

C-C Bond Cleavage of 2-Acylimidazolium Salts in a Sequence Involving a New Ester Homoenolate Equivalent. A Synthesis of γ -Lactones

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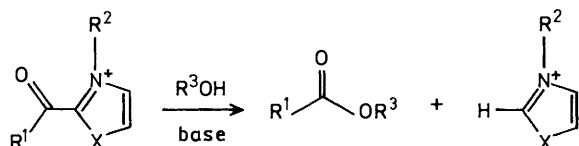
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Reaction of the anion of 2-(1-tri-isopropylsilyloxyallyl)-*N*-methoxymethylimidazole with ketones and aldehydes proceeds regioselectivity to give the enol silyl ethers of 2-acylimidazoles which suffer cleavage to γ -lactones after desilylation, *N*-methylation, and base treatment.

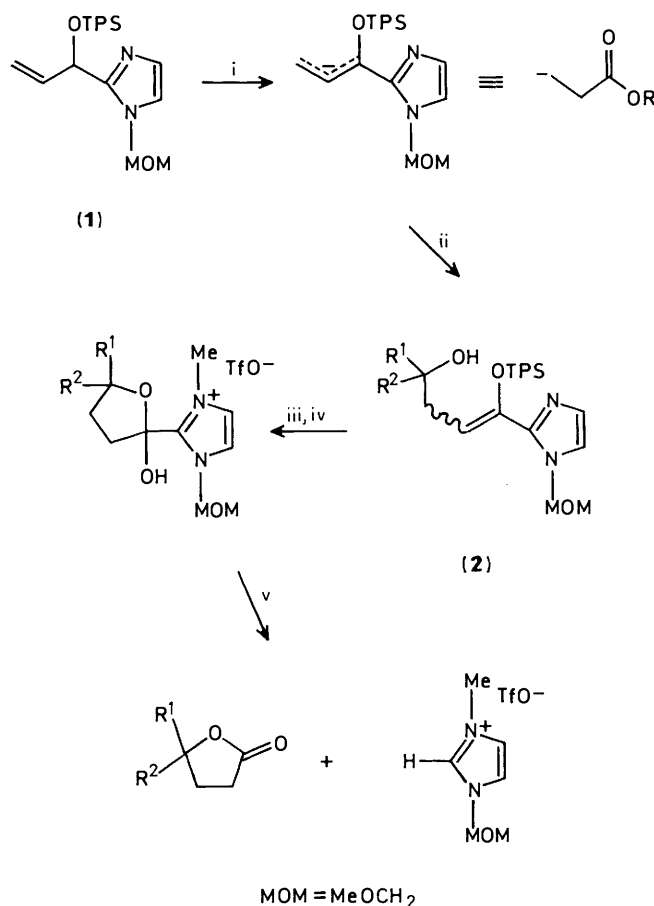
There are a limited number of examples of 2-acylthiazolium¹ and -imidazolium² salts acting as acylating agents for alcohols (Scheme 1). Herein we describe the first examples of the



Scheme 1. X = S or NR⁴

application of this reaction in an intramolecular sense using imidazolium salts to give γ -lactones. Moreover, we show how the precursor 2-acylimidazoles are derived from an oxylallyl-imidazole carbanion which thereby represents a new ester homoenolate equivalent³ (Scheme 2).

Treatment of 2-lithio-*N*-methoxymethylimidazole⁴ with acrylaldehyde (1.5 equiv., -78 °C, THF*, 1 h) followed by addition of TIPS-Cl* and hexamethylphosphoramide (5%) (-50 °C) and stirring overnight (r.t.) gave the allyl TIPS ether, (1),† in 65% yield. Deprotonation of (1) with BuLi-TMEDA* (1 equiv. each, THF, -78 °C, 0.5 h) gave a yellow solution which was cooled to -90 °C before dropwise addition of the carbonyl compound at such a rate as to keep the temperature < -80 °C. After 3 min the reaction was quenched to give the hydroxy silyl ethers, (2),† (γ -products) in moderate to good yields. Products,



Scheme 2. Reagents and conditions: i, BuLi-TMEDA; ii, R¹R²CO; iii, TBAF-THF-H₂O; iv, MeOTf; v, Et₃N

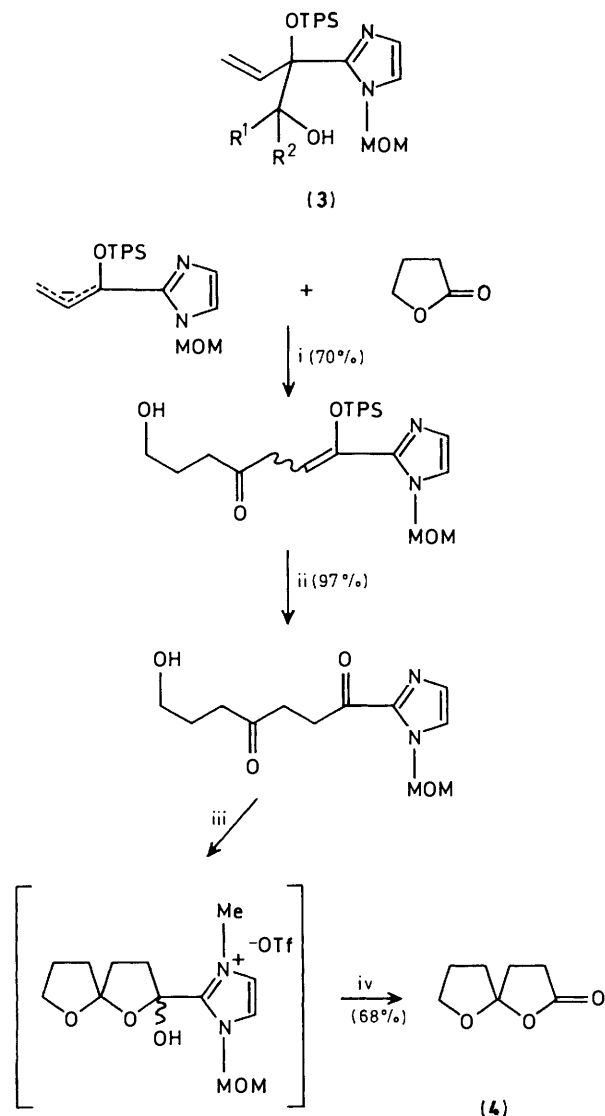
* THF = tetrahydrofuran, TIPS-Cl = tri-isopropylsilyl chloride, TMEDA = tetramethylethylenediamine, TBAF = tetrabutylammonium fluoride MeOTf = methyl trifluoromethanesulphonate.

† New compounds were fully characterised spectroscopically and by microanalysis or high resolution mass spectrometry. Details are available as a Supplementary publication [56745 (10 pp.)]. For details see 'Instructions for Authors (1989),' *J. Chem. Soc., Perkin Trans. 1*, 1989, Issue 1.

Table.

R ¹ R ² CO	γ-Product (2) (%)	α-Product (3) (%)	Lactone (%) ^a
PhCHO	62 ^b	0	84
Pr ⁱ CHO	35†	53	99
Cyclohex-3-enecarbaldehyde	40†	37	90
Me ₂ CO	40†	24	33 ^c
Bu ⁱ COMe	47†	17	95
Et ₂ CO	68†	13	91
Cyclohexanone	70†	0	83
<i>cis</i> - and <i>trans</i> -2,6-Dimethylcyclohexanone	85† ^d	0	90

^a Yields are overall for the desilylation, methylation, and cleavage steps. ^b Characterised as the ketone after desilylation. ^c Some losses due to volatility occurred. ^d *cis:trans* 7:1.



Scheme 3. Reagents and conditions: i, -65°C ; ii, TBAF-THF- H_2O ; iii, $\text{MeOTf}\cdot\text{CH}_2\text{Cl}_2$, 29h; iv, Et_3N

(3), derived by attack at the α -position (α -products) of the allyl anion were also formed but their yields diminished with increasing bulk of the carbonyl compound as expected (Table).

Desilylation of the enol silyl ether (1 equiv. TBAF*, 3–4 drops water, THF, 15–30 min) gave the crude ketones which were subjected to methylation with MeOTf^* (1 equiv., CH_2Cl_2) (the 2-acyl group attenuates the nucleophilicity of the imidazole nitrogen to the extent that the milder methylating agents, MeI and Me_2SO_4 were not effective). The latter reaction could be conveniently followed by solution cell i.r. spectroscopy monitoring the loss of the carbonyl stretch since the 2-acylimidazolium salts existed almost entirely in the lactol forms. Once the methylation was complete neat triethylamine (1 equiv.) was added and the cleavage to the lactone proceeded rapidly. This cleavage could also be induced by catalytic quantities (0.1 equiv.) of base but reaction was slower.

The sequence was also applied to the synthesis of the [4,4]-spiro lactone, (4),† (Scheme 3).

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*† See footnotes on p. 837.

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