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Reductive Lithiation of Arylalkyl Methyl Ethers

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Abstract. We have investigated the reductive cleavage of arylalkyl methyl ethers with an excess of lithium metal and a catalytic amount of naphthalene. The reaction proceeds regioselectively in the presence of various substituents on the aromatic ring, allowing access to a wide array of arylalkyl lithium derivatives, some of which are not easily accessible by conventional methods.

INTRODUCTION

Generation of arylalkyl derivatives of alkali metals is an interesting challenge and a topic of actual interest in organic synthesis,[1,2]

Recently, Yus et al. have described the reductive lithiation of *O*-silylated benzylic alcohols; under Barbier-type conditions, they have synthesized a series of 5-substituted resorcinol dimethyl ethers, although in modest yield.[3]

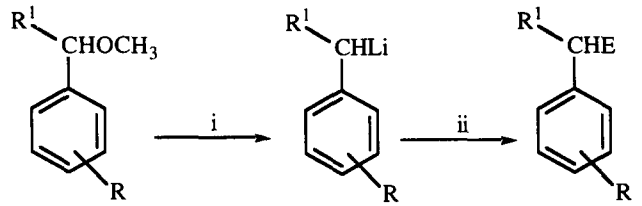
On the other side, attempts to generate arylalkyl carbanions by the reductive cleavage of carbon - halogen bonds are usually complicated by the formation of Wurtz-type products;[4] at variance with these findings, Yus et al. have reported the successful reductive electrophilic substitution of benzyl chloride as well as of 2-, 3- and 4-chlorobenzyl chlorides under Barbier-type conditions.[5]

Besides reductive cleavage methods, deprotonation of toluene derivatives is widely employied in the generation of arylalkyl derivatives of alkali metals.[1,2] Indeed, Schlosser,[6] Napolitano,[7] and Mordini[8] have reported good selectivities in the metalation of the benzylic position of toluene derivatives by employing butyllithium/diisopropylamine/potassium *tert*-butoxide (LIDAKOR) as a metalating reagent. However, the nature of the substituents on the aromatic ring often affects the regioselectivity of this reaction (benzylic *vs.* ring proton abstraction).[2,6]

We wish now to report that reductive lithiation of arylalkyl methyl ethers is an alternative and efficient way to generate a wide array of arylalkyl lithium derivatives, some of which are not easily accessible by the above mentioned procedures (Scheme 1). It is worth noting that whilst reductive lithiation of phenylmethyl alkyl ethers is long time known, only few reports concern the reductive cleavage of ring substituted arylalkyl methyl ethers.[2,9-11]

RESULTS AND DISCUSSION

Arylalkyl methyl ethers were synthesized according to known procedures, *i.e.*, either by reaction of the corresponding sodium arylalkyl alkoxides with CH_3I (**1a-d, 1f-1h**)[12] or by reaction of the corresponding arylmethyl chloride with sodium methoxide in methanol (**1e**).[13] The reductive cleavage reactions were carried out under Ar in the presence of an excess (5 equiv) of Li metal and a catalytic amount of naphthalene (5 mol %) in tetrahydrofuran (THF); the resulting mixtures were allowed to react with different electrophiles for 10 minutes before aqueous work up and purification (Scheme 1).



1a-h **2a-f** **3aa-3gb**

Scheme 1. *Reagents:* i, Li excess, naphthalene cat. (5 mol %), THF; ii, EX.

*Reductive Lithiation of Methoxy-Substituted Arylmethyl Methyl Ethers **1a-1d**.* The reaction of 4-methoxyphenylmethyl methyl ether **1a** with Li dispersion (5 equiv) and a catalytic amount of naphthalene (5 mol %) in THF afforded, after 4 h stirring at -10 °C, the lithium derivative **2a**. Reaction of **2a** with D_2O or Bu^tCHO yielded, after aqueous work up, the desired derivatives **3aa-ab** (Table, entries 1 and 2). No cleavage of either carbon - oxygen bonds of the aromatic methoxyl group[11] occurred.

Similar results were obtained employing the arylmethyl methyl ethers **1b** or **1c** as starting materials (Table, entries 3-6). Reductive cleavage of 3,5-dimethoxyphenylmethyl methyl ether, **1d**, was accomplished in a similar way; quenching with 1-bromobutane afforded olivetol dimethyl ether, **3da**, in 87% isolated yield (Table, entry 7).

As a comparison with known procedures, it is interesting to observe that reductive lithiation of 4-methoxybenzyl chloride is contaminated by polymerization of the starting material as well as by formation of Wurtz-type products.[4] Application of the reductive lithiation of [(3,5-dimethoxybenzyl)oxy]trimethylsilane to the synthesis of olivetol afforded the desired dimethyl ether in 37% yield.[3] Metalation of the arylmethyl position of 2-, 3- and 4-methoxytoluene required the employment of the LIDAKOR base at -78 °C.[6,14]

*Reductive Lithiation of 4-(*N,N*-Dimethylamino)phenylmethyl Methyl Ether **1e**.* Generation of an arylalkyl carbanion bearing a strong electron-donating substituent in the *para* position is a difficult task.[2] Indeed, the benzylic deprotonation of *N,N*,4-trimethylaniline is a sluggish reaction which requires the use of the LICKOR base (butyllithium/potassium *tert*-butoxide) at -75 °C in a relatively long reaction time (48 h).[2,15]

These difficulties are easily overcome by employing our reductive cleavage procedure. Indeed, we have accomplished the reductive lithiation of 4-(*N,N*-dimethylamino)phenylmethyl methyl ether **1e** within 4 h at -10

°C. Quenching of the reaction mixture with D_2O showed almost quantitative formation of the corresponding lithium derivative **2e**, whilst quenching with Bu^{t}CHO led, after aqueous work up and flash chromatography, to the recovery of 1-[4-(*N*,*N*-dimethylamino)phenyl]-3,3-dimethylbutan-2-ol, **3eb**, in 64% isolated yield (Table, entries 8 and 9).

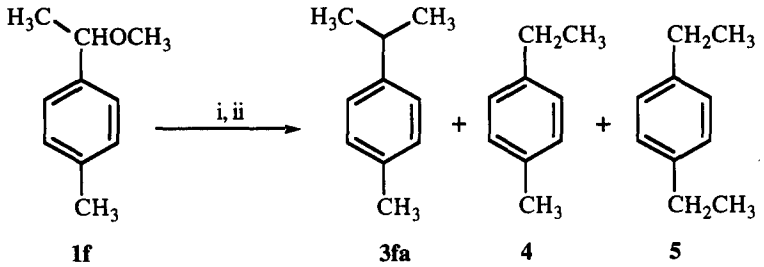
Table. Reductive Electrophilic Substitution of Compounds **1**.

Entry	Compd	R =	R^1 =	T, °C	t, h	EX	Product, E =	Yield[a] (%)
1	**1a**	4-CH_3O	H	-10	4	D_2O[b]	**3aa**, D	>90[c]
2	**1a**	4-CH_3O	H	-10	4	Bu^{t}CHO	**3ab**, Bu^{t}CHOH	82
3	**1b**	3-CH_3O	H	-10	4	D_2O[b]	**3ba**, D	>90[c]
4	**1b**	3-CH_3O	H	-10	4	Bu^{t}CHO	**3bb**, Bu^{t}CHOH	78
5	**1c**	2-CH_3O	H	-10	4	D_2O[b]	**3ca**, D	>90[c]
6	**1c**	2-CH_3O	H	-10	4	Bu^{t}CHO	**3cb**, Bu^{t}CHOH	81
7	**1d**	3,5-$(CH_3O)_2$	H	-10	4	BuBr	**3da**, Bu	87
8	**1e**	4-$(CH_3)_2N$	H	-10	4	D_2O[b]	**3ea**, D	>90[c]
9	**1e**	4-$(CH_3)_2N$	H	-10	4	Bu^{t}CHO	**3eb**, Bu^{t}CHOH	64
10	**1f**	4-CH_3	CH_3	-20	4	CH_3I	**3fa**, CH_3	56[d]
11	**1f**	4-CH_3	CH_3	-20	24	CH_3I	**3fa**, CH_3	35[e]
12	**1f**	4-CH_3	CH_3	-70	3	CH_3I	**3fa**, CH_3	80[f]
13	**1f**	4-CH_3	CH_3	-70	3	D_2O[b]	**3fb**, D	>90[c]
14	**1f**	4-CH_3	CH_3	-70	3	Bu^{t}CHO	**3fc**, Bu^{t}CHOH	60[g]
15	**1g**	4-F	H	-20	2	Bu^{t}CHO	**3ga**, Bu^{t}CHOH	70[h]
16	**1g**	4-F	H	-80	4	Bu^{t}CHO	**3ga**, Bu^{t}CHOH	97[i]
17	**1g**	4-F	H	-80	4	PhCHO	**3gb**, PhCHOH	67

[a]Isolated yield, unless otherwise indicated. [b]2 ml of D_2O were added. [c]As determined by ^{1}H NMR by monitoring the percentage of deuterium incorporation in the arylalkyl position. [d]Determined by ^{1}H NMR. 39% of **4** and 5% of **5** were also recovered. [e]Determined by ^{1}H NMR. 45 % of **4** and 20% of **5** were also detected; see text. [f]Determined by ^{1}H NMR. 18 % of **4** and 2% of **5** were also detected; see text. [g]A diastereoisomeric mixture (70:30 by ^{1}H NMR) was obtained. [h]Determined by ^{1}H NMR. 9 % of **6** and 21% of **7** were also detected; see text. [i]Determined by ^{1}H NMR. 3 % of **7** was also detected; compound **3ga** was isolated in 65% yield; see text.

Reductive Lithiation of 1-(4-Methylphenyl)ethyl Methyl Ether 1f. We have investigated the reductive lithiation of 1-(4-methylphenyl)ethyl methyl ether **1f** with the aim to generate 1-(4-methylphenyl)ethyllithium, **2f**. This intermediate cannot be prepared by metalation of 4-methylphenylethane for thermodynamic reasons.[16] Furthermore, reductive lithiation of methyl-substituted arylmethyl chlorides afforded the parent carbanions in modest to low yields (with the notable exception of the 3-methyl isomer), and contaminated by Wurtz-type reaction products.[4]

Reduction of 1-(4-methylphenyl)ethyl methyl ether **1f** with Li and a catalytic amount of naphthalene in THF at -20 °C during 4 h led, after quenching with CH_3I and aqueous work up, to the recovery of a reaction mixture containing, besides the expected 2-(4-methylphenyl)propane, **3fa**, considerable amounts of 4-methylphenylethane, **4**, and 1,4-diethylbenzene, **5**. The hydrocarbons were obtained in a 56:39:5 ratio, as determined by ^{1}H-NMR spectroscopy of the crude reaction mixture (Scheme 2; Table, entry 10).



1f **3fa** **4** **5**

Scheme 2. *Reagents:* i, Li excess, naphtahlene cat. (5 mol %), THF; ii, CH_3I.

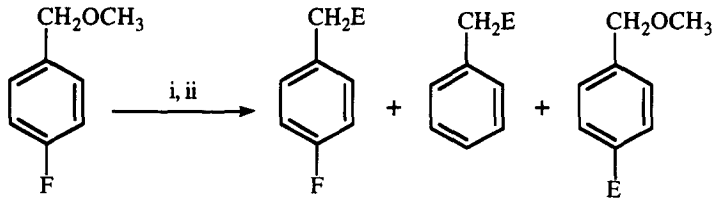
This result suggests that intermediate **2f** is not stable under the reaction conditions; indeed, it undergoes proton exchange affording either the product of quenching **4**, and the more stable 4-ethylphenylmethyllithium; the latter then reacts with the electrophile to give **5**. This hypothesis is supported by the result obtained running the reaction for 24 h before addition of the electrophile; under the new conditions, the hydrocarbons **3fa**, **4** and **5** were obtained in a 35:45:20 ratio (Table, entry 11).

Lowering the temperature to -70 °C resulted in almost complete suppression of the side reactions (Table, entry 12). Under these conditions, quantitative intermediate formation of the lithium derivative **2f** was evidenced by D_2O quenching (Table, entry 13), whilst quenching the reaction mixture with Bu^{t}CHO led, after aqueous work up and flash chromatography, to the recovery of 2-(4-methylphenyl)-4,4-dimethylpentan-3-ol, **3fc**, in 60% yield (70/30 diasteromeric ratio) (Table, entry 14).

Reductive Lithiation of 4-Fluorophenylmethyl Methyl Ether ***1g***. Reductive lithiation of 4-fluorophenylmethyl methyl ether, **1g**, was studied at different reaction temperatures. A reaction run at -20 °C led to cleavage of the arylmethyl carbon - oxygen bond, as well as to cleavage of the aromatic carbon - fluorine bond. Indeed, quenching of the reaction mixture with 1 equiv of Bu^{t}CHO led, after aqueous work up, to the recovery of alcohols **3ga**, **6** and **7** in a 70:21:9 ratio, as determined by ^{1}H-NMR spectroscopy of the crude reaction mixture (Scheme 3; Table, entry 15).

Compound **3ga** is the product of addition of the lithium derivative **2g** to Bu^{t}CHO, whilst the alcohol **7** is the product of a reductive electrophilic substitution reaction occurring at the aromatic carbon - fluorine bond. Further reduction at the aryl carbon - fluorine bond of alcohol **3ga** afforded compond **6**.

Lowering the reaction temperature to -80 °C led to almost exclusive formation of alcohol **3ga**, and allowed its recovery by flash chromatography in 65% yield (Table, entry 16). Under these conditions, quenching of the reaction mixture with benzaldehyde afforded compound **3gb** in 67% isolated yield (Table, entry 17), whilst quantitative formation of the carbanion **2g** was evidenced by D_2O quenching (not reported in the Table).

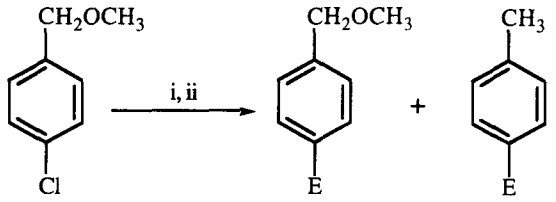


1g **3ga** **6** **7**

Scheme 3. *Reagents:* i, Li excess, naphthalene cat. (5 mol %), THF; ii, EX = Bu^{t}CHO.

The highly regioselective generation of an arylmethyl lithium carbanion bearing a fluorine atom in the *para* position is of great interest. Indeed, reduction of 4-fluorobenzyl chloride is contaminated by formation of a significant amount of the corresponding 4,4'-difluorobibenzyl (32% determined by GC for a reaction run at -95 °C).[4] Furthermore, metalation of 4-fluorotoluene with the LIDAKOR base at -75 °C afforded benzylic deprotonation in 7% and aromatic deprotonation (*ortho* to the fluorine atom) in 53% yield, respectively, whilst reaction with the LICKOR base led to exclusive aromatic deprotonation.[6]

Reductive Lithiation of 4-Chlorophenylmethyl Methyl Ether ***1h***. This reaction was investigated to get further insights on the reductive cleavage of halo-substituted arylmethyl methyl ethers. The reaction was run at -80 °C during 4 h. Quenching of the reaction mixture with 1 equiv of Bu^{t}CHO led to the recovery of alcohols **7** (56% isolated yield) and **8** (22% isolated yield), thus showing preferential cleavage of the aromatic carbon - chlorine bond (Scheme 4).



1h **7** **8**

Scheme 4. *Reagents:* i, Li excess, naphthalene cat. (5 mol %), THF; ii, EX = Bu^{t}CHO.

Attempts to obtain reductive electrophilic substitution at both the carbon - chlorine and the carbon - oxygen bonds in a one-pot reaction, similarly to what reported for the reductive cleavage of 4-chlorobenzyl chloride,[5] led to the formation of complex reaction mixtures.

CONCLUDING REMARKS

The described synthetic procedure allows the regioselective generation of several arylalkyl lithium derivatives bearing a wide array of substituents on the aromatic ring. Strong electron-donor substituents do not

affect the reaction and the corresponding carbanions can be generated under mild reaction conditions. The arylalkyl carbon - oxygen bond is regioselectively cleaved in the presence of aromatic carbon - oxygen or carbon - fluorine bonds; on the contrary, it is less easily reduced than an aromatic carbon - chlorine bond. In some cases, a careful check of the reaction temperature is crucial to avoid side reactions, like proton exchange (*i.e.*, in the reduction of compound **1f**), or further reductive cleavage (*i.e.*, in the reduction of compound **1g**). Reaction conditions are similar to (or milder than) those reported for the generation of the same carbanions by one of the procedures recently reported in the literature,[2-4,6] whilst our yields are usually better and Barbier-type reaction conditions are not needed. Successful application of this methodology to the preparation of olivetol dimethyl ether (**3da**) shows its potential usefulness in the synthesis of interesting biologically active compounds.

EXPERIMENTAL PART

General. Boiling and melting points are uncorrected; the air bath temperature on bulb-to-bulb distillations are given as boiling points. Starting materials were of the highest commercial quality and were used without further purification. D_2O was 99.8% isotopic purity. THF was distilled from Na/K alloy under N_2 immediately prior to use. Ethers were prepared according to general procedures described in ref. 12 (**1a-d, 1f-1h**) and in ref. 13 (**1e**). ^1H NMR spectra were recorded at 300 MHz and ^{13}C NMR spectra were recorded at 75 MHz in $CDCl_3$ with $SiMe_4$ as internal standard. Deuterium incorporation was calculated as reported in ref. 9. Elemental analyses were performed by the Microanalytical Laboratory of the Dipartimento di Chimica, Università di Sassari.

Lithiation of Ethers ***1*** *and Reaction with Electrophiles. General Procedure.* Li metal (42 mg atom, 0.96 g of a 30% wt. dispersion in mineral oil, 5 equivs) was placed under Ar in a two-necked flask equipped with reflux condenser and magnetic stirrer, washed with THF (3 x 10 mL), and suspended in 30 mL of THF. Naphthalene (30 mg, 0.2 mmol) was added to the suspension of the metal and the mixture was stirred until a dark green colour appeared. The mixture was chilled to the temperature reported in the Table and a solution of the appropriate substrate (8 mmol) in 5 mL of THF was added. After stirring for the reported time, the appropriate electrophile (1 equiv), dissolved in 5 ml of THF, was added dropwise. After stirring for 10 minutes, the mixture was quenched by slow dropwise addition of H_2O (10 mL, *caution!*), the cold bath removed, and the resulting mixture extracted with Et_2O (3 x 30 mL). The organic phase was dried (Na_2SO_4) and the solvent evaporated. Crude products were purified by distillation or flash chromatography (silica gel, hexane/AcOEt). Compounds **3da**[17] and **6**[18] were already described, whilst compounds **3fa, 4,** and **5** are commercially available; these compounds were characterized by comparison of their physical and spectroscopic data. Other products were purified and characterized as follows.

1-(4-Methoxyphenyl)-3,3-dimethylbutan-2-ol (3ab). Purified by flash chromatography (hexane/AcOEt = 7:3); bp 165 °C/5 mmHg; ν (film) 3383 (OH) cm^{-1}; δ_H 0.99 (9 H, s, $C(CH_3)_3$), 1.48 (1 H, bs, OH), 2.40 (1 H, dd, J = 13.7, 10.6 Hz, ArCH), 2.85 (1 H, dd, J = 13.7, 1.8 Hz, ArCH), 3.34 - 3.42 (1 H, m, CHO), 3.79 (3 H, s, CH_3O), 6.83-6.89 (2 H, m, ArH), 7.12-7.18 (2 H, m, ArH); δ_C 25.8, 34.7, 37.4, 55.2, 80.6, 114.0, 130.2, 131.7, 158.1. Anal. Calcd. for $C_{13}H_{20}O_2$: C, 74.94; H, 9.70. Found: C, 75.02; H, 9.84.

1-(3-Methoxyphenyl)-3,3-dimethylbutan-2-ol (3bb). Purified by flash chromatography (hexane/AcOEt = 7:3); bp 155 °C/5 mmHg; ν (film) 3379 (OH) cm^{-1}; δ_H 1.00 (9 H, s, $C(CH_3)_3$), 1.45 (1 H, bs, OH), 2.44 (1 H, dd, *J* = 13.5, 10.6 Hz, ArCH), 2.89 (1 H, dd, *J* = 13.5, 1.8 Hz, ArCH), 3.40 - 3.47 (1 H, m, CHO), 3.81 (3 H, s, CH_3O), 6.76-6.85 (3 H, m, ArH), 7.21-7.27 (1 H, m, ArH); δ_C 25.8, 34.8, 38.5, 55.1, 80.5, 111.8, 114.9, 121.6, 129.6, 141.5, 159.8. Anal. Calcd. for $C_{13}H_{20}O_2$: C, 74.94; H, 9.70. Found: C, 74.96; H, 9.89.

1-(2-Methoxyphenyl)-3,3-dimethylbutan-2-ol (3cb). Purified by flash chromatography (hexane/AcOEt = 8:2); bp 140 °C/5 mmHg; ν (film) 3375 (OH) cm^{-1}; δ_H 0.99 (9 H, s, $C(CH_3)_3$), 1.61 (1 H, bs, OH), 2.44 (1 H, dd, *J* = 13.5, 10.6 Hz, ArCH), 2.89 (1 H, dd, *J* = 13.5, 1.8 Hz, ArCH), 3.40 - 3.47 (1 H, m, CHO), 3.81 (3 H, s, CH_3O), 6.76-6.85 (3 H, m, ArH), 7.21-7.27 (1 H, m, ArH); δ_C 25.7, 33.4, 35.0, 55.3, 80.1, 110.4, 120.8, 127.6, 128.5, 131.1, 157.5. Anal. Calcd. for $C_{13}H_{20}O_2$: C, 74.94; H, 9.70. Found: C, 75.08; H, 9.87.

1-4-(*N*,*N*-Dimethylamino)phenyl-3,3-dimethylbutan-2-ol (3eb). Purified by flash chromatography (hexane/AcOEt/Et_3N = 8:2:0.1); mp 65 °C (MeOH/H_2O); ν (nujol) 3282 (OH) cm^{-1}; δ_H 0.99 (9 H, s, $C(CH_3)_3$), 1.57 (1 H, bs, OH), 2.36 (1 H, dd, *J* = 13.8, 10.8 Hz, ArCH), 2.82 (1 H, dd, *J* = 13.8, 2.1 Hz, ArCH), 2.92 (s, 6 H, $N(CH_3)_3$), 3.34 - 3.42 (1 H, m, CHO), 6.69-6.75 (2 H, m, ArH), 7.08-7.14 (2 H, m, ArH); δ_C 25.9, 34.6, 37.2, 40.8, 80.5, 113.2, 127.4, 129.9, 149.4. Anal. Calcd. for $C_{14}H_{23}NO$: C, 75.95; H, 10.49; N, 6.33. Found: C, 75.84; H, 10.76; N, 6.42.

2-(4-Methylphenyl)-4,4-dimethylpentan-3-ol (3fc). Purified by flash chromatography (hexane/AcOEt = 9:1); first diastereoisomer eluted: bp 135 °C/5 mmHg; ν (film) 3576 (OH), 3486 (OH) cm^{-1}; δ_H 0.84 (9 H, s, $C(CH_3)_3$), 1.35 (3 H, d, *J* = 7.2 Hz, CH_3CH), 1.62 (1 H, bs, OH), 2.32 (3 H, s, $ArCH_3$), 3.00 (1 H, qd, *J* = 7.2, 3.7 Hz, ArCH), 3.38 (1 H, dd, *J* = 6.6, 3.7 Hz, CHO), 7.06-7.14 (2 H, m, ArH), 7.16-7.23 (2 H, m, ArH); δ_C 21.0, 22.5, 26.7, 35.9, 41.3, 83.4, 128.7, 129.1, 135.9, 140.9; second diastereoisomer eluted: bp 135°C/5 mmHg; ν (film) 3471 (OH) cm^{-1}; δ_H 0.93 (9 H, s, $C(CH_3)_3$), 1.58 (1 H, bs, OH), 1.28 (3 H, d, *J* = 6.9 Hz, CH_3CH), 2.31 (3 H, s, $ArCH_3$), 3.00 (1 H, qd, *J* = 7.1, 3.6 Hz, ArCH), 3.38-3.44 (1 H, m, CHO), 7.08-7.17 (4 H, m, ArH); δ_C 16.4, 20.9, 26.8, 36.0, 40.7, 83.1, 127.2, 129.1, 135.4, 145.0. Anal. Calcd. for $C_{14}H_{22}O$: C, 81.48; H, 10.77. Found: C, 81.21; H, 10.70.

1-(4-Fluorophenyl)-3,3-dimethylbutan-2-ol (3ga). Purified by flash chromatography (hexane/AcOEt = 9:1); bp 145 °C/5 mmHg; ν (film) 3442 (OH), 1221 (ArF) cm^{-1}; δ_H 0.99 (9 H, s, $C(CH_3)_3$), 1.44 (1 H, bs, OH), 2.45 (1 H, dd, *J* = 13.8, 10.8 Hz, ArCH), 2.87 (1 H, dd, *J* = 13.8, 2.1 Hz, ArCH), 3.39 (1 H, dd, *J* = 10.8, 2.1 Hz, CHO), 6.96-7.04 (2 H, m, ArH), 7.16-7.27 (2 H, m, ArH); δ_C 25.8, 34.8, 37.5, 80.7, 115.3 (d, *J* = 21 Hz), 130.7 (d, *J* = 8 Hz), 135.6 (d, *J* = 4 Hz), 161.6 (d, *J* = 244 Hz). Anal. Calcd. for $C_{12}H_{17}FO$: C, 73.42; H, 8.75. Found: C, 73.56; H, 8.97.

1-Phenyl-2-(4-fluorophenyl)-ethanol (3gb). Purified by flash chromatography (hexane/AcOEt = 9:1); mp 45 °C (hexane); ν (film) 3337 (OH), 1217 (ArF) cm^{-1}; δ_H 1.82 (1 H, bs, OH), 2.99 (2 H, d, *J* = 6.9 Hz, CH_2), 4.86 (1 H, t, J = 6.9 Hz, CH), 6.92-7.01 (2 H, m, ArH), 7.08-7.16 (2 H, m, ArH), 7.26-7.37 (5 H, m, ArH); δ_C 45.0, 75.4, 115.2 (d, *J* = 22 Hz), 125.9, 127.7, 128.4, 130.9 (d, *J* = 8 Hz), 133.6 (d, *J* = 3 Hz), 143.6, 161.6 (d, *J* = 244 Hz). Anal. Calcd. for $C_{14}H_{13}FO$: C, 77.75; H, 6.07. Found: C, 77.43; H, 6.19.

4-(2,2-Dimethylpropan-1-ol)phenylmethyl methyl ether (7). Purified by flash chromatography (hexane/AcOEt = 9:1); bp 165 °C/5 mmHg; ν (film) 3461 (OH) cm^{-1}; δ_H 0.92 (9 H, s, $C(CH_3)_3$), 1.85 (1 H,

bs, OH), 3.40 (3 H, s, CH_3O), 4.40 (1 H, s, CH), 4.45 (2 H, s, CH_2), 7.29 (4 H, s, ArH); δ_C 25.9, 35.6, 58.1, 74.5, 82.1, 127.0, 127.6, 137.1, 141.2. Anal. Calcd. for $C_{13}H_{20}O_2$: C, 74.94; H, 9.70. Found: C, 75.13; H, 9.54.

1-(4-Methylphenyl)-2,2-dimethylpropan-1-ol (8). Purified by flash chromatography (hexane/AcOEt/CH_2Cl_2 = 5:1:5); bp 115 °C/5 mmHg; ν (film) 3387 (OH) cm^{-1}; δ_H 0.91 (9 H, s, $C(CH_3)_3$), 1.73 (1 H, bs, OH), 2.34 (3 H, s, $ArCH_3$), 4.37 (1 H, s, CH), 7.10-7.14 (2 H, m, ArH), 7.17-7.22 (2 H, m, ArH); δ_C 21.1, 25.9, 35.6, 82.3, 127.5, 128.2, 136.7, 139.2. Anal. Calcd. for $C_{12}H_{18}O$: C, 80.83; H, 10.20. Found: C, 81.07; H, 10.39.

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