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MAGNESIUM TRIFLUOROMETHANESULFONIMIDE(TRIFLIMIDE) PROMOTED SUBSTITUTION REACTIONS OF ALLYLIC AND BENZYLIC ACETATES. MAGNESIUM TRIFLIMIDE AS A SUBSTITUTE FOR MAGNESIUM PERCHLORATE.

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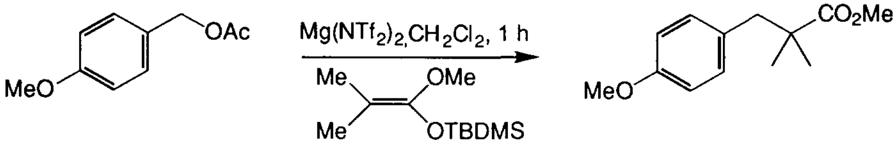
Abstract: Magnesium triflimide(10 mol% in methylene chloride) is a convenient catalyst for the nucleophilic substitution of allylic and benzylic acetates, and constitutes a useful alternative to magnesium perchlorate. © 1997 Elsevier Science Ltd.

Studies have demonstrated that highly substituted allylic acetates undergo facile substitution by a variety of nucleophiles in the presence of either 10 mol% lithium cobalt-bis-dicarbollide in 1,2-dichloroethane[1] or 10 mol% lithium tetrakis(1,1,1,3,3,3-hexafluoro-2-phenyl-2-propyloxy)aluminate in toluene.[2] Unfortunately, a number of the allylic and benzylic acetates examined either failed to react or reacted very slowly.[3] In an effort to expand the scope of these substitution reactions so as to accommodate benzylic acetates and less reactive allylic acetates, magnesium perchlorate and magnesium triflimide, which are more Lewis acidic than the corresponding lithium salts, were examined. We wish to report that both $Mg(ClO_4)_2$ and $Mg(NTf_2)_2$ are effective catalysts for promoting the nucleophilic substitution of "activated" acetates.

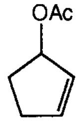
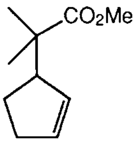
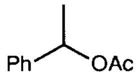
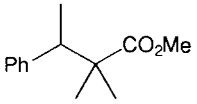
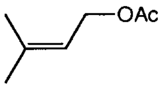
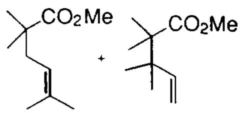
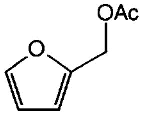
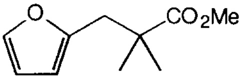
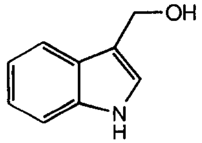
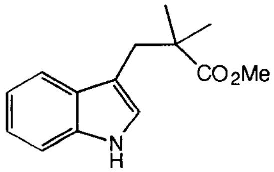


1 2 3 (99%)

Preliminary results with *p*-methoxybenzyl acetate (**1**) and silylketene acetal **2** employing 10 mol% magnesium perchlorate (note that the $Mg(ClO_4)_2$, which was purchased from Aldrich, contained ca. 8% water and was used as received) were promising. For example, exposure of a 0.1 M solution of **1** in methylene chloride containing 2.0 equiv of silyl ketene acetal **2** with 10 mol% $Mg(ClO_4)_2$ gave rise to a 99% yield of **3** after 1 h at ambient temperature. The above general procedure has been extended to a number of allylic and benzylic acetates (Table 1). Whereas reactions are complete within a few hours and yields are excellent with the exception of furfuryl acetate (Table 1, entry 4), the routine use of perchlorates can be a safety concern.[4] In view of our previous success employing lithium triflimide[5] as a substitute for lithium perchlorate, we chose to examine magnesium triflimide[6] as a replacement for magnesium perchlorate. Use of 10 mol% magnesium triflimide as the catalyst gave rise to results which were essentially indistinguishable from those obtained using magnesium perchlorate. For example, treatment of **1**, 0.1 M in methylene chloride containing 10 mol%

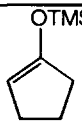
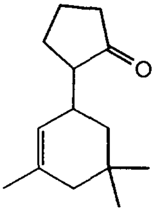
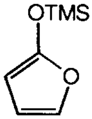
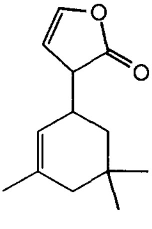
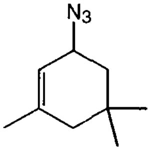
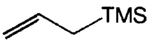
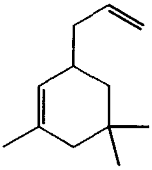
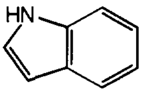
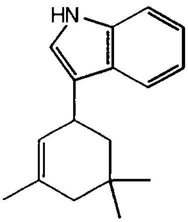
$Mg(NTf_2)_2$, with 2.0 equiv of **2** afforded **3** in 99% yield after 1 h.[7] For comparison purposes the results using $Mg(NTf_2)_2$ are displayed in Table 1 alongside the data obtained with $Mg(ClO_4)_2$. Yields are quite comparable, with the exception of entry 4 where an improved yield was obtained with $Mg(NTf_2)_2$. Of particular note is the reaction of 3-indolemethanol which proceeds directly to product in excellent yield employing either 10 mol% $Mg(NTf_2)_2$ or 10 mol% $Mg(ClO_4)_2$. In general, allylic and benzylic alcohols do not react to any significant extent under the standard conditions described above.

Table 1. Reaction of Allylic and Benzylic Acetates With Silyl Ketene Acetal **2** Using Magnesium Triflimide and Magnesium Perchlorate as Catalysts.[a]

Entry	Acetate	Product	Catalyst,[b] Time	Yield[c] %
1			A, 20 min B, 20 min	82 85
2			A, 2 h B, 2 h	79 82
3			A, 4 h B, 4 h	83[d] 84[d]
4			A, 1 h B, 1 h	48 24
5			A, 30 min B, 30 min	93 89

[a] All reactions performed 0.1 M in substrate in methylene chloride with 2 equivalents of silyl ketene acetal and 10 mol% catalyst. [b] Catalysts: A=$Mg(NTf_2)_2$, B=$Mg(ClO_4)_2$. [c] Isolated yield. [d] Ratio of formal S_N2 to S_N2' product is 2.5:1.0.

Table 2. Reaction of Isophorol Acetate with Nucleophiles Using Magnesium Triflimide and Magnesium Perchlorate as Catalysts.[a]

Entry	Nucleophile	Product	Catalyst,[b] Time	Yield[c] %
1			A, 30 min B, 30 min	95 81
2			A, 20 min B, 20 min	86 72
3	TMSN$_3$		A, 4 h B, 4 h	99 72
4			A, 20 min B, 20 min	76 76
5			A, 20 min B, 20 min	96 79

[a] All reactions performed 0.1 M in substrate in methylene chloride with 2 equivalents of nucleophile and 10 mol% catalyst. [b] Catalyst: A=Mg(NTf$_2$)$_2$, B=Mg(ClO$_4$)$_2$. [c] Isolated yield.

In addition to silyl ketene acetal **2**, other nucleophiles have been examined. The reactions of isophorol acetate with a number of nucleophilic species in the presence of both $Mg(NTf_2)_2$ and $Mg(ClO_4)_2$ are depicted in Table 2. In general, reactions are facile and complete in 30 min. Yields are excellent. Interestingly, the reaction of allyltrimethylsilane and isophorol acetate in the presence of either catalyst resulted in 76% yield; however, when allyltributylstannane was substituted for allyltrimethylsilane no reaction was observed!

In summary, we have demonstrated that magnesium triflimide is a mild and effective catalyst for the nucleophilic substitution of allylic and benzylic acetates. More importantly, magnesium triflimide is a safe substitute for magnesium perchlorate.

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References

1. Grieco, P.A.; DuBay, W.J.; Todd, L.J. *Tetrahedron Lett.* **1996**, *37*, 8707.
2. Barbarich, T.J.; Handy, S.T.; Miller, S.M.; Anderson, O.P.; Grieco, P.A.; Strauss, S.H. *Organometallics* **1996**, *15*, 3776.
3. Treatment of a 0.1 M solution of *p*-methoxybenzyl acetate (**1**) in methylene chloride containing 10 mol% lithium cobalt-bis-dicarbollide with 2.0 equiv of silyl ketene acetal **2** afforded only recovered starting material after 120 h. Lithium tetrakis(1,1,1,3,3,3-hexafluoro-2-phenyl-2-propyloxy)aluminate, as well as lithium perchlorate and lithium triflimide, were equally ineffective.
4. Schumacher, J.C. *Perchlorates: Their Properties, Manufacture, and Uses.* Reinhold Publishing Corporation, New York, 1960.
5. Handy, S.T.; Grieco, P.A.; Mineur, C.; Ghosez, L. *Synlett* **1995**, 565.
6. Magnesium triflimide can be readily prepared from bis(triflouromethanesulfonyl)imide and magnesium hydroxide. Prior to use, magnesium triflimide was dried under high vacuum at 150 °C for 24 h. For an earlier study reporting the use of this salt as a catalyst for Diels-Alder reactions, see: Kobayashi, H.; Nie, J.; Sonoda, T. *Chem. Lett.* **1995**, 307.
7. The following experimental procedure for the reaction between *para*-methoxybenzyl acetate (**1**) and silyl ketene acetal **2** serves as a general procedure. To a solution of *para*-methoxybenzyl acetate (31.2 mg, 0.17 mmol) in 2 mL of methylene chloride containing silyl ketene acetal **2** (82 mg, 0.34 mmol) under argon was added magnesium triflimide (11 mg, 0.0173 mmol). The heterogenous reaction was stirred at ambient temperature for 1 h. The reaction was quenched by the addition of water and the product isolated by extraction with methylene chloride. The combined organic extracts were dried with anhydrous magnesium sulfate and concentrated *in vacuo*. Flash chromatography using 10% ether/hexanes afforded 38.3 mg (99%) of adduct **3**.

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