Deuteration of Bromophenol Derivatives with Cu-Al Alloy in a D_2O Solution of Sodium Carbonate or Barium Oxide

Kakinami, Takaaki
Department of Chemical and Biological Engineering, Ube Technical College

Iida, Yukiko
Department of Chemical and Biological Engineering, Ube Technical College

Kajigaeshi, Shoji
Department of Applied Chemistry and Chemical Engineering, Faculty of Engineering, Yamaguchi University

Eguchi, Hisao
Chemical Reserach Laboratory Tosoh Ltd.

他

https://doi.org/10.15017/6641

出版情報：九州大学機能物質科学研究所報告. 8 (1), pp.41-43, 1994-11-10. 九州大学機能物質科学研究所
バージョン：
権利関係：

Rep. Inst. Adv. Mat.
Study, Vol. 8 No. 1
pp. 41~43(1994)

Deuteration of Bromophenol Derivatives with Cu-Al Alloy in a D_2O Solution of Sodium Carbonate or Barium Oxide

Takaaki KAKINAMI,[a*] Yukiko IIDA,[a] Shoji KAJIGAESHI,[b]
Hisao EGUCHI,[c] and Masashi TASHIRO

The reductive debromination of bromophenol derivatives and 1-bromonaphthalene-2-ol with Cu-Al alloy in a D_2O solution of sodium carbonate or barium oxide at 60°C under a nitrogen atmosphere gives ring-deuteriated phenol derivatives and 1-deuterionaphthalene-2-ol, respectively, in good yields and in high isotopic purities.

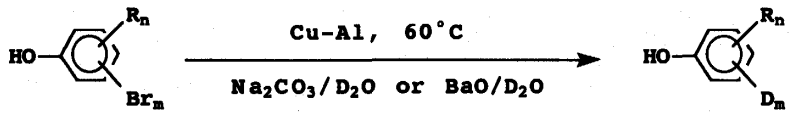
INTRODUCTION

It has been reported previously that the reductive dehalogenation of halo-phenols,[1] halo-benzoic acids,[2] halo-acetophenones,[3] and halo-salicylic acids[4] with Raney Ni-Al, Cu-Al, or Co-Al alloys in NaOD-D_2O solution affords the corresponding deuteriated phenols, benzoic acids, 1-phenylethanols, and salicylic acids, respectively. Furthermore, deuteriated thiophene-2-, furan-2-, and pyrrole-2-carboxylic acids have been prepared by treatment of the corresponding bromothiophene-2-, bromofuran-2-, and bromopyrrole-2-carboxylic acids with Cu-Al alloy in NaOD-D_2O solution.[5] However, NaOD-D_2O solution is quite expensive, and the operations described in these reports require some difficult conditions to prepare the deuteriated derivatives in a laboratory. Recently, we found that both Na_2CO_3-D_2O and BaO-D_2O solutions are useful alkaline deuterium oxide solutions similar to the NaOD-D_2O solution. In this paper, we wish to report on a simpler and more convenient reductive debromination of bromophenol derivatives (including methyl- and methoxy-substituted bromophenols) **1** and 1-bromonaphthalene-2-ol (**3**) to the corresponding deuteriated phenols **2** and 1-deuterionaphthalene-2-ol (**4**) with Cu-Al alloy in a D_2O solution of Na_2CO_3 or BaO.

RESULTS AND DISCUSSION

The reaction of **1** with Cu-Al alloy in Na_2CO_3-D_2O or saturated BaO-D_2O solution at 60°C gave corresponding **2** in fairly good yields and in high isotopic purities. The results are summarized in Scheme 1 and Table 1.

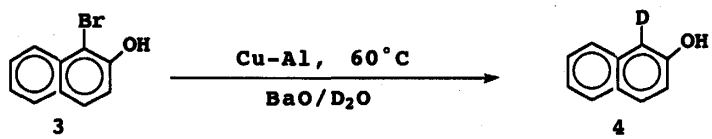
Received July 4, 1994
Dedicated to Professor Tetsu Fujii on the occasion of his retirement
[a]Department of Chemical and Biological Engineering, Ube Technical College, Tokiwadai, Ube 755, Japan
[b]Department of Applied Chemistry and Chemical Engineering, Faculty of Engineering, Yamaguchi University, Tokiwadai, Ube 755, Japan
[c]Chemical Reserach Laboratory, Tosoh Ltd., Kaisei-cho Shinnanyo 746, Japan



1 **2**

Scheme 1

a ; 2-Br	j ; 2,4-Br_2-3,6-Me_2	a ; 2-D	j ; 2,4-D_2-3,6-Me_2
b ; 3-Br	k ; 4-Br-2,6-Me_2	b ; 3-D	k ; 4-D-2,6-Me_2
c ; 4-Br	l ; 2,6-Br_2-3,4-Me_2	c ; 4-D	l ; 2,6-D_2-3,4-Me_2
d ; 2,4-Br_2	m ; 2,4,6-Br_3-3,5-Me_2	d ; 2,4-D_2	m ; 2,4,6-D_3-3,5-Me_2
e ; 2,4,6-Br_3	n ; 2,4-Br_2-6-OMe	e ; 2,4,6-D_3	n ; 2,4-D_2-6-OMe
f ; 2,4-Br_2-6-Me	o ; 2,4,6-Br_3-3-OMe	f ; 2,4-D_2-6-Me	o ; 2,4,6-D_3-3-OMe
g ; 2,4,6-Br_3-3-Me	p ; 2,4,Br_2-4-OMe	g ; 2,4,6-D_3-3-Me	p ; 2-4,D_2-4-OMe
h ; 2,4-Br_2-5,6-Me_2	q ; 2,6-Br_2-4-t-Bu	h ; 2,4-D_2-5,6-Me_2	q ; 2,6-D_2-4-t-Bu
i ; 2-Br-4,6-Me_2		i ; 2-D-4,6-Me_2	



3 **4**

Scheme 2

As shown in the table, it has been found that methyl- (**1f-1m**) and methoxy-substituted bromophenols (**1n-1p**) give the corresponding deuteriated **2** in better yields than unsubstituted bromophenols (**1a-1e**). Electron donating groups such as methyl- and methoxy-groups in **1** increase the reactivity of **1** for the reduction in an alkaline D_2O solution. Bromonaphthol **3** was similarly reduced to the corresponding deutriated naphthol **4** as shown in scheme 2 and Table 1.

We believe that the reductive debromination of **1** with Cu-Al alloy in Na_2CO_3-D_2O or BaO-D_2O solution is a very useful method owing to the ease of the procedure, the cheapness of the alkaline reagents, and the mildness of conditions.

EXPERIMENTAL

2-Deuteriophenol (2a). Typical Procedure Using Na_2CO_3-D_2O Solution: 2-Bromophenol (0.52 g, 3 mmol) was dissolved in a solution of 0.625 M-Na_2CO_3-D_2O (30 cm^{-3}) (1 M= 1 mol dm^{-3}) at 60°C under a nitrogen atmosphere. To the solution was gradually added Cu -Al alloy (0.051 g × 16) at 10 min intervals. Vigorous reaction occurred each time the alloy was added. After the reaction mixture was stirred for an additional hour, the insoluble material was separated by filtration. The filtrate was acidified with a 12 M-HCl solution and extracted with dichloromethane (40 cm^{-3} × 4). The dichloromethane solution was dried over $MgSO_4$ and evaporated to afford **2a** as a colorless oil, which was analyzed by GC and MS; yield 0.20 g (69%).

2, 4-Dideutrio-6-methylphenol (2f). Typical Procedure Using a Saturated BaO-D_2O Solution: 2, 4-Dibromo-6-methylphenol (0.78 g, 3 mmol) was dissolved in a saturated solution of BaO-D_2O (50 cm^{-3}) at 60°C under a nitrogen atmosphere. To the solution was added Cu-Al alloy (0.16 g × 21) at 10 min intervals. A subsequent work-up as mentioned above gave **2f** as a colorless solid; yield 0.22 g (69%).

Table 1 Reductive Deuteration of Bromophenol Derivatives **1** and 1-Bromonaphthalene-2-ol (**2**) with Cu-Al alloy in Na_2CO_3-D_2O or Saturetated BaO-D_2O Solution at 60°C

Substrate[a]	Alkaline[b] medium (cm^{-3})	Cu-Al[c]	Product (Yield %)[d]	Composition (%)[e] d_0	d_1	d_2	d_3	d_4
1a	A (30)	0.051 g ×16	**2a** (69)	3	96	1	0	0
1b	A (30)	0.08 g ×16	**2b** (52)	3	96	1	0	0
1c	A (30)	0.051 g ×16	**2c** (59)	4	95	1	0	0
1d	A (30)	0.16 g ×21	**2d** (55)	0	5	92	3	0
1e	A (40)	0.23 g ×26	**2e** (69)	0	1	5	93	1
1f	B (50)	0.15 g ×16	**2f** (69)	0	10	90	0	0
1g	B (45)	0.15 g ×16	**2g** (70)	0	3	14	78	5
1h	B (35)	0.15 g ×16	**2h** (92)	0	10	87	3	0
1i	B (50)	0.15 g ×16	**2i** (46)	9	85	6	0	0
1j	B (50)	0.15 g ×21	**2j** (76)	0	12	82	6	0
1k	B (35)	0.15 g ×16	**2k** (76)	5	93	2	0	0
1l	B (50)	0.15 g ×16	**2l** (81)	0	12	85	3	0
1m	A (50)	0.19 g ×26	**2m** (89)	0	1	11	83	5
1n	B (50)	0.15 g ×16	**2n** (82)	0	7	92	1	0
1o	B (50)	0.19 g ×26	**2o** (99)	0	3	23	72	2
1p	B (50)	0.15 g ×21	**2p** (97)	0	7	91	2	0
1q	B (50)	0.15 g ×21	**2q** (70)	0	2	95	3	0
3	B (35)	0.15 g ×13	**4** (91)	18	77	5	0	0

a) Every experiment was carried out using 3.5 mmol of a substrate. b) A: 0.625M-Na_2CO_3-D_2O. B: Saturated BaO-D_2O. c) The alloy was added at 10 min. intervals. d) Yield of isolated product. e) Determined by MS.

References

1. M. Tashiro, A. Iwasaki, and G. Fukata, *J. Org. Chem.*, **43**, 196 (1978).
2. M. Tashiro, K. Nakayama, and G. Fukata, *J. Chem. Soc., Perkin Trans.* 1, 2315 (1983).
3. M. Tashiro, S. Mataka, H. Nakamura, and K. Nakayama, *J. Chem. Soc., Perkin Trans.* 1, 179 (1988).
4. M. Tashiro, H. Tsuzuki, J. Matsumoto, S. Mataka, K. Nakayama T. Tsuruta, and T. Yonemitsu, *J. Chem. Res.*(*S*), 372 (1989).
5. M. Tashiro, S. Mataka, K. Nakayama, H. Tsuzuki, and T. Yonemitsu, *J. Chem. Res.*(*S*), 136 (1988).