; Widger, W. R.; Openshaw, M.; Gaskell, S. J.; Kohn, H. *Biochemistry* **2000**, 39, 9067.
- (3) Crumbie, R. L. *J. Chem. Educ.* **2006**, 83, 268.
- (4) de la Hoz, A.; Díaz-Ortiz, Á.; del Carmen Mateo, M.; Moral, M.; Moreno, A.; Elguero, J.; Foces-Foces, C.; Rodríguez, M. L.; Sánchez-Migallón, A. *Tetrahedron* **2006**, 62, 5868.
- (5) Hudhomme, P.; Sallé, M.; Gautier, N.; Belyasmine, A.; Gorgues, A. *ARKIVOC* **2006**, (iv), 49.
- (6) Jacob, A. M.; Moody, C. J. *Tetrahedron Lett.* **2005**, 46, 8823.
- (7) Bogdal, D.; Lukasiewicz, M.; Pielichowski, J.; Miciak, A.; Bednarz, S. *Tetrahedron* **2003**, 59, 649.
- (8) Sun, Y.-H.; Ko, K.-Y. *Bull. Korean Chem. Soc.* **2000**, 21, 665.
- (9) Ko, K.-Y.; Kim, J.-Y. *Bull. Korean Chem. Soc.* **1999**, 20, 771.
- (10) Park, S.-T.; Ko, K.-Y. *Bull. Korean Chem. Soc.* **2002**, 23, 367.
- (11) Ko, K.-Y.; Park, S.-T. *Tetrahedron Lett.* **1999**, 40, 6025.
- (12) Lukasiewicz, M.; Bogdal, D.; Pielichowski, J. *Adv. Synth. Catal.* **2003**, 345, 1269.
- (13) Ko, K.-Y.; Kim, J.-Y. *Tetrahedron Lett.* **1999**, 40, 3207.