CHEMISTRY LETTERS, pp. 1939-1940, 1994.

α-Umpolung of Ketones and Aldehydes via the Corresponding Silyl Enol Ether Cation Radicals[1)]

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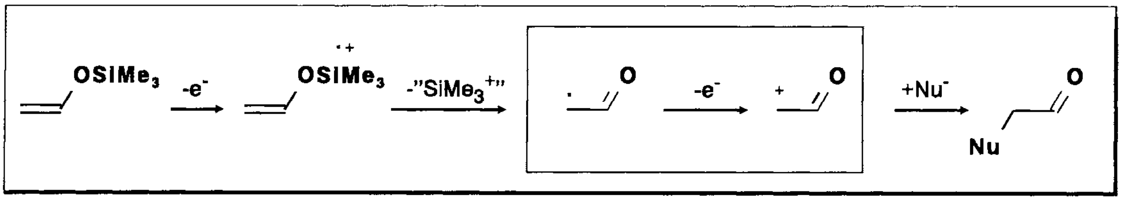
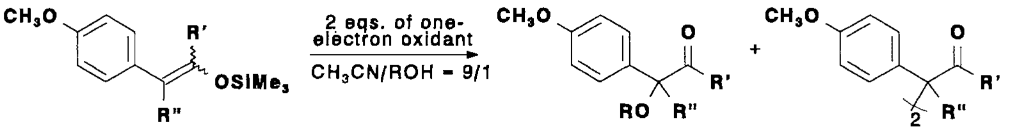
The α-Umpolung of ketones and aldehydes via their silyl enol ether cation radicals has been developed and tested for the use of different nucleophiles.

Our experience with the recently developed α-Umpolung of ketones via the corresponding enol cation radicals,[1)] necessitating the extensive control of two oxidation steps with quite often conflicting requirements on the oxidant, initiated the present study of the one-electron oxidation of silyl enol ethers. Since silyl enol ether cation radicals[2)] are known to form α-carbonyl radicals[3)] after C-Si bond cleavage, we reasoned, that in case of electron-rich radicals[4)] a further one-electron oxidation should follow. Interestingly, this straightforward approach to α-carbonyl cation chemistry has not been studied, yet.



In contrast to other α-Umpolung strategies for ketones starting from silyl enol ethers that make an electron-rich enol component react with an electropositive oxygen source,[5)] this new approach via α-carbonyl cations allows to introduce polyfunctional nucleophiles in one step. Since the nucleophiles have to withstand the oxidative conditions, we have first turned our attention to alcohols. Importantly, this new α-substitution also works for aldehydes, a reaction not often realized in literature.[6)]



1 (R': CH_3, R'': H)
2 (R': H, R'': CH_3)

3a-g (R': CH_3, R'': H)
4a-b (R': H, R'': CH_3)
R: **a**: Me, **b**: $Br(CH_2)_3$, **c**: Et, **d**: tBu,
R: **e**: $CH_3CH(NO_2)CH_2$, **f**: $NC(CH_2)_3$, **g**: L-menthyl.

When we reacted the electron-rich silyl enol ethers **1** or **2** in the presence of alcohols with various one-electron oxidants, indeed the α-substituted products **3a-g** and **4a,b** were obtained, demonstrating the feasibility of our approach. With **1** we observed oxidative dimerization of the silyl enol ether as a side route, a well documented reaction of less sterically hindered systems.[7)]

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Table 1. Yields in the α-Umpolung via Silyl Enol Ethers **1** or **2** in Anhydrous Acetonitrile Using Different Nucleophiles and One-electron Oxidants.

Silyl enol ether	Nucleophile ROH	One-electron oxidant[a]	Addition time/ min	α-Umpolung product (Yield/ %)	Dimer yield/ %
1	MeOH	**TTA**$^{+\bullet}$	2	**3a** (56)	--
1	MeOH	**CAN**	im[b]	**3a** (34)	--
1	3-bromopropanol	**CAN**	4	**3b** (67)	--
1	EtOH	**FePhen**	im[b]	**3c** (53)	2
1	*t*BuOH	**TTA**$^{+\bullet}$	im[b]	**3d** (23)	15
1	$CH_3CH(NO_2)CH_2OH$	**CAN**	4	**3e** (48)	50
1	$NCCH_2CH_2CH_2OH$	**CAN**	4	**3f** (11)	10
1	L-menthol	**CAN**	4	**3g** (53)	39
1	L-menthol	**Fephen**	4	**3g** (76)	7
2	MeOH	**FePhen**	im[b]	**4a** (80)	--
2	MeOH	**CAN**	im[b]	**4a** (80)	--
2	MeOH	$Cu(OTf)_2$	im[b]	**4a** (71)	--
2	3-bromopropanol	**CAN**	im[b]	**4b** (98)	--
2	3-bromopropanol	**FePhen**	im[b]	**4b** (77)	--

a) **TTA**$^{+\bullet}$: tri(*p*-tolyl)aminium hexafluoroantimonate, **CAN**: $Ce(NH_4)_2(NO_3)_6$, **FePhen**: tris-(1,10-phenanthroline)iron(III) hexafluorophosphate, for details see Ref. 1 and 8. b) Immediate addition of the whole amount of the silyl enol ether.

Financial support by the Stiftung Volkswagenwerk, the Wissenschaftliche Gesellschaft Freiburg and the Fonds der Chemischen Industrie is gratefully acknowledged.

References

1) Enol Cation Radicals in Solution, 8, for part 7 see M. Schmittel and M. Levis, *Chem. Lett.*, previous paper.

2) S. Fukuzumi, M. Fujita, J. Otera, and Y. Fujita, *J. Am. Chem. Soc.*, **114**, 10271 (1992).

3) P. G. Gassman and K. J. Bottorff, *J. Org. Chem.*, **53**, 1097 (1988).

4) $E_{1/2}^{ox}$ (pAn-C$^{\bullet}$HCOCH$_3$) = 0.18 V; $E_{1/2}^{ox}$ (pAn-C$^{\bullet}$(CH$_3$)CHO) = 0.13 V, both referenced against ferrocene/ferrocenium. They were determined by AM1 calculated adiabatic ionization potentials and a correlation of $E_{1/2}^{ox}$ with IP_a: D. D. M. Wayner, B. A. Sim, and J. J. Dannenberg, *J. Org. Chem.*, **56**, 4853 (1991).

5) D. R. Reddy and E. R. Thornton, *J. Chem. Soc., Chem. Commun.*, **1992**, 172 and cited references; W. Adam, L. Hadjiarapoglou, and X. Wang, *Tetrahedron Lett.*, **32**, 1295 (1991).

6) M. Schmittel and M. Röck, *Chem. Ber.*, **125**, 1611 (1992); D. Enders and V. Bushan, *Tetrahedron Lett.*, **29**, 2437 (1988); A. Hassner, R. H. Reuss, and A. W. Pinnick, *J. Org. Chem.*, **40**, 3427 (1975).

7) E. Baciocchi, A. Casu, and R. Ruzziconi, *Tetrahedron Lett.*, **30**, 3707 (1989) and references cited therein.

8) M. Schmittel, *Top. Curr. Chem.*, **169**, 183 (1994).

(Received July 8, 1994)