A Simple and Effective Electrocatalytic Deprotection of the 4-Phenyl-1,3-dioxolane Protecting Group

Masaichiro Masui,* Tetsuo Kawaguchi, and Shigeko Ozaki

Faculty of Pharmaceutical Sciences, Osaka University 1—6, Yamadaoka, Suita, Osaka-fu, 565 Japan

Anodic deprotection of ketone acetals under very mild conditions may be achieved by a combination of 1-phenylethane-1,2-diol as a protecting reagent and *N*-hydroxyphthalimide as a mediator.

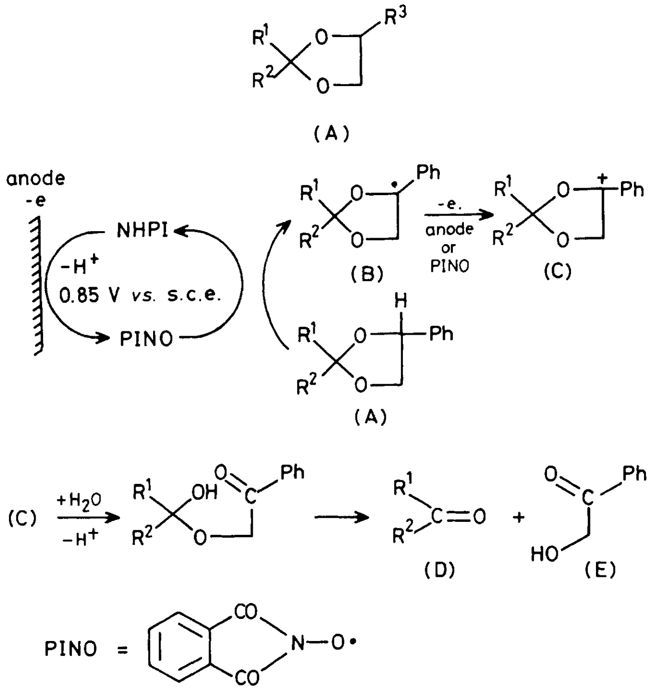
Many protecting groups used in the synthesis of organic compounds can be removed by electrochemical reactions.[1] The mild conditions which do not require the use of high temperatures, strong acid or base, or transition metal salts, make electrochemical deprotection an attractive method. The removal of various protecting groups, especially for hydroxy and amino compounds, by electrode reactions with or without the use of a catalyst as the electron carrier[1,2] have been studied extensively. However, there are no reports on the electrochemical deprotection of ketone acetals, in spite of the fact that the electrochemical deprotection of 1,3-dithianes,[3,4] dithiolanes,[4] and a hemithioacetal[3b] by direct or indirect methods has been studied.

We have been studying the electrochemical oxidation of various organic compounds using *N*-hydroxyphthalimide (NHPI) as a mediator,[5] although when NHPI was used as a mediator for the anodic deprotection of the 1,3-dioxolane group, the recovery of the ketone was poor [(**5**), Table 1]. However, satisfactory electrochemical deprotection of the 4-phenyl-1,3-dioxolane group could be achieved electrochem-

Table 1. Yields of ketones from 1,3-dioxolanes (A).

	Dioxolane (A)			Recovered[a] carbonyl compound (%)	F/mol[b]	Recovered[c] NHPI (%)
	R^1	R^2	R^3			
(**1**)	$-[CH_2]_5-$		Ph	90	2.5	22
(**2**)	Ph	Me	Ph	84	2.5	13
(**3**)	n-C_6H_{13}	Me	Ph	84	2.5	35
				67	2.0	[d]
				70[e]	2.0	[d]
				82[f]	2.0	[d]
(**4**)	Bu^nOCOCH_2	Me	Ph	65	2.5	15
				74[f]	2.0	[d]
(**5**)[g]	Ph	Me	H	12[h]	2.0	[d]
(**6**)	CH_2=$CHCH_2$	Me	Ph	22	1.0	13

[a] Determined by g.l.c. [b] Electricity passed per mole of 1,3-dioxolane. [c] Determined by h.p.l.c. [d] Not determined. [e] Concentration of pyridine 5 mM. [f] Electrolysed in acetonitrile containing 1% water. Freshly distilled acetonitrile (ref. 6) was found to absorb moisture up to *ca.* 20 mM when left in the air for several hours with mechanical stirring. [g] The 1,3-dioxolane was used in place of the 4-phenyl-1,3-dioxolane. [h] 57% (**5**) was recovered.



Scheme 1

ically under simple and mild conditions using NHPI (Table 1).† The yields of the carbonyl compounds are higher than those observed in direct electrolysis of dithioacetals[3a] and comparable to those obtained from the indirect oxidation of 1,3-dithianes using tris-*p*-tolylamine as the mediator.[4] The ease of handling 1-phenylethane-1,2-diol and avoidance of the use of propane-1,3-dithiol are additional advantages. The 4-phenyl-1,3-dioxolanes used may easily be made by standard procedures, although in slightly lower yields than the corresponding 1,3-dioxolanes.

The phenyl group (R^3) greatly increases the yield [*cf.* (**5**) in Table 1], and we propose the route in Scheme 1 for the oxidation in moist acetonitrile.

As the oxidation potential of NHPI in the presence of pyridine (0.85 V *vs.* standard calomel electrode, s.c.e.)[5] is about 0.95—1.35 V less positive than the irreversible oxidation potentials of the 4-phenyl-1,3-dioxolanes (A) derived from (**1**) (2.10), (**2**) (2.10), (**3**) (1.80), and (**4**) (2.20 V), it is apparent that the substrate (A) is oxidized by homogeneous reaction with electrogenerated phthalimide *N*-oxyl (PINO). The radical (B) is oxidized to the cation (C) by either the anode or PINO, since the oxidation potentials of (B) are possibly less positive than those of (A).[7] The cations are, then, hydrolysed by water to yield the carbonyl compounds. The addition of 1% water increased the yields of the carbonyl compounds.

Since PINO is a versatile oxidizing agent for various functional groups,[5] the reaction may be less satisfactory for molecules having easily oxidizable groups [*e.g.* (**6**)].

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† Compounds (**1**)—(**5**) (20 mM), NHPI (5 mM), pyridine (5 or 10 mM) dissolved in acetonitrile (20 ml) containing *ca.* 0.1 M $LiClO_4$ were electrolysed potentiostatically (0.85 V *vs.* s.c.e.) in an undivided cell using a glassy-carbon plate electrode (1 × 3 cm) at room temperature until 2.0 or 2.5 F per mole of 1,3-dioxolane had been consumed. Evaporation followed by silica gel column chromatography of concentrated solutions of the residue in chloroform gave the carbonyl compounds (D) and 2-hydroxyacetophenone (E). The structures of the products were confirmed by ^1H n.m.r. comparison with authentic samples.

References

1 V. G. Mairanovsky, *Angew. Chem., Int. Ed. Engl.*, 1976, **15**, 281, and references quoted therein.

2 W. Schmidt and E. Steckhan, *Angew. Chem., Int. Ed. Engl.*, 1978, **17**, 673; 1979, **18**, 801, 802.

3 (a) Q. N. Porter and J. H. P. Utley, *J. Chem. Soc., Chem. Commun.*, 1978, 255; (b) T. Mandai, H. Irei, M. Kuwata, and J. Otera, *Tetrahedron Lett.*, 1984, **25**, 2371.

4 M. Platen and E. Steckhan, *Tetrahedron Lett.*, 1980, **21**, 511; *Chem. Ber.*, 1984, **117**, 1679.

5 M. Masui, T. Ueshima, and S. Ozaki, *J. Chem. Soc., Chem. Commun.*, 1983, 479; M. Masui, S. Hara, T. Ueshima, T. Kawaguchi, and S. Ozaki, *Chem. Pharm. Bull.*, 1983, **31**, 4209.

6 J. F. O'Donnel, J. T. Ayres, and C. K. Mann, *Anal. Chem.*, 1965, **37**, 1169.

7 H. Sayo, S. Ozaki, and M. Masui, *Chem. Pharm. Bull.*, 1973, **21**, 1988; see Table II.