Friedel–Crafts Reactions of 2-Naphthol with α-Amido Sulfones and Conversion of the Products with Nucleophiles[1]

Biswanath Das,* Cheruku Ravindra Reddy, Chava Sindhu, Chithaluri Sudhakar, Siddavatam Nagendra

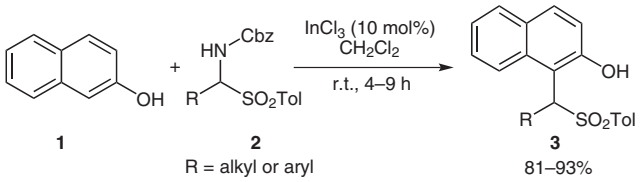
Organic Chemistry Division-1, Indian Institute of Chemical Technology, Hyderabad 500 007, India
Fax +91(40)27193198; E-mail: biswanathdas@yahoo.com

Received 6 July 2010; revised 13 July 2010

Abstract: 2-Naphthol underwent Friedel–Crafts reaction with *N*-benzyloxycarbonylamino sulfones in the presence of $InCl_3$ at room temperature to form the corresponding sulfonyl derivatives in high yields. The products were subsequently reacted with nucleophiles such as allyltributyltin and anisole to replace the sulfonyl group.

Key words: 2-naphthol, α-amido sulfone, $InCl_3$, Friedel–Crafts reaction, nucleophile

2-Naphthol derivatives exhibit various important biological properties including hypotensive and bradycardiac effects.[2] Many of these compounds have recently been prepared by us[3] as well as by others.[2,4] In continuation of our work[5] on the development of useful synthetic methodologies applying an α-amido sulfone we have observed that 2-naphthol can easily undergo Fridel–Crafts reaction with this reagent in the presence of catalytic amount of $InCl_3$ at room temperature (Scheme 1). The products (sulfone derivatives **3**) were formed in high yields (81–93%).



1 2 3

R = alkyl or aryl 81–93%

Scheme 1

N-Benzyloxycarbonylamino sulfones **2** used in the present conversion can be conveniently prepared[6] from aldehydes and are generally stable. Both the aromatic and aliphatic aldehydes were employed to prepare these sulfone derivatives. The aromatic aldehydes contained electron-donating as well as electron-withdrawing groups. *N*-Benzyloxycarbonylamino sulfones were used[6] earlier by us in the presence of $InCl_3$ in various synthetic work. In the present conversion, initially we treated 2-naphthol with the sulfone **2a** (R = Ph) using different Lewis acids (Table 1). Considering the reaction time and yield, $InCl_3$ was found to be most efficient. Thus, subsequently it was used to prepare a series of sulfonyl derivatives **3** from *N*-benzyloxycarbonylamino sulfones **2** (Table 2). Different functionalities such as halogen, ether, and nitro groups remained intact. The structures of the products were established from their spectral (IR, ^1H and ^{13}C NMR, ESI-MS, and HR-ESI-MS) and analytical data.

Table 1 Evaluation of Catalytic Activity of Different Catalysts for the Preparation of Sulfone Derivative **3a**[a]

Entry	Catalyst	Yield (%)[b]	Time (h)
1	$InCl_3$	93	5
2	$BF_3{\cdot}OEt_2$	91	5.5
3	$FeCl_3$	87	8
4	$ZnCl_2$	84	10
5	$ZrCl_4$	85	9
6	I_2	81	12
7	$Cu(OTf)_2$	86	10
8	$Sc(OTf)_3$	83	11
9	$Ba(NO_3)_2$	81	16

[a] Reaction conditions: *N*-benzyloxycarbonylamino sulfone **2a** (R = Ph, 1 mmol), 2-naphthol (**1**; 1 mmol) and catalyst (10 mol%) were stirred at r.t.
[b] Isolated yields after purification.

It is known[7] that α-amido sulfones are converted into the corresponding protected imines (*N*-acyliminium ions) on treatment with a Lewis acid (Scheme 2). These imine derivatives are highly suitable for nucleophilic addition. 2-Naphthol (**1**) reacts first with these ions and next the amine moiety of the resulting intermediate is displaced by a sulfonyl group in the presence of the catalyst to form the products **3**.

The sulfone derivatives of type **3** were subsequently treated with the nucleophiles such as allyltributyltin and anisole in the presence of $BF_3{\cdot}OEt_2$ at –10 °C (Scheme 3).

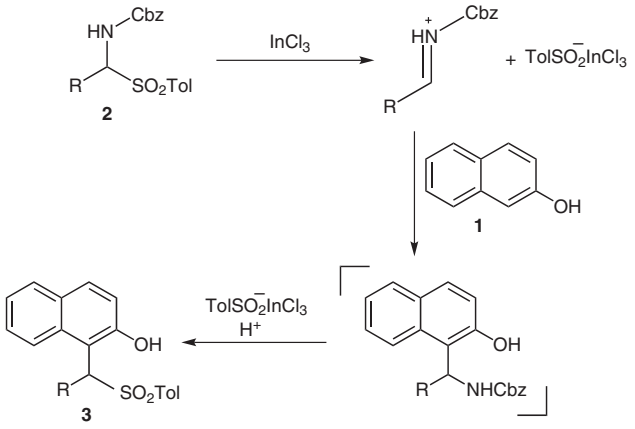
The conversion of **3** with allyltributyltin required one hour while with anisole the reaction time was 45 minutes. The products **4** and **5** were formed by replacement of the sulfonyl group of **3** by the nucleophiles (Table 3) in high yields (81–89%). Thus, the present method has been utilized for the preparation of 4,4-diarylbut-1-ene and triarylmethanes starting from 2-naphthol (**1**). The interesting point is that the conversions of **3** into **4** and **5** did not proceed in the presence of $InCl_3$.

SYNTHESIS 2010, No. 21, pp 3731–3735
Advanced online publication: 18.08.2010
DOI: 10.1055/s-0030-1258218; Art ID: Z17310SS

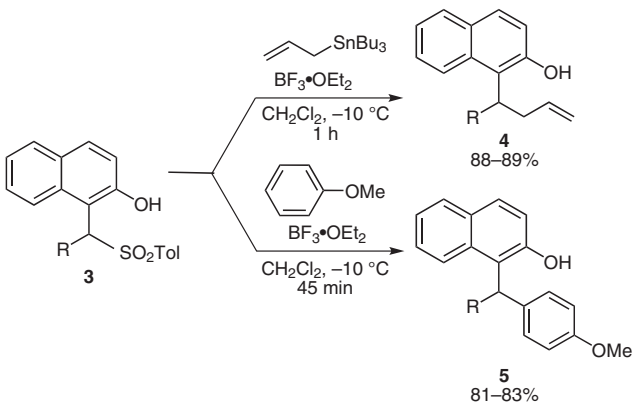
Table 2 Synthesis of Sulfone Derivatives **3**[a]

Sulfone **2**	R	Time (h)	Product[b]	Yield (%)[c]
2a	Ph	5	**3a**	93
2b	4-MeC_6H_4	4	**3b**	91
2c	4-*i*-PrC_6H_4	4.5	**3c**	92
2d	3-FC_6H_4	7	**3d**	90
2e	4-ClC_6H_4	6	**3e**	89
2f	2-Cl-4-FC_6H_3	8.5	**3f**	83
2g	3,4-$(OCH_2O)C_6H_3$	6	**3g**	86
2h	3,4,5-$(MeO)_3C_6H_2$	8.5	**3h**	81
2i	4-$O_2NC_6H_4$	9	**3i**	82
2j	2-naphthyl	6.5	**3j**	88
2k	*n*-Pr	9	**3k**	85
2l	*i*-Pr	8	**3l**	89

[a] Reaction conditions: *N*-benzyloxycarbonylamino sulfone **2** (1 mmol), 2-naphthol (**1**; 1 mmol), and $InCl_3$ (10 mol%), r.t.
[b] The structures of the products were established from their spectral (IR, ^1H and ^{13}C NMR, ESI-MS, and HR-ESI-MS) and analytical data.
[c] Isolated yields after purification.



Scheme 2



Scheme 3

Table 3 Synthesis of **4** and **5** from Sulfone Derivatives[a]

Sulfone	R	Time (h)	Product[b]	Yield (%)[c]
3a	Ph	1	**4a**[d]	89
3a	Ph	0.75	**5a**[e]	83
3b	4-MeC_6H_4	1	**4b**[d]	88
3c	4-*i*-PrC_6H_4	0.75	**5b**[e]	81

[a] Reaction conditions: sulfone derivative **3a–c** (1 mmol), nucleophile (1.5 mmol), and $BF_3{\times}OEt_2$ (20 mol%), –10 °C, N_2 atmosphere.
[b] The structures of the products were established from their spectral (IR, ^1H, ^{13}C NMR and ESI-MS) and analytical data.
[c] Isolated yields after purification.
[d] Derived from allyltributyltin.
[e] Derived from anisole.

In conclusion, we have demonstrated the synthesis of various 2-naphthol derivatives **3** by Friedel–Crafts reaction of 2-naphthol (**1**) with *N*-benzyloxylcarbonylamino sulfones **2** in the presence of $InCl_3$ and by subsequent treatment of the products with nucleophiles using $BF_3{\cdot}OEt_2$ as a catalyst.

The spectra were recorded with the following instruments; IR: PerkinElmer RX1 FT-IR spectrophotometer; NMR: Varian Gemini 200 MHz (^1H) and 50 MHz (^{13}C) spectrometer; ESI-MS: VG-Autospec micromass and HR-ESI-MS: QSTAR XL, Hybrid MS system. Column chromatography was carried out with silica gel (BDH 100–200 mesh) and TLC with silica gel GF_{254} precoated plates.

Reaction of 2-Naphthol (1) with *N*-Benzyloxycarbonylamino Sulfones 2; General Procedure

$InCl_3$ (10 mol%) was added to a solution of an α-amido sulfone 2 (1 mmol) and 2-naphthol (**1**; 144 mg, 1 mmol) in CH_2Cl_2 (5 mL) under N_2. The mixture was stirred at r.t. and the reaction was monitored by TLC. After completion, the reaction mixture was concentrated and H_2O (10 mL) and EtOAc (10 mL) were added. The organic layer was separated and concentrated. The residue was subjected to column chromatography (silica gel, hexane–EtOAc) to obtain the pure product.

1-[(Phenyl)(*p*-tosyl)methyl]-2-naphthol (3a)

Yellow oil.

IR (KBr): 3377, 1624, 1598, 1442, 1280 cm^{-1}.

^1H NMR (200 MHz, $CDCl_3$): δ = 8.74 (1 H, br s), 7.60–7.51 (7 H, m), 7.32–7.11 (6 H, m), 7.01 (2 H, d, *J* = 8.0 Hz), 6.41 (1 H, s), 2.22 (3 H, s).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 156.4, 144.8, 135.1, 131.9, 130.6, 129.8, 129.5, 129.2, 129.0, 127.3, 123.5, 121.2, 120.8, 70.2, 21.3.

ESI-MS: *m*/*z* = 389 $[M + H]^+$.

HR-ESI-MS: *m*/*z* $[M + Na]^+$ calcd for $C_{24}H_{20}O_3S$ + Na: 411.1030; found: 411.1013.

1-[(*p*-Tolyl)(*p*-tosyl)methyl]-2-naphthol (3b)

Yellow oil.

IR (KBr): 3320, 1595, 1512, 1403, 1248 cm^{-1}.

^1H NMR (200 MHz, $CDCl_3$): δ = 8.79 (1 H, br s), 7.68–7.55 (5 H, m), 7.54 (2 H, d, *J* = 8.0 Hz), 7.30–7.07 (5 H, m), 7.01 (2 H, d, *J* = 8.0 MHz), 6.39 (1 H, s), 2.31 (3 H, s), 2.20 (3 H, s).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 154.8, 145.1, 136.1, 131.8, 130.0, 129.9, 129.7, 129.5, 129.0, 127.9, 127.1, 123.5, 121.4, 120.2, 70.0, 21.5, 21.1.

ES-IMS: *m*/*z* = 425 $[M + Na]^+$.

HR-ESI-MS: *m*/*z* $[M + Na]^+$ calcd for $C_{27}H_{26}O_6S$ + Na: 501.1187; found: 425.1169.

1-[(4-Isopropylphenyl)(*p*-tosyl)methyl]-2-naphthol (3c)
Yellow oil.

IR (KBr): 3369, 1624, 1592, 1513, 1281 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 8.86 (1 H, br s), 7.70–7.51 (7 H, m), 7.29–7.11 (5 H, m), 6.99 (2 H, d, *J* = 8.0 Hz), 6.36 (1 H, s), 2.84 (1 H, m), 2.20 (3 H, s), 1.20 (6 H, d, *J* = 7.0 Hz).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 154.4, 149.1, 144.7, 134.8, 133.1, 131.9, 130.0, 129.2, 129.1, 128.7, 127.0, 126.9, 123.1, 121.0, 120.5, 96.3, 69.9, 33.7, 23.5, 21.2.

ESI-MS: *m*/*z* = 453 $[M + Na]^+$.

HR-ESI-MS: *m*/*z* $[M + Na]^+$ calcd for $C_{27}H_{26}O_3S$ + Na: 453.1500; found: 453.1512.

1-[(3-Fluorophenyl)(*p*-tosyl)methyl]-2-naphthol (3d)
Yellow oil.

IR (KBr): 3375, 1591, 1485, 1441, 1250 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 8.69 (1 H, br s), 7.69–7.59 (2 H, m), 7.51 (2 H, d, *J* = 8.0 Hz), 7.41–7.06 (7 H, m), 7.01–6.90 (3 H, m), 6.40 (1 H, s), 2.12 (3 H, s).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 164.6, 154.4, 145.4, 136.1, 132.0, 130.0, 129.1, 129.0, 128.7, 127.2, 125.8, 123.2, 116.8 (d, *J* = 10 Hz), 115.2 (d, *J* = 8.0 Hz), 69.8, 21.6.

ESI-MS: *m*/*z* = 429 $[M + Na]^+$.

HR-ESI-MS: *m*/*z* $[M + Na]^+$ calcd for $C_{24}H_{19}ClO_3S$ + Na: 429.0936; found: 429.0922.

1-[(4-Chlorophenyl)(*p*-tosyl)methyl]-2-naphthol (3e)
Yellow oil.

IR (KBr): 3378, 1624, 1590, 1490, 1261 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 8.72 (1 H, br s), 7.74–7.47 (7 H, m), 7.39–7.08 (5 H, m), 6.99 (2 H, d, *J* = 8.0 Hz), 6.35 (1 H, br s), 2.22 (3 H, s).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 154.8, 144.9, 133.0, 131.8, 131.2, 129.1, 128.9, 128.2, 127.0, 123.2, 121.0, 120.2, 69.1, 21.2.

ESI-MS: *m*/*z* = 445, 447 $[M + Na]^+$.

HR-ESI-MS: *m*/*z* $[M + Na]^+$ calcd for $C_{24}H_{19}ClO_3S$ + Na: 445.0641; 445.0637.

1-[(2-Chloro-4-fluorophenyl)(*p*-tosyl)methyl]-2-naphthol (3f)
Yellow oil.

IR (KBr): 3385, 1600, 1490, 1279 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 9.34 (1 H, s), 8.38 (1 H, m) 7.74–7.58 (4 H, m), 7.33–7.02 (8 H, m), 6.72 (1 H, s), 2.38 (3 H, s).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 164.5, 154.0, 145.6, 134.8, 133.7, 132.1, 130.0, 129.9, 127.3, 123.8, 122.1, 121.8, 117.9 (d, *J* = 10.0 Hz), 115.1 (d, *J* = 10.0 Hz), 67.0, 21.5.

ESI-MS: *m*/*z* = 463, 465 $[M + Na]^+$.

HR-ESI-MS: *m*/*z* $[M + Na]^+$ calcd for $C_{24}H_{18}ClO_3S$ + Na: 463.0541; found: 463.0544.

1-[(1,3-Benzodioxo1-5-yl)(*p*-tosyl)methyl]-2-naphthol (3g)
Yellow oil.

IR (KBr): 3382, 1625, 1598, 1491, 1250 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 8.85 (1 H, br s), 7.68–7.52 (3 H, m), 7.35–7.11 (6 H, m), 7.09–7.00 (3 H, m), 6.72 (1 H, d, *J* = 8.0 Hz), 6.31 (1 H, s), 5.08 (2 H, s), 2.22 (3 H, s).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 154.8, 152.3, 148.1, 144.6, 136.7, 133.2, 131.9, 129.8, 129.7, 129.5, 128.9, 127.1, 124.2, 123.2, 119.8, 119.2, 111.0, 67.6, 21.8.

ESI-MS: *m*/*z* = 455 $[M + Na]^+$.

HR-ESI-MS: *m*/*z* $[M + Na]^+$ calcd for $C_{24}H_{20}O_3S$ + Na: 455.0929; found: 455.0927.

1-[(*p*-Tosyl)(3,4,5-trimethoxyphenyl)methyl]-2-naphthol (3h)
Yellow oil.

IR (KBr): 3377, 1592, 1509, 1460, 1253 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 8.90 (1 H, br s), 7.75–7.52 (5 H, m), 7.32–7.11 (3 H, m), 7.02 (2 H, d, *J* = 8.0 Hz), 6.86 (2 H, s), 6.32 (1 H, s), 3.82 (3 H, s), 3.80 (6 H, s), 2.21 (3 H, s).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 154.9, 153.5, 144.8, 133.1, 132.0, 129.4, 129.2, 128.6, 127.1, 123.2, 121.1, 120.9, 70.4, 61.0, 56.1, 21.5.

ESI-MS: *m*/*z* = 479 $[M + H]^+$.

HR-ESI-MS: *m*/*z* $[M + Na]^+$ calcd for $C_{27}H_{26}O_6S$ + Na: 501.1347; found: 501.1334.

1-[(4-Nitrophenyl)(*p*-tosyl)methyl]-2-naphthol (3i)
Yellow oil.

IR (KBr): 3414, 1690, 1598, 1516, 1345, 1275 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 8.60 (1 H, br s), 7.89–7.80 (3 H, m), 7.75–7.62 (2 H, m), 7.58 (1 H, m), 7.38 (1 H, m), 7.31–7.20 (4 H, m), 7.05–6.92 (3 H, m), 6.46 (1 H, s), 2.22 (3 H, s).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 156.1, 146.3, 144.0, 136.0, 131.8, 131.2, 129.8, 128.2, 127.9, 127.8, 126.0, 122.9, 121.1, 118.0, 117.3, 66.5, 21.1.

ESI-MS: *m*/*z* = 456 $[M + Na]^+$.

HR-ESI-MS: *m*/*z* $[M + Na]^+$ calcd for $C_{24}H_{19}NO_5S$ + Na: 456.0876; found: 456.0873.

1-[(Naphthalene-2-yl)(*p*-tosyl)methyl]-2-naphthol (3j)
Yellow oil.

IR (KBr): 3418, 1689, 1609, 1445, 1341 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 8.78 (1 H, br s), 7.77–7.52 (6 H, m), 7.40–7.12 (9 H, m), 6.98 (2 H, d, *J* = 8.0 Hz), 6.58 (1 H, s), 2.17 (3 H, s).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 153.3, 145.2, 136.1, 133.1, 131.8, 129.7, 129.2, 128.8, 128.5, 128.2, 127.5, 127.3, 127.1, 126.8, 125.0, 123.2, 123.0, 120.4, 70.0, 21.1.

ESI-MS: *m*/*z* = 461 $[M + Na]^+$.

HR-ESI-MS: *m*/*z* $[M + Na]^+$ calcd for $C_{28}H_{22}O_3S$ + Na: 461.1182; found: 461.1179.

1-[1-(*p*-Tosyl)butyl]-2-naphthol (3k)
Yellow oil.

IR (KBr): 3348, 1624, 1597, 1462, 1280 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 8.60 (1 H, s), 7.70–7.59 (2 H, m), 7.54 (2 H, d, *J* = 8.0 Hz), 7.34–7.22 (2 H, m), 7.20–7.13 (2 H, m), 7.02 (2 H, d, *J* = 8.0 Hz), 4.98 (1 H, dd, *J* = 7.0, 2.0 Hz), 2.70 (1 H, m), 2.41 (1 H, m), 2.21 (3 H, s), 1.20–1.09 (2 H, m), 0.82 (3 H, t, *J* = 7.0 Hz).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 155.1, 144.6, 135.1, 131.5, 129.5, 129.1, 129.0, 126.9, 123.1, 121.3, 120.6, 64.7, 26.2, 21.1, 20.7, 13.9.

ESI-MS: *m*/*z* = 377 $[M + Na]^+$.

HR-ESI-MS: *m*/*z* $[M + Na]^+$ calcd for $C_{21}H_{22}O_3S$ + Na: 377.1187; found: 377.1186.

1-[2-Methyl-1-(*p*-tosyl)propyl]-2-naphthol (3l)
Yellow oil.

IR (KBr): 3360, 1598, 1514, 1457, 1338, 1283 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 8.92 (1 H, br s), 7.51 (2 H, d, *J* = 8.0 Hz), 7.41–7.22 (6 H, m), 6.90 (2 H, d, *J* = 8.0 Hz), 5.41 (1 H, d, *J* = 7.0 Hz), 3.31 (1 H, m), 2.22 (3 H, s), 1.29 (6 H, d, *J* = 7.0 Hz).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 153.1, 143.0, 138.2, 133.2, 131.0, 130.5, 129.0, 128.7, 127.5, 126.5, 126.2, 125.2, 123.0, 122.8, 67.3, 27.5, 31.2, 14.4.

ESI-MS: *m*/*z* = 377 $[M + Na]^+$.

HR-ESI-MS: *m*/*z* $[M + Na]^+$ calcd for $C_{21}H_{22}O_3S$ + Na: 377.1187; found: 377.1189.

Reaction of Sulfone Derivatives 3 with Nucleophiles; General Procedure
To a stirred solution of the sulfonyl derivative **3** (1 mmol) in anhyd CH_2Cl_2 (4 mL) kept under N_2 at –10 °C were added allyltributyltin or anisole (1.5 mmol) and $BF_3{\cdot}Et_2O$ (20 mol%) under stirring. The reaction was monitored by TLC. After completion, the reaction mixture was concentrated. H_2O (10 mL) and EtOAc (10 mL) were added. The organic layer was separated and concentrated. The residue was subjected to column chromatography (silica gel; hexane–EtOAc) to isolate the pure product.

1-(1-Phenylbut-3-enyl)-2-naphthol (4a)
Yellow oil.

IR (KBr): 3423, 1603, 1512, 1461, 1267 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 8.02 (1 H, d, *J* = 8.0 Hz), 7.72 (1 H, d, *J* = 8.0 Hz), 7.61 (1 H, d, *J* = 8.0 Hz), 7.40 (1 H, t, *J* = 8.0 Hz), 7.36–7.21 (3 H, m), 7.10 (2 H, d, *J* = 8.0 Hz), 6.95 (1 H, d, *J* = 8.0 Hz), 5.71 (1 H, m), 5.14–4.98 (2 H, m), 5.87 (1 H, d, *J* = 7.0 Hz), 3.12 (1 H, m), 2.95 (1 H, m), 2.27 (3 H, s).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 152.2, 139.6, 136.9, 135.0, 133.4, 129.6, 128.8, 127.5, 126.3, 123.2, 122.4, 119.1, 116.4, 40.5, 36.2, 21.1.

ESI-MS: *m*/*z* = 289 $[M + H]^+$.

Anal. Calcd for $C_{21}H_{20}O$: C, 87.50; H, 6.94. Found: C, 87.61; H, 6.98.

1-[(4-Methoxyphenyl)(phenyl)methyl]-2-naphthol (5a)
Yellow oil.

IR (KBr): 3481, 1610, 1508, 1460, 1249 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 7.91 (2 H, d, *J* = 8.0 Hz), 7.75–7.68 (2 H, m), 7.40–7.20 (7 H, m), 7.11 (2 H, d, *J* = 8.0 Hz), 7.02 (1 H, d, *J* = 8.0 Hz), 6.81 (2 H, d, *J* = 8.0 Hz), 6.30 (1 H, s), 5.11 (1 H, br s), 3.73 (3 H, s).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 159.5, 153.2, 141.8, 133.6, 133.5, 130.0, 129.8, 129.2, 129.0, 127.3, 127.0, 123.1, 122.8, 120.2, 114.8, 55.0, 48.2.

ESI-MS: *m*/*z* = 329 $[M + H]^+$.

Anal. Calcd for $C_{23}H_{20}O_2$: C, 84.15; H, 6.10. Found: C, 84.22; H, 6.07.

1-(1-*p*-Tolylbut-3-enyl)-2-naphthol (4b)
Yellow oil.

IR (KBr): 3423, 1603, 1512, 1461, 1267 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 8.02 (1 H, d, *J* = 8.0 Hz), 7.75 (1 H, d, *J* = 8.0 Hz), 7.61 (1 H, d, *J* = 8.0 Hz), 7.40 (1 H, t, *J* = 8.0 Hz), 7.33–7.20 (3 H, m), 7.16–7.04 (2 H, m), 6.93 (1 H, d, *J* = 8.0 Hz), 5.70 (1 H, m), 5.12–4.99 (2 H, m), 4.88 (1 H, br d, *J* = 8.0 Hz), 3.12 (1 H, m), 2.95 (1 H, m), 2.29 (3 H, s).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 152.5, 140.0, 137.2, 136.1, 133.4, 129.7, 128.9, 128.0, 126.8, 123.2, 122.3, 119.5, 116.6, 40.2, 35.9, 21.0.

ESI-MS: *m*/*z* = 289 $[M + H]^+$.

Anal. Calcd for $C_{21}H_{20}O$: C, 87.50; H, 6.94. Found: C, 87.63; H, 6.87.

1-[(4-Isopropylphenyl)(4-methoxyphenyl)methyl]-2-naphthol (5b)
Yellow oil.

IR (KBr): 3483, 1615, 1509, 1462, 1250 cm^{-1}.

^{1}H NMR (200 MHz, $CDCl_3$): δ = 7.92 (1 H, d, *J* = 8.0 Hz), 7.71 (1 H, d, *J* = 8.0 Hz), 7.65 (1 H, d, *J* = 8.0 Hz), 7.40–7.21 (2 H, m), 7.18–7.08 (6 H, m), 7.01 (1 H, d, *J* = 8.0 Hz), 6.81 (2 H, d, *J* = 8.0 Hz), 6.25 (1 H, s), 3.75 (3 H, s), 2.89 (1 H, m), 1.27 (6 H, d, *J* = 7.0 Hz).

^{13}C NMR (50 MHz, $CDCl_3$): δ = 158.9, 153.2, 148.0, 139.5, 133.4, 130.0, 129.8, 128.9, 128.8, 127.5, 126.4, 123.0, 122.8, 120.1, 114.3, 55.6, 47.8, 30.0, 24.1.

ESI-MS: *m*/*z* = 405 $[M + Na]^+$.

Anal. Calcd for $C_{27}H_{26}O_2$: C, 84.82; H, 6.81. Found: C, 84.71; H, 6.87.

Acknowledgment

The authors thank CSIR and UGC, New Delhi for financial assistance.

References

(1) Part 209 in the series ‘Studies on Novel Synthetic Methodologies’.
(2) Shen, A. Y.; Tsai, C. T.; Chen, C. L. *Eur. J. Med Chem.* **1999**, *34*, 877.
(3) (a) Das, B.; Laxminarayana, K.; Ravikanth, B.; Rao, B. R. *J. Mol. Catal. A: Chem.* **2007**, *261*, 180. (b) Das, B.; Veeranjaneyulu, B.; Krishnaiah, M.; Balasubramanyam, P. *Synth. Commun.* **2009**, *39*, 1929.
(4) (a) Khodaei, M. M.; Khosropour, A. R.; Moghanian, H. *Synlett* **2006**, 916. (b) Selvam, N. P.; Perumal, P. T. *Tetrahedron Lett.* **2006**, *47*, 7481. (c) Srihari, G.; Nagaraju, M.; Murthy, M. M. *Helv. Chim. Acta* **2007**, *90*, 1497. (d) Shaterian, H. R.; Amirzadeh, A.; Khorami, E.; Ghashang, M. *Synth. Commun.* **2008**, *38*, 2983. (e) Mahdavinia, G. H.; Bigdeli, M. A. *Chin. Chem. Lett.* **2009**, *20*, 383.
(5) (a) Das, B.; Damodar, K.; Saritha, D.; Chowdhury, N.; Krishnaiah, M. *Tetrahedron Lett.* **2007**, *48*, 7930. (b) Das, B.; Damodar, K.; Shashi Kanth, B.; Srinivas, Y.; Kalavathi, I. *Synlett* **2008**, 3133. (c) Das, B.; Damodar, K.; Bhunia, N. *J. Org. Chem.* **2009**, *74*, 5607.
(6) (a) Pearson, W. H.; Lindbeck, A. C.; Kampf, J. W. *J. Am. Chem. Soc.* **1933**, *115*, 2622. (b) Mecozzi, T.; Petrini, M. *J. Org. Chem.* **1999**, *64*, 8970.

(7) (a) Petrini, M. *Chem. Rev.* **2005**, *105*, 3949. (b) Petrini, M.; Torregiani, E. *Synthesis* **2007**, 159. (c) Thirupathi, P.; Kim, S. S. *J. Org. Chem.* **2009**, *74*, 7755. (d) Reingruber, R.; Baumann, T.; Dabmen, S.; Bräse, S. *Adv. Synth. Catal.* **2009**, *351*, 1019.