Tetrahedron Letters, Vol. 33, No. 9, pp. 1135-1138, 1992
Printed in Great Britain

0040-4039/92 $3.00 + .00
Pergamon Press plc

TIN(II) CHLORIDE DIHYDRATE: A MILD AND EFFICIENT REAGENT FOR CLEAVING ACETALS.

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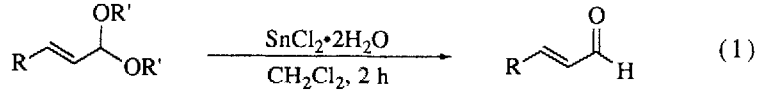
Key Words: Tin(II) chloride dihydrate, Lewis acid, deprotection of acetals.

Summary: Tin(II) chloride dihydrate ($SnCl_2 \cdot 2H_2O$) efficiently converts conjugated dioxolanes, and both dimethoxy and diethoxy acetals to aldehydes (84-98%). Similarly, nonconjugated dimethoxy and diethoxy acetals are also efficiently converted to aldehydes (84-94%). Conjugated pyrans and nonconjugated dioxolanes, however, are only converted to aldehydes in 17-38% yields.

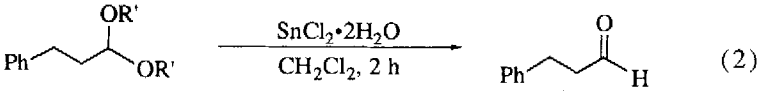
Although stannous chloride is commonly used as a reducing agent,[1] it has recently found new application as a Lewis acid catalyst. We discovered, for example, that $SnCl_2$ catalyzes the formal insertion of diazo compounds into aldehyde C-H bonds.[2] Other researchers have used stannous chloride to cataylze trans-acetalization[3] reactions, to methylate alcohols,[4] to activate alkyl and silyl chlorides,[5] and in modified Nef reactions.[6] In addition, stannous chloride can undergo conjugate addition reactions with α,β-unsaturated carbonyl compounds to yield monoalkyl trichlorostannanes.[7]



(1)

R = Ph, C_3H_7; R' = Me, Et, $-CH_2CH_2-$

(84-98%)

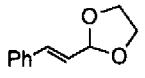
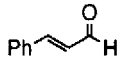
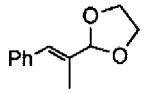
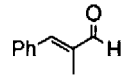
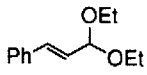
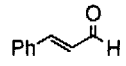
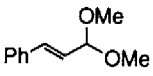
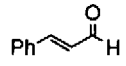
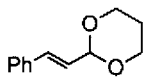
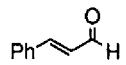
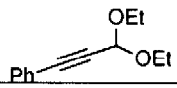
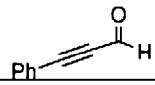
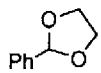
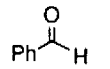
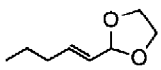
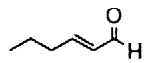
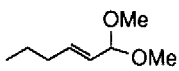
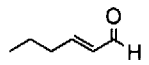
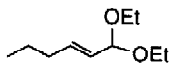
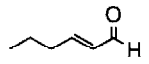
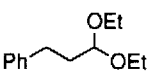
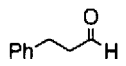
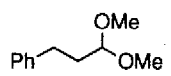
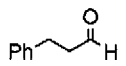
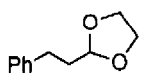
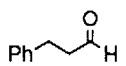


(2)

R' = Me, Et

(84-94%)

Table I. Conversion of Acetals to Aldehydes.

Acetal	Aldehyde	% Yield	Time (h)
		95	2
		88	2
		84	1
		86	1
		38	16
		66	3
		91[a]	8
		98[a]	2
		92[a]	1
		94[a]	1
		88[a]	16
		84[a]	16
		17[a]	16

a. GC yield based on a calibrated internal standard (naphthalene).

Acetals are generally cleaved by protic acids with water as a cosolvent.[8] As part of a continuing program aimed at developing synthetic methods based on divalent germanium and tin, we examined the addition of $SnCl_2 \cdot 2H_2O$ to acetals (eq 1, 2). In so doing, we found that it efficiently converts conjugated dioxolanes, dimethoxy acetals, and diethoxy acetals to aldehydes (Table 1).[9] Similarly, both nonconjugated, dimethoxy and diethoxy acetals are efficiently converted to aldehydes. Conjugated pyrans and nonconjugated dioxolanes, however, react very sluggishly and are not deprotected even over extended periods of time.

We have noted that these acetal cleavages require more than 0.5 mole equivalents of $SnCl_2 \cdot 2H_2O$. If less $SnCl_2 \cdot 2H_2O$ is used the reactions do not go to completion, even though there is a theoretical excess of water. We also observed that the acetal begins to reform if the reaction is left for long periods of time. This reacetalization is completely inhibited, however, when the reaction is run in the presence of sodium bicarbonate. Thus, the deprotection of acetals by a Lewis acid may be performed under nearly anhydrous and mildly basic conditions.

In the case of dioxolane acetals we recovered ethylene glycol as the side product. Mechanistically, we surmise that tin dichloride acts as a Lewis acid, coordinating to and activating the acetal to addition by water. The tin(II) chloride may also complex the alcohol side product, inhibiting acetal formation. When the reaction is run for extended periods of time, the tin(II) chloride may be responsible for generating trace amounts of protic acids, which could catalyse acetal formation.

The following experimental is representative: To a well stirred suspension of 0.196 g (0.870 mmol) of $SnCl_2 \cdot 2H_2O$ in 10 mL of methylene chloride at O°C was slowly added a solution of 0.153 g (0.870 mmol) of 2-(2-(E)-phenylethylenyl)-1,3-dioxolane in 15 mL of methylene chloride. The ice bath was then removed and the reaction mixture allowed to warm to room temperature. After stirring for 2 h at room temperature, the reaction mixture was filtered and the volatiles removed in vacuo. The resulting oil was purified by Kugelrohr distillation (0.2 mmHg) to give 0.109 g (95%), of cinnamaldehyde as a light yellow oil.

Acknowledgement: We wish to thank the Donors of The Petroleum Research Fund, administered by the American Chemical Society, and the National Institute of Health (GM42732) for support of this research.

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(Received in USA 4 November 1991)