3-BROMO-2-t-BUTYLSULFONYL-1-PROPENE.
A VERSATILE MULTI-COUPLING REAGENT
Part 1

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Summary –
The 3-bromo-2-t-butylsulfonyl-1-propene $\underline{3}$ was prepared in two steps from allyl-t-butylthioether in 70% overall yield. This reagent reacts selectively with a broad range of nucleophiles (amine, thiolate, lithium ester- and keto- enolates, magnesium, zinc and lithium organometallics) to furnish the unsaturated sulfones of type $\underline{4}$ in typical yields of 80-90%. The sulfone $\underline{3}$ reacts also in the presence of zinc with various electrophiles (aldehydes, ketones, nitriles and an imine) to afford the functionalized unsaturated sulfones of type $\underline{7}$ in good yields.

A - Introduction

Convergent synthesis is one of the most useful strategy in organic synthesis. In such an approach, there is a need of highly reactive and selective reagents of type $\underline{1}$ which are able to form sequencially two new bonds with two different reagents A and B (see scheme 1). To be of general utility and versatility, the carbon skeleton of $\underline{1}$ must be simple, so that it can be found in many retrosynthetic approaches.

Reagents of type $\underline{1}$ which satisfy these conditions were

Scheme 1

$\underline{1}$
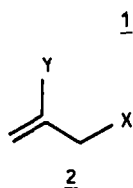
called multi-coupling reagents[2,3]. Functionalized allylic compounds of type $\underline{2}$ are a class of such reagents which are synthetically very useful. The groups X and Y can be : Y=COOR, X=Br[4] or ZnBr[5] ; Y=CONR[1]R[2], X=Li or ZnBr[5b,6] ; Y=COR, X=OH[7] ; Y=OR, X=Hal[8] ; Y=P(0)(OR)$_2$, X=Br[9] or X=ZnBr[5b,10], X and Y=Hal[11] ; Y=CH$_2$SiMe$_3$, X=OR[12] ; Y=SR, X=OR[13], Y=SiMe$_3$, X=Br,I[14] or MgBr,ZnBr[15,5b] ; Y=SePh, X=Br[16] ; Y=SOR, X=Br or ZnBr[5b,17] ; Y=SO$_2$R, X=Br[5b,17,18,19] and ZnBr[20].

$\underline{2}$

We describe here the preparation and reactions of 3-bromo-2-t-butylsulfonyl-1-propene $\underline{3}$ (preliminary reports : ref. 19 and 20a).

The reactivity pattern of the sulfone $\underline{3}$ is shown in scheme 2. It reacts with a nucleophile Nu[1] to give selectively the unsaturated sulfone $\underline{4}$ without any bis-addition of Nu[1] (which

would lead to the saturated sulfone $\underline{5}$. By reaction with a different nucleophile Nu^2, a sulfone of type $\underline{6}$ is obtained (see accompanying paper).

Scheme 2
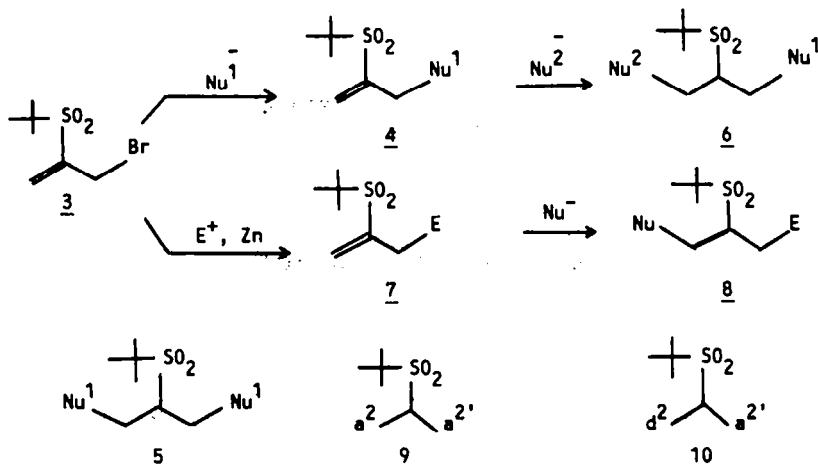
The 3-bromo-2-tert-butylsulfonyl propene $\underline{3}$ reacts also readily with electrophiles E in the presence of zinc and affords mono-coupling products of type $\underline{7}$ which can react with a nucleophile Nu to furnish the highly functionalized sulfones $\underline{8}$. The sulfone $\underline{3}$ is a multi-coupling reagent which is synthetically equivalent to the $a^2/a^{2'}$ synthon $\underline{9}$ and to the $d^2/a^{2'}$ synthon $\underline{10}$ (see ref. 21 for this nomenclature). The scope of the reactions of $\underline{3}$ with nucleophiles and electrophiles will be indicated.

B - Preparation of 3-bromo-2-tert-butylsulfonyl-1-propene $\underline{3}$

The sulfone $\underline{3}$ is easily available in 2 steps from tert-butylthioether[22] $\underline{11}$ with an overall yield of 70% (see scheme 3). The addition of one equivalent of bromine to a carbon tetrachloride solution of the thioether $\underline{11}$ furnishes a yellow precipitate of the episulfonium salt $\underline{12}$ which, by warming to 15°, gives the unstable[23] dibromo thioether $\underline{13}$. This thioether was directly oxidized to the dibromo sulfone $\underline{14}$ with meta-chloroperbenzoic acid (2.4 equiv.) with an isolated yield of 87%. The elimination of HBr occurs smoothly by stirring an ethereal solution of $\underline{14}$ with 1.5 eq. of dry sodium acetate for 2.5hr at 25° to afford the desired sulfone $\underline{3}$ as a crystalline solid (m.p. 43° ; purity : 96% ; 80% yield).

Scheme 3
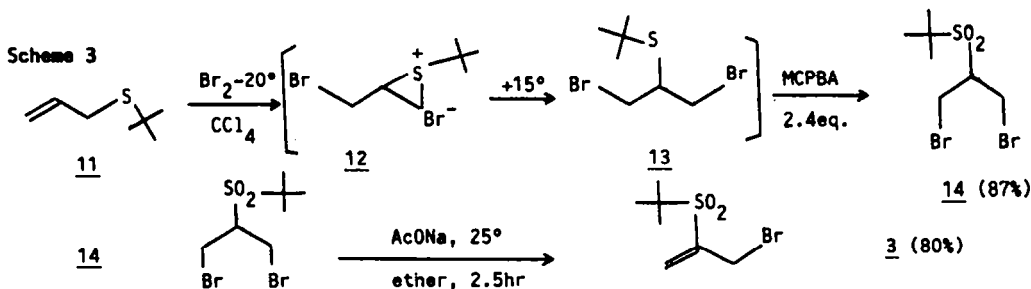
All these reactions can easily be performed on a 50 gr scale, making the reagent $\underline{3}$ readily available in large quantities. The sulfone $\underline{3}$ can be stored many months in a refrigerator without any decomposition.

C - Reaction of the sulfone $\underline{3}$ with nucleophiles

The simultaneous presence of an allylic bromine atom and of a vinylic sulfone confers an exceptional electrophilicity on $\underline{3}$ (as compared to an allylic bromide or to a vinylic sulfone). Various nucleophiles Nu^1 react rapidly with $\underline{3}$ and afford the highly functionalized

sulfones of type **4** (see scheme 2 and table 1). Thus even an amine like aniline reacts at
-50° within 0.5 hr (see entry 2 of table 1) ; other soft nucleophiles like lithium
thiophenolate or a malonate type enolate react also smoothly (see entry 1 and 3 of table 1).
More reactive nucleophiles like lithium enolates furnish the desired addition products in
good yield providing that the sulfone **3** is slowly added as a THF solution at a low
temperature (-80°) ; see entries 4-6 of table 1 and the experimental part. Very reactive
nucleophiles like lithium or magnesium reagents can also be added (entries 7-14 of table 1).
The best yields are obtained by adding the organometallics to a THF solution of the sulfone
3 at -90° and then warming up to the temperature indicated in the table. Under these
conditions a large variety of organometallics (alkynyl, aryl, vinylic, primary, secondary
and tertiary alkyl) afford the unsaturated sulfones (**4g** – **4n**) in 60 to 94% yields (see
table). An exception was dimethylphenylsilyllithium[23] which gives low yields of the desired
coupling product **4m** under various conditions ; but the corresponding cyanocuprate[24,25]
generated by adding one equivalent of CuCN (0.5 hr at -40°) to dimethylphenylsilyllithium
gives a clean substitution reaction which furnishes the allylsilane **4m** in 74% yield (see
entry 13 of table 1). The reactivity of **4m** was shortly investigated : pivaloyl chloride in
the presence of TiCl$_4$ (compare with ref. 26) did not react with **4m** and the reaction of **4m**
with dimethyl maleate in the presence of tetrabutylammonium fluoride only gives 2-propenyl-
t-butylsulfone ; no cyclic[20b] product could be detected. Finally even an activated zinc
reagent like allylzinc bromide was able to add to **3** although after a longer reaction time
(24 hr at 25°) to yield in 85% the 1,5-dienylsulfone **4c** (see entry 15 of table 1).
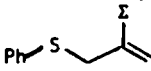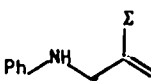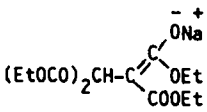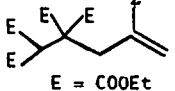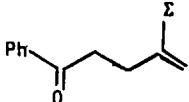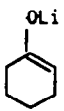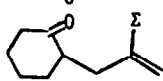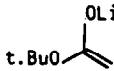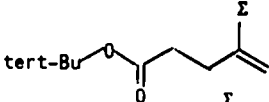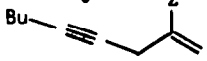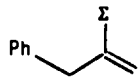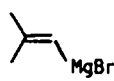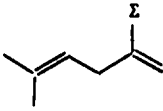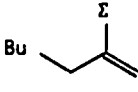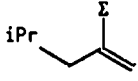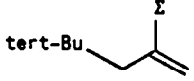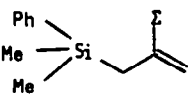
D – Reaction of sulfone **3** with electrophiles

As indicated in scheme 2, the sulfone **3** is also able to react with various electrophiles in
the presence of zinc[20a] or of chromium (II) salts[20c]. Under previously developped Barbier
conditions[5b] (generation of the organometallic species in the presence of the electrophile),
the sulfone **3** reacts readily with aldehydes, ketones and nitriles in the presence of zinc ;
even some alkynes can be used as electrophiles in this reaction (see ref. 5b). Thus the
dropwise addition of a THF solution of **3** to a THF solution of the carbonyl compound
containing activated zinc (see experimental part) at 40°-50° gives, after a reaction time of
typically 0.5 hr, the desired addition product of type **7** (see scheme 2 and table 2) in good
to excellent yields. The reaction flask was immersed into an ultrasound bath during the
reaction. This procedure allows an efficient stirring of the highly concentrated reaction
mixture and an additional activation of the zinc[27]. Aldehydes and ketones give a very fast
addition and high yields (see entries 1-10 of table 2) ; the zinc salt of α-hydroxyacetone
is an exception and the desired diol is only isolated in 40% (see entry 11 of table 2).
Unsatured ketones or aldehydes react specifically in a 1,2 fashion and even the sensitive
β-ionone (entry 9 of table 2) furnishes the corresponding unsaturated tertiary alcohol in
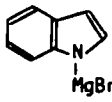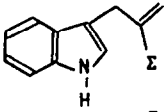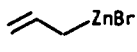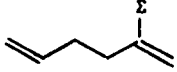83% yield. Nitriles give an imine which is easily hydrolysed (1 NHCl, 0°, 0.5 hr) to afford
the corresponding ketone in 64% yield to 70% yield (see entries 12-14 of table 2) ; even a
moderately electrophilic imine reacts with **3** and zinc, leading to the unsaturated
aminosulfone **7o** in 65% yield (see entry 15 of table 2).

Conclusion
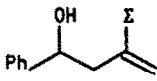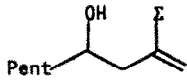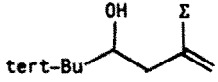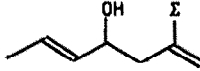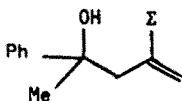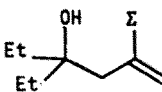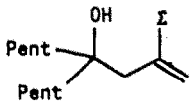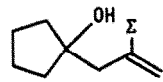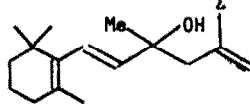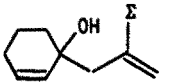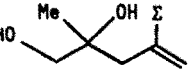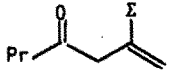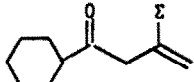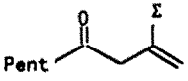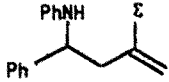
In this article we have shown the great versatility of reagent **3** to form new carbon-carbon bonds
with various substrates (electrophiles and nucleophiles) ; we have thus demonstrated the
multicoupling ability of this reagent.

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Table 1. Products of type 4 obtained by the reaction of 3-bromo-2-tert-butylsulfonyl-1-propene with nucleophiles

Entry	Nucleophile	Product of type 4 (a)	Reaction conditions	Yield %
1	PhSLi	4a	0.25hr at -78°	84
2	PhNH$_2$	4b	0.5 hr at -50°	92
3	(EtOCO)$_2$CH-C=C(ONa)(OEt)(COOEt)	4c (E = COOEt)	1 hr at -50°	65
4	Ph-C(OLi)=CH$_2$	4d	1 hr at -80° ; 0.25hr at -40°	84
5	cyclohexenyl-OLi	4e	1 hr at -70° ; then 0.25hr at -60°	94
6	t.BuO-C(OLi)=CH$_2$	4f	1 hr at -80°	86
7	Bu-≡-Li	4g	0.5 hr at -78° ; then 0.25hr at -70°	80
8	Ph-MgBr	4h	0.5 hr at -78° ; then 1.5 hr at -50°	89
9	(CH$_3$)$_2$C=CH-MgBr	4i	0.5 hr at -78° ; then 1 hr at -45°	93
10	BuMgBr	4j	0.5 hr at -78° ; ten 1 hr at -65°	85
11	i-Pr-MgCl	4k	0.5 hr at -78° ; then 1 hr at -65°	90
12	tert-Bu-MgCl	4l	0.5 hr at -90° ; then 0.5 hr at -75°	94
13	Ph-SiCuCNLi Me$_2$	4m	0.5 hr at -80°	74
14	indolyl-MgBr	4n	0.5 hr at -60° ; then 1.5 hr at -50° (solvent : toluene)	60
15	CH$_2$=CH-CH$_2$-ZnBr	4o	24 hr at 25°	85

(a) Σ stands for SO$_2$-tert-Butyl

Table 2. Products of type **7** obtained by the reaction of 3-bromo-2-tert-butylsulfonyl-1-propene with aldehydes, ketones, nitriles and an imine

Entry	Electrophile		Product of type **7**	Yield %
1	Benzaldehyde	**7a**		85
2	Hexanal	**7b**		85
3	Pivalaldehyde	**7c**		85
4	Crotonaldehyde	**7d**		88
5	Acetophenone	**7e**		86
6	3-pentanone	**7f**		88
7	6-undecanone	**7g**		82
8	Cyclopentanone	**7h**		84
9	β-ionone	**7i**		83
10	Cyclohexenone	**7j**		80
11	α-hydroxyacetone	**7k**		40
12	Butyronitrile	**7l**		64
13	Cyclohexyl cyanide	**7m**		65
14	Hexanenitrile	**7n**		70
15	Benzalanilin	**7o**		65

EXPERIMENTAL PART –

THF and ether were distilled from sodium/benzophenone. Infrared spectra were recorded on a Perkin Elmer 457G spectrometer. Proton NMR spectra were obtained at 100MHz with a Jeol MH100 and at 250MHz with a Bruker AM 250. ^{13}C NMR spectra were obtained with a Jeol FX90. Chemical shifts in CDCl$_3$ solution are reported in ppm relative to tetramethylsilane as an internal standard. Gas chromatography was carried out with a Carlo Erba 2150 model equiped with an OV 101 (20 m) column. Merck 60 (70-230 mesh) silica gel was used for the flash chromatography.[28]

1,3-Dibromo-2-t-butylsulfonylpropane 14

In a dry three-neckflask, equipped with mechanical stirring, a pressure equilibrating dropping funnel and a thermometer, is placed a solution of allyl, tert butyl thioether[22] 7.35 g (56.5 mmol) in 50 ml CCl$_4$. To this solution, cooled at -20°C, is added dropwise, a solution of 9.03 g bromine (56.5 mmole) in 25 ml CCl$_4$, so that temperature never exceeds -15°C. A yellow precipitate of the episulfonium bromide separates out. The temperature is then allowed to raise up to +15°C (the precipitates dissolves to give an orange solution of 13), the mixture is stirred over 5 min and poured out in the dropping funnel of a second device, analogous to the former one, where a suspension of 29.5 g (135 mmol) of metachloroperbenzoic acid in 80 ml CH$_2$Cl$_2$ has been prepared in the flask. The solution of 13 is then added dropwise at -20° within 15 min, and the mixture 13 allowed to warm up to room temperature and stirred over 3 hrs. 300 ml CH$_2$Cl$_2$ and 600 ml CHCl$_3$ are then added, the organic layer is washed with water (300 ml) and a 20% sodium hydrogenosulfite solution (3 x 150 ml). The aqueous phase thus obtained is extracted once more (150 ml of CH$_2$Cl$_2$). The joined organic phases are then washed successively with a sodium carbonate solution (3 x 150 ml), water (2 x 150 ml) and sat. NaCl (150 ml). After drying over MgSO$_4$ and evaporation of solvents under reduced pressure, 17.3 g of crude 14 are obtained. They are purified by filtration on a silica gel column (CH$_2$Cl$_2$) to give 15.8 g (87%) of 14 used as such for the next step.
I.R. (neat, KBr) : 1315, 1295, 1260, 110, 1085, 865, 845, 690
RMN ^{13}C (CDCl$_3$) : 57.47, 28.3, 23.39 ppm
RMN ^{1}H (CDCl$_3$) : 4.0 (m,5H), 1.43 (s,9H)

3-Bromo-2-t-butyl sulfonyl-1-propene 3

14.5 g (45 mmol) of 14, 120 ml THF, 5.6 g (67,5 mmol) of AcONa (previously dried under a vacuum, 5 hr at 100°C) are placed in a flask immersed in an ultrasound laboratory cleaner (48kHz, 30 w), and allowed to react for 2.5 hrs at room temperature. The white fine suspension is then filtrated, the precipitate is washed (2 x 30 ml CH$_2$Cl$_2$), the filtrate is partly concentrated under a vacuum to evaporate THF, and diluted with 150 ml CH$_2$Cl$_2$, then washed with water (3 x 30 ml), then a sat. NaCl solution (2 x 30 ml) and dried over magnesium sulfate. After evaporation of solvents, under reduced pressure, 9.9 g of 3 are obtained (purity 93% according to VPC). This product can be used as such, or chromatographed on silica gel (cyclohexane/ethylacetate = 80/20) to give 80% of 3 (purity 96%). m.p. :43°C
I.R. (KBr, neat) : 3100, 3040, 2970, 1480, 1460, 1435, 1395, 1284, 1118, 1098, 972, 800, 760, 720
RMN ^{13}C (CDCl$_3$) : 143.76, 134.55, 60.51, 27.14, 23.39
RMN ^{1}H (CDCl$_3$) : 6.63 (s,2H), 4.38 (s,2H), 1.46 (s,9H).

General procedure for the addition of a nucleophile to the sulfone 3

Method A : direct addition (addition of a solution of 3 to the nucleophile)
This procedure has been used with keto- and ester- enolates. A dry three-neck flask equipped with a pressure-equilibrating dropping funnel, a magnetic bar, a thermometer and a rubber septum was flushed with Ar. Diisopropylamine (7.5 mmol) and 21 ml of dry THF were added through the rubber septum. The stirred mixture was cooled to -78° (acetone/dry ice) and 6.4 mmol of BuLi (2.1N in ether) were added through the dropping funnel. After 0.5 hr at -78°C, a solution of the ketone or ester (6.35 mmol) in 3 ml of THF was slowly added to the LDA solution. The lithium enolate was formed after 1-1.5 hr stirring at -78°C. Then a solution of 3 (6.22 mmol) in 25 ml of THF was added within 20 min. After the time indicated in the table 1 (determinated by taking aliquots and controlling the progress of the reaction by t.l.c. or g.c.), the reaction mixture was diluted with 150 ml of ether and aq. NH$_4$Cl (40 ml). The two layers were separated and the aq. layer was extracted with ether (2 x 30 ml). The combined organic phases were washed with aq. NH$_4$Cl (30 ml), H$_2$O (2 x 30 ml) and brine (40 ml), dried (MgSO$_4$) and filtered. The solvent was evaporated and the residue was purified by flash-chromatography.

Method B : inverse addition (addition of the nucleophile to a solution of the sulfone 3)
The same apparatus as in method A was used. A stirred solution of 10 mmol of the sulfone 3 in 50 ml of THF was cooled to -90° and an ether or THF solution of the organometallics (10 mmol) was slowly added within 10 min. The reaction was then stirred as indicated in the table 1 (time and temperature) and worked up as above.

2-t-Butylsulfonyl-3-thiophenyl-1 propene 4a

Method B : A solution of 3.33 ml of BuLi (1.83N ; 6.10 mmol) was added at -78° to 671 mg (6.10 mmol) of thiophenol in 20 ml of THF, followed, after 5 min, by a solution of 1.5 g (5.98 mmol) of the sulfone 3 in 20 ml of THF. After 0.25 hr at -78°, the reaction was worked up and purified by flash chromatography (solvent : hexane : CH$_2$Cl$_2$: ether/55:35:5) to give 1.35 g (84%) of a solid m.p. 89°C. See table 4 for the spectroscopic data.
Found : C, 57.60 ; H, 6.75%. Calcd. for C$_{13}$H$_{18}$S$_2$O$_2$: C, 57.74 ; H, 6.71%.

2-t-Butylsulfonyl-3-(N-phenylamino)-1-propene 4b
A solution of 800 mg ((8.6 mmol) of anilin in 5 ml THF is added to a solution of 1 g (4.15
mmol) of sulfone **3** in 5 ml THF at -78°.
The temperature is allowed to raise to -50°C. After stirring for 30 min at -50°C, the reaction
is over (check by t.l.c) and 20 ml of aq. sat. NH₄Cl and 50 ml CH₂Cl₂ are added. The organic
phase is washed with brine (20 ml), dried over MgSO₄, and the solvents are evaporated under
vacuum. The residue is chromatographed on silicagel (solvent Hexane :CH₂Cl₂ : ether/70:30:2) to
give 960 mg (91,5%) of amine **4b**. m.p.:124.5°C (CH₂Cl₂, pentane) ; see table 3 for spectroscopic
data.
Found : C, 61.41 ; H, 7.50%. Calcd. for C₁₃H₁₉NSO₂ : C, 61.63 ; H, 7.56%.

Ethyl-1,1,2,2-tetracarboxylate-4-t-Butylsulfonyl-4-pentene 4c
Method A : The reagent is prepared from 105 mg NaH (4.37 mmol) freed of oil by washing with THF,
dispersed in 15 ml of THF. A solution of 1.32 g (4.15 mmol) of ethyl ethane tetracarboxylate in
10 ml THF is added dropwise at 0°C to this suspension and the mixture is then stirred over 1 hr
at 0°C.
The solution is then added to a solution of **3** (1 g, 4.15 mmol) in 10 ml THF at -78°. The
temperature is allowed to raise to -50°C. After 1 hr, a copious white precipitate is formed. 20
ml of sat. NH₄Cl solution are added, the organic layer is separated, washed with water (3 x 5
ml) dried over magnesium sulfate and solvents are evaporated under a vacuum. The remaining crude
oil is chromatographed on silica gel (solvent : hexane : CH₂Cl₂ : ether/70:30:5) to give 1.88 g
(95%) of ester **4c**. m.p : 64°C , see table 3 for spectroscopic data.
Found : C, 52.30 ; H, 7.26%. Calcd. for C₂₁H₃₄SO₁₀ : C, 52.70 ; H, 7.16%.

4-t-Butylsulfonyl-1-oxo-1-phenyl-4-pentene 4d
Method A : The lithium enolate of acetophenone was generated as indicated in the general
procedure with the following quantities : 750 mg (7.4 mmol) of diisopropylamine in 21 ml of THF,
3.05 ml (6.40 mmol) of BuLi 2.1N in ether, 762 mg (6.35 mmol) of acetophenone. After 1.5 hr at
-70°, 1.5 g (6.2 mmol) of the sulfone **3** in 25 ml of THF was added at -80° within 20 min and
after 1 hr at -80°, the reaction mixture was warmed up to -40° and worked up after 15 min at
this temperature to give after a purification by flash chromatography (solvent :
CH₂Cl₂:hexane/6:1) 1.46 g of white crystals (m.p. 110° ; 84% yield). See table 3 for the
spectroscopic data.
Found : C, 64.05 ; H, 7.12%. Calcd. for C₁₅H₂₀SO₃ : C, 64.25 ; H, 7.19%.

-(2'-t-Butylsulfonyl-2'-propenyl)-1-cyclohexanone 4e
Methode A : The lithium enolate of cyclohexanone was indicated in the general procedure with the
same quantities as for the synthesis of **4d** and 622 mg (6.35 mmol) of cyclohexanone. After 1.5 hr
at -40°, 1.5 g (5.98 mmol) of the sulfone **3** in 20 ml of THF was added at -80° within 20 min and
after 1 hr at -70°, the reaction mixture was warmed up to -60° and worked up after 15 min at
this temperature to give after a purification by flash chromatography (solvent :
CH₂Cl₂:hexane/9:1) 1.45 g of white crystals (m.p. 86° ; 94% yield). See table 3 for the
spectroscopic data.

t-Butyl 4-t-butylsulfonyl-4-pentenoate 4f
Method A : The lithium enolate of t-butyl acetate was generated as indicated in the general
procedure with the same quantities as for the synthesis of **4d** and 737 mg (6.35 mmol) of t-butyl
acetate. After 1 hr at -80°, 1.5 g (5.98 mmol) of the sulfone **3** in 30 ml of THF was added within
20 min. After 1 hr at -78° the reaction was worked up and the residue was purified by flash
chromatography (solvent : CH₂Cl₂ and CH₂Cl₂ : ether/97:3) to give 1.41 g of an oil which
crystallizes (m.p. 43° (ether/hexane) : 86% yield). See table 3 for the spectroscopic data.
Found : C, 56.29 ; H, 8.70%. Calcd. for C₁₃H₂₄SO₄ : C, 56.49 ; H, 8.75%.

2-t-Butylsulfonyl-1-nonen-4-yne 4g
Method B : A solution of hexynyllithium (prepared by the addition of 3.9 ml of BuLi (7.5 mmol)
1.98N in ether to 738 mg (9.0 mmol) of 1-hexyne in 10 ml of THF at -30° ; after 15 min at 25°,
the solution is ready for use) was added to a stirred solution of 1.5 g (5.98 mmol) of the
sulfone **3** dissolved in 25 ml of THF at -90°. After 0.5 hr at -78°, the mixture was warmed up to
-70° and worked up after 0.25 hr at this temperature to give after a purification of the residue
by flash chromatography (solvent : hexane : ether : CH₂Cl₂/15:1:15) 1.15 g (80% yield) of an
oil; See table 3 for the spectroscopic data.

2-t-Butylsulfonyl-3-phenyl-1-propene 4h
Method B : A solution of phenylmagnesium bromide (6.6 mmol) in 10 ml of THF was added to a
solution of 1.5 g (5.98 mmol) of the sulfone **3** in 30 ml of THF at -90°. The reaction mixture was
stirred 0.5 hr at -78° and was then warmed up to -50° and worked up after 1.5 hr at this
temperature to give, after a purification by flash chromatography (solvent : hexane : CH₂Cl₂ :
ether/40:40:3), 1.26 g of an oil which crystallizes readily (m.p. 72°, 89% yield). See table 3
for the spectroscopic data.
Found : C, 65.21 ; H,7.70%. Calcd. for C₁₃H₁₈SO₂ : C, 65.51 ; H, 7.70%.

2-t-Butylsulfonyl-5-methyl-1,4-hexadiene 4i
Method B :A solution of 2-methyl-1-propenylmagnesium bromide 8 ml (6.6 mmol) 0.84N in THF was
added at -85° to a solution of 1.5 g (5.98 mmol) of the sulfone **3** in 20 ml of THF. After 0.5 hr
at -78°, the reaction mixture was stirred 1 hr at -45° to give, after work-up, a residue which
was purified by flash chromatography (solvent : hexane : ether : CH₂Cl₂/40:4:40) to furnish 1.20
g of a pure oil (93% yield); See table 3 for the spectroscopic data.

2-t-Butylsulfonyl-1-heptene 4j

Method B : A solution of 6 mmol of butylmagnesium bromide (1.82N in ether) was added at -90° to a stirred solution of 1.5 g (5.98 mmol) of the sulfone **3**. After 0.5 hr at -78°, the reaction mixture was stirred 1 hr at -65° and then worked up. The residue was purified by flash chromatography (solvent : CH_2Cl_2 : hexane : ether/8:4:1) to furnish 1.11 g (85% yield) of a pure oil; See table 3 for the spectroscopic data.

2-t-Butylsulfonyl-4-methyl-1-pentene 4k

Method B : A solution of isopropylmagnesium chloride (6.6. mmol of a 1.56N solution in THF) in 10 ml of THF was slowly added within 15 min at -90° to a solution of 1.5 g (5.98 mmol) of the sulfone **3** in 30 ml of THF. After 0.5 hr at -78°, the reaction was stirred 1 hr at -65° and worked up; The residue was purified by flash chromatography (solvent : hexane : CH_2Cl_2 : ether/8:8:1) to afford 1.12 g of an oil (90% yield). See table 3 for the spectroscopic data.[2]

2-t-Butylsulfonyl-4,4-dimethyl-1-pentene 4l

Method B : A solution of 4.2 ml (6.6 mmol) of t-butylmagnesium chloride 1.56N in THF was dissolved in 10 ml of THF and added within 15 min to a cooled solution (-90°) of 1.5 g (5.98 mmol) of the sulfone **3**. After 0.5 hr at -90°, the reaction mixture was stirred 0.5 hr at -75° and worked up; The residue was purified by flash chromatography (solvent : CH_2Cl_2 : hexane : ether/8:8:1) 1.25 g of an oil which crystallizes readily to give white crystals (m.p. 91° ; 94% yield); See table 3 for the spectroscopic data.
Found : C, 60.50 ; H, 10.25%. Calcd. for $C_{11}H_{22}SO_2$: C,60.51 ; H, 10.25%.

(2-t-Butylsulfonyl-2-propenyl)-dimethylphenylsilane 4m

Method B : A solution of dimethylphenylsilyllithium in THF[24] (6 mmol) was added at -60° to a suspension of 532 mg (5.95 mmol) of copper cyanide in 25 ml of THF. The reaction mixture was then stirred at -40° for 0.5 hr after which time the copper cyanide was dissolved. This solution was cooled to -80° and cannulated to a cooled solution (-9°) of 1.5 g (5.98 mmol) of the sulfone **3** dissolved in 20 ml of THF. After 0.5 hr at -20° the reaction mixture was worked up to give a residue which, after flash chromatography (solvent : hexane : CH_2Cl_2 : ether/40:60:1) gives an oil (1.30 g ; 74% yield). This compound had only a purity of 85%. See table 3 for the spectroscopic data.

3-(2-t-Butylsuylfonyl-2-propenyl)-indole 4n

Method B : A solution of 3 ml of ethylmagnesium bromide (6.10 mmol) 2.05N in ether was added at -40° to a solution of 702 mg (6.0 mmol) of indole in 10 ml of toluene[37]. This solution was stirred 0.5 hr at 25° and then cooled to -30° and cannulated to a solution of 1.5 g (5.98 mmol) of the sulfone **3** in 30 ml of dry toluene at -90°. After 0.5 hr at -60°, the reaction mixture was stirred 1.5 hr at -50° and worked up. A flash chromatography of the residue (solvent : hexane : CH_2Cl_2 : ether/3:5:1) yields 0.99 g of an oil which crystallizes readily (m.p. 180° ; 60% yield). See table 3 for the spectroscopic data.
Found : C, 65.05 ; H, 6.85%. Calcd. for $C_{15}H_{19}NSO_2$: C, 64.95 ; H, 6.90%.

2-t-Butylsulfonyl-1,5-hexadiene 4o

Method B : A solution of allylzinc bromide[30] (7.2 mmol) prepared from 470 mg (7.2 mmol) of zinc and 880 mg (7.2 mmol) of allyl bromide in 4 ml of THF was added at -85° to a cooled solution of 1.5 g (5.98 mmol) of the sulfone **3** in 30 ml of THF. The reaction mixture was then stirred 24 hr at 25° and worked up. The residue was purified by flash chromatography (solvent : hexane : CH_2Cl_2 : ether/35:65:3) to furnish 1.0 g of a pure oil (85% yield). See table 3 for the spectroscopic data.

General procedure for the reaction of the sulfone 3 with an electrophile in the presence of zinc

In a three neck flask fitted with a pressure-equilibrating dropping funnel, a magnetic bar, a thermometer, are placed 1 g (15.4 mmol) of Zinc foil 99.995% cut in pieces and a small quantity (about 0.1 g) of crushed glass. The flask is flushed with argon. 1,2-dibromoethane (460 mg) in 2.5 ml THF are added. The flask is heated to start boiling and stirring is continued at 30-35° for 15-20 min. The flask is immersed in a laboratory ultra sound cleaner (48kHz, 30W) containing water at 55°C. The suspension in the flask being at a temperature of 45°, part of the electrophile (3 mmol) is added, the remaining part (3.3 mmol) is admixed with 1.5 g (6.2 mmol) of bromosulfone **3** in 4.5 ml of THF and sequencially added over a period of 15 min (the temperature may raise up to 52°C in some cases. Sonication is better than magnetic stirring. After 15-60 min (check by t.l.c. or g.c.) the reaction is over. The flask is cooled to 0°C and 20 ml of a sat. NH_4Cl solution and 50 ml CH_2Cl_2 are added under stirring. Zinc metal is filtrated, the two phases are separated and the aqueous one is extracted with CH_2Cl_2 (2 x 30 ml). The joined organic phases are washed with water (2 x 30 ml), HCl2N (30 ml) and brine (30 ml), dried over magnesium sulfate. The solvents are evaporated under a vacuum. The crude product is purified by flash chromatography[36]. In one case, (**7q**), the reaction was performed on a 25 mmol scale with analogous yields.
The spectroscopic data of the following compounds are collected in table 4.

1-Phenyl-3-tert butylsulfonyl-3-buten-1-ol 7a

(from benzaldehyde). See general procedure
Eluant for flash chromatography : CH_2Cl_2 : hexane : ether/70:30:10, obtained 1.1 g (85%) of **7a**.
m.p. : 97°C (CH_2Cl_2/Pentane).
Found : C, 62.56 ; H, 7.42%. Calcd. for $C_{14}H_{20}SO_3$: C, 62.66 ; H, 7.51%.

2-tert-Butylsulfonyl-1-nonen-4-ol 7b
(from Hexanal).See general procedure. Obtained 1.34 g (85%) of 7b. Same eluent as above for chromatography.
m.p. : 25°C (from : CH_2Cl_2/Pentane)

2,2-Dimethyl-5-tert butylsulfonyl-5-hexen-3-ol 7c
(from pivalaldehyde). See general procedure. Obtained 1.27 g (85%) of 7c. Same eluent for chromatography as above.
m.p. : 83°C (from : CH_2Cl_2/Pentane)
Found : C, 58.10 ; H, 9.64%. Calcd. for $C_{12}H_{24}SO_3$: C, 58.03 ; H, 9.73%.

2-tert-Butylsulfonyl-1,5-hexadien-4-ol 7d
(from crotonaldehyde). See general procedure. Obtained 1.21 g of 7d (88%). Eluent for chromatography : CH_2Cl_2:Hexane: ether/70:30:30. Oil.

1- Phenyl-1-methyl-3-tert butylsulfonyl-3-buten-1-ol 7e
(from acetophenone). See general procedure. Obtained 1.46 g of 7e (86%). Eluent for chromatography : CH_2Cl_2: hexane : ether/70:30:10. m.p. : 127°C (from : CH_2Cl_2/pentane).

2-tert-Butylsulfonyl-4-ethyl-1-hexen-4-ol 7f
(from 2-pentanone). See general procedure. Obtained 1.35 g of 7f (88%). Eluent for chromatography : same as preceding case. m.p. : 61°C (from : CH_2Cl_2/pentane).
Found : C, 57.88 ; H, 9.60%. Calcd. for $C_{12}H_{24}SO_3$: C, 58.03 ; H, 9.73%.

2-tert-Butylsulfonyl-4-pentyl-1 nonen-4-ol 7g
(from 6-undecanone, on 25 mmol). See general procedure. Obtained 6.8 g of 7g (82%). Eluent, same as the preceding case. m.p. : 51°C (from CH_2Cl_2/pentane).

1-(2-tert-Butylsulfonyl-1-propen-3-yl) cyclopentan-1-ol 7h
(from cyclopentanone). See general procedure. Obtained 1.28 g (84%). Eluent for chromatography : CH_2Cl_2:hexane:ether/ 70:30:15. m.p. : 87°C (from CH_2Cl_2/pentane).

5-tert-Butylsulfonyl-3-methyl-1-(2,6,6-trimethyl-1-cyclohexenyl)1,5 hexadien-3-ol 7i
(from -ionone). See general procedure. Obtained : 1.77 g of 7i (83%). Same eluent as in the case of 7e. m.p. : 87°C (from : pentane/CH_2Cl_2).

1-(2-ter-Butylsulfonyl-1-propen-3-yl)-2-cyclohexen-1-ol 7j
(from cyclohexenone). See general procedure. Obtained 1.24 g (80%). Same eluent as for 7e.
m.p. : 81°C (from CH_2Cl_2/pentane).
Found : C, 60.52 ; H, 8.38%. Calcd. for $C_{13}H_{22}SO_3$: C, 60.43 ; H, 8.58%.

2-tert-Butylsulfonyl-4-methyl-1-penten-4,5-diol 7k
(from -hydroxyacetone). See general procedure but on a 12.4 mmol scale. Zinc is activated as indicated, then the mixture is cooled at -35°C, and hydroxyacetone (0.92 g, 12.4 mmol) is added, then 8.03 ml of a 1.55 N solution of allyl zinc bromide (12.45 mmol) is added. The temperature is raised to 35°C, then the bromosulfone 3 is added and the general procedure is followed. Obtained : 0.59 g (40%). Eluent for chromatography : 1.5% MeOH in Et_2O. m.p. : 89°C.

2-tert-Butylsulfonyl-1-hepten-4-one 7l
(from butyronitrile). See the general procedure. The obtained imine is hydrolysed by stirring the crude product with a 1N HCl solution at 0°C for 15 min. Obtained : 0.9 g (64%) of 7l. Eluent for chromatography : CH_2Cl_2 : hexane : ether/70:30:5. m.p. : 51°C (from CH_2Cl_2/pentane).
Found : C, 56.96 ; H, 8.54%. Calcd. for $C_{11}H_{20}SO_3$: C, 56.86 ; H, 8.67%.

2-tert-Butylsulfonyl-4 cyclohexyl-1-buten-4-one 7m
(from cyclohexylcyanide). Same hydrolysis as for 7l. Obtained : 1.06 g of 7m (65%)
Eluent for chromatography : CH_2Cl_2:hexane:ether/70:30:5. m.p. : 23° (from CH_2Cl_2/pentane).

2-tert-Butylsulfonyl-1-nonen-4-one 7n
(from hexane nitrile). See the general procedure. Same hydrolysis as for 7l. Obtained : 1.1 g (70%) of 7m. Eluent : same mixture as for 7l. m.p. : 49°C (from CH_2Cl_2/hexane).

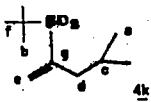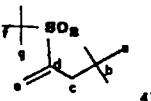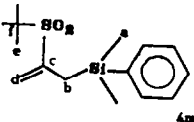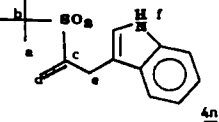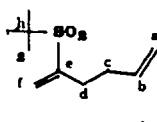**2-tert-Butylsulfonyl-4-phenyl-4(N-phenylamino)-1-butene 7o**
(from benzalanilin). See the general procedure. Obtained : 1.34 g of 7o (65%).
Eluent for chromatography : CH_2Cl_2:hexane:ether/70:30:10. m.p. : 143°C (from ether/pentane).
Found : C, 70.05 ; H, 7.20%. Calcd. for $C_{20}H_{25}NSO_2$: C, 69.94 ; H, 7.33%.
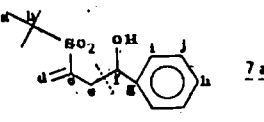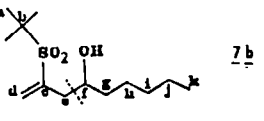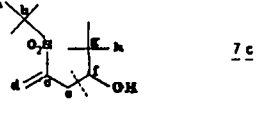
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Table 3. Spectroscopic data of compounds 4a–4o

Structure	¹H NMR spectra[a]	¹³C NMR spectra[a]	I.R.[b]
4a	1.42(s,9H,(a));4.08(s, 2H,(b));6.55(m,2H,(c)); 7.55(m,5H,arom.,H)	23.6(a); 34.7(b);60.5(d) 127.0;129.2;129.9;131.6 134.5;143.5	3095,3050,2960, 1475,1440,1400, 1282,1125,1110, 990,800,750,725, 695
4b	1.40(s,9H(a);4.20(m,3H, (e,NH);3.16(s,1H,(d) trans/SO₂;3.25(s,1H,(d), cis/SO₂;6.66 and 7.20 (m,5H,phenyl)	23.54(a);45.14(e);60.18 (b);118.11(i);112.9 and 129.31(g,h);129.76(d); 144.65(c);146.59(f)	3415,3370,3100, 3080,3050,3015, 2985,2965,2925, 2890,1920,1820, 1730,1605,1555, 1510,1475,1460, 1450,1435,1285, 1160,1120,1030, 1015,995,960,800, 755,710,695
4c	1.32(m,12H,(k,m);1.38(s, 9H,(a));3.24(s,2H,(e)); 4.26(m,8H,(j,l);6.36(s, 2H,(d))	13.70 and 13.91(k,m); 23.48(a);34.20(e);56,55 (f);58.90(g);60.35(b); 62.21 and 61.88((j,l); 142.84(c);131.93(d); 168.07 and 166.70(h,i)	2960,1735,1460, 1390,1295,1210, 1105,1030,860, 800,740,700
4d	1.45(s,9H,(a));2.96(t, J=7Hz,2H,(b));3.41(t, J=7Hz,2H,(c));6.10(s,1H, (d)cis-SO₂-t-Bu);6.31 (s,1H,(d)trans-SO₂-t-Bu) 7.64(m,3H,arom.H);8.09 (m,2H,arom.H)	23.7(a);27.1(c);37.9(b); 60.4(e);128.0;128.7; 129.4;133.3;136.5;146.7; 198.0(f)	3098,3060,2990, 1688,1600,1560, 1450,1430,1318, 1281,1218,1160, 1100,970,,926,815, 802,750,701,690
4e	1.42(s,9H),(a);2.57-1.51 (m,9H);2.93(m,2H);6.00 (s,1H,(b)cis SO₂-t-Bu); 6.28(s,1H,(b)trans SO₂-t-Bu)	23.7(a);25.2;28.1;32.6; 33.9;42.3;49.7;60.4; 130.3(b);145.4(c);211.4 (d)	2990,2940,1705, 1480,1462,1440, 1400,1280,1130, 1006,980,950,840, 800,750,698,625
4f	1.43(s,9H,(a));1.51(s, 9H,(b));2.70(m,4H,(c,d)) 6.13(s,1H,(e)cis SO₂- t-Bu);6.41(s,1H,trans SO₂-t-Bu)	23.6(a);27.5(d);30.0(b); 33.9(c);60.2(f);80.7(g); 128.6(e);146.5(h);171.0 (i)	2990,2940,1730, 1480,1393,1370, 1292,1160,1106,960 850,801,738
4g	0.97(t,J=6Hz,3H,(a)); 1.43(s,9H,(j);1.32-1.63 m,4H,(b,c);2.26(m,2H, (d));3.46(m,2H,(g)); 6.46(s,1H,(i)cis SO₂- t-Bu);6.60(s,1H,(i)trans SO₂-t-Bu)	13.6(a);18.4;21.9;23.0; 23.5(j);30.9;60.2(k); 74.0 and 85.4(e,f);130.2 (i);143.9(h)	2960,2938,2870, 1630,1480,1460, 1295,1160,1102, 955,801,749
4h	1.48(s,9H,(a));3.91(s, 2H,(b));5.77(s,1H,(c) cis SO₂-t-Bu);6.43(s,1H, (c)trans SO₂-t-Bu); 7.49(m,5H,arom.H)	23.8(a);38.2(b);60.4(d); 127.1;128.8;129.4;130.4 136.8;147.8	3060,2980,1620, 1600,1500,1472, 1450,1432,1390, 1360,1285,1192, 1150,1092,950,800, 765,735,710,700
4i	1.42(s,9H,(i);1.69(s, 3H,(b));1.84(s,3H,(a)); 3.23(d,J=7.5Hz,2H,(e)); 5.34(t,J=7.5Hz,1H,(d)); 6.10(s,1H,(g)cis SO₂- t-Bu);6.34(s,1H,(g)trans SO₂-t-Bu)	17.8 and 25.6(a,b);23.7 (i);30.6(e);60.0(h);118.9 (d);128.7(g);135.8(c); 146.9(f)	2980,2960,1480, 1450,1290,1100, 950,800,740
4j	0.93(t,J=6Hz,3H,(a)); 1.2-1.84(m,6H,(g,h,i); 1.42(s,9H,(b));2.52(t, J=7.8Hz,2H,(f));6.13(s, 1H,(d)cis SO₂-t-Bu;6.37 (s,1H,(d)trans SO₂-t-Bu)	13.9(a);22.4;23.7(b); 28.4;31.2;31.9;60.0(c); 128.0(d);147.9(e)	2970,2930,2860, 1460,1361,1290, 1110,950,801,740, 700

Structure	^{1}HNMR Spectra[a]	^{13}C NMR Spectra[a]	I.R.[b]
4k	1.02(d,J=6.9Hz,6H,(a)); 1.42(s,9H,(b));2.08(m, 1H,(c));2.42(d,J=6.3Hz, 2H,(d));6.13(s,1H,(c)cis SO$_2$-t-Bu;6.43(s,1H,(e) trans SO$_2$-t-Bu	22.1(a);23.7(b);27.8(c); 41.1(d);60.0(f);129.2 (e);146.4(g)	2980,1470,1390, 1370,1290,1110, 800,760,700
4l	1.02(s,9H,(a));1.39(s, 9H,(g));2.43(s,2H,(c)); 6.22(s,1H,(e)cis SO$_2$- t-Bu);6.42(s,1H,(e) trans SO$_2$-t-Bu)	23.5(g);29.4(a);32.3(c) 44.1(b);60.1(f);130.8(e) 145.0(d)	3100,2980,2961, 2950,2865,1480, 1392,1365,1295, 1282,1270,1140, 1108,979,803,750
4m	0.42(s,6H,(a));1.42(s, 9H,(f));2.20(s,2H,(b)); 5.64(s,1H,(d)cis SO$_2$- t-Bu);6.04(s,2H,(d) trans SO$_2$-t-Bu);7.42- 7.49(m,5H,arom.H)	3.2(a);21.7(b);23.6(f) 60.0(e);126.1;127.8; 129.3;133.6;137.4;144.4 (c)	3060,3040,2960, 1612,1480,1460, 1430,1395,1365, 1290,1250,1195, 1110,1090,940,930, 840,800,738,700
4n	1.51(s,9H,(a));4.47(s, 2H,(e));5.89(s,1H,(d) 6.34(s,1H,(d)trans SO$_2$- t-Bu);7.21-7.82(m,5H, arom.H);8.48(s,1H,(f)	23.9(a);28.4(e);60.3(b) 110.9;111.5;118.8;119.7 122.3;123.4;126.8;130.0 136.5;146.9(c)	3330,3100,3058, 2980,2910,1640, 1620,1572,1460, 1430,1340,1270, 1232,1200,1145, 1090,1070,1010, 975,970,910,828, 800,780,760,742, 703,660
4o	1.40(s,9H,(g));2.41- 2.72(m,4H,(c,d));5.04- 5.29(3s,2H,(a));5.85(m, 1H,(b));6.07(s,1H,(f) cis SO$_2$-t-Bu);6.28(s,1H, (f)trans SO$_2$-t-Bu)	23.6(g);31.2(c);32.5(d) 60.0(h);116.1(a); 128.7(f);136.4(b); 146.8(e)	2990,1640,1480, 1450,1390,1365, 1290,1101,1000, 915,800,740

(a) All spectra were obtained in CDCl$_3$ with tetramethyl silane as an internal standard
(b) Infrared spectra were recorded as film (liquids) or KBr plates (solids)

Table 4. Spectroscopic data of compounds 7a-7o

Structure	^{1}HNMR Spectra[a]	^{13}C NMR Spectra[a]	I.R.[b]
7a	1.36(s,9H,(a));2.84(d, 2H,J=6.5Hz,(e));3.44(d, 1H,J=4.5Hz,OH);5.08(m, 1H,(f));6.20(s,1H,Hd trans/SO$_2$);6.40(s,1H, Hd cis/SO$_2$);7.56(s,5H, (phenyl)	143.55(c);143.28(g); 131.99(d);128.35(i); 127.55(h);125.79(j); 72.76(f);60.30(b);42.10 (e);23.50(a)	3520,3030,2980, 2930,2890,1600, 1495,1455,1400, 1370,1280,1200, 1150,1100,1050, 965,940,915,880, 845,805,760,740, 700,630
7b	0.90(t,3H,J=6.5Hz,(k); 1.40(Ls,,9H,(a));2.60 (m,2H,(e));3.32(La,1H, OH);3.92(La,1H,(f)); 6.38(s,1H,(Hd trans/SO$_2$)) 6.44(s,1H,(Hd cis/SO$_2$)	144.21(c);131.19(d); 70.32(f);60.18(b);39.95 (e);37.39(g);31.79;25.29; 23.57(a);22.58;14.06(k)	3500,2930,2860, 1620,1480,1460, 1400,1290,1195, 1160,1100,1030, 950,865,800,740, 700
7c	0.92(s,9H,(h));1.40(s, 9H,(a));3.60(m,1H,(f)); 2.50(m,3H,(e,OH));6.32 (s,1H,(Hd trans/SO$_2$)); 6.44(s,1H,(Hd cis/SO$_2$))	145.25(c);131.01(d);78.60 (f);60.24(b);34.94(e); 29.88(g);25.59(h);23.63 (a)	3460,2950,2900, 2860,1625,1480, 1390,1365,1285, 1190,1155,1100, 1060,1040,1025, 1005,950,900,865, 805,780,740,690, 625

Structure	^1H NMR	^{13}C NMR	IR
7d	1.40(s,9H,(a));1.70(d, 3H,J=6.5Hz,(i));2.60(d, 2H,J=7.5Hz,(e));3.40(la, 1H,(OH));4.40(m,1H,(f)); 5.7(m,2H,(g,h));6.3(s, 1H,(Hd trans/SO$_2$));6.4 (s,1H,(Hd cis/SO$_2$))	140.81(c);130.35(d); 128.83(g);124.36(h);68.38 (f);57.59(b);37.07(e); 20.89(a);14.96(i)	3460,2980,2920, 1480,1450,1395, 1285,1195,1155, 1100,1030,965, 870,800,740
7e	1.36(s,9H,(a));1.62(s, 3H,(g));3.00(s,2H,(e)); 3.8(la,1H,OH);5.84(s,1H, (Hd trans/SO$_2$));6.26(s, 1H,(Hd cis/SO$_2$));7.5(m, 5H,(phenyl)	146.83(h),142.21(c); 133.15(d);128.09;126.75 (i);125.11;73.98(f);60.42 (b);45.97(e);30.12(g); 23.57(a)	3450,3080,3010, 2980,2930,1600, 1490,1475,1450, 1385,1360,1340, 1270,1225,1180, 1000,1060,1030, 975,950,920,900, 850,805,775,745, 700
7f	0.90(t,6H,J=6.5Hz,(h)); 1.40(s,9H,(a));1.56(q, 4H,J=6.5Hz,(g));2.64(s, 2H,(e));3.00(s,1H,OH); 6.37(s,1H,(Hd trans/SO$_2$)) 6.43(s,1H,(Hd cis/SO$_2$))	143.31(c);132.74(d); 74.10(f);60.39(b); 40.73(e);30.66(g);23.59 (a);7.89(h)	3430,3100,2960, 2940,2880,1620, 1455,1400,1375, 1350,1330,1280, 1270,1190,1125, 1095,1035,980,970, 900,875,800,745,
7g	0.90(t,6H,J=6.5Hz,(k)); 1.40(ls,9H,(a));2.62(s, 2H,(e));3.00(s,1H,OH); 6.32(s,1H,(Hd trans/SO$_2$)) 6.40(s,1H,(Hd cis/SO$_2$))	143.34(c);132.65(d); 73.77(f);60.36(b); 41.62(e);38.85(g); 32.36;23.59(a);23.24; 22.61;14.06(k)	3500,3100,2950, 2860,1620,1480, 1460,1400,1370, 1362,1335,1270, 1200,1130,1095, 1020,1000,970,940 915,880,800,745, 710,690,630
7h	1.41(s,9H,(a));1.74(la, 9H,(g,h));2.91(m,3H,(e, OH));6.42(m,2H,(d))	144.09(c);132.11(d); 81.46(f);60.33(b);42.73 (e);39.84(g);23.66 and 23.48(h and a)	3420,2950,2860, 1480,1430,1400, 1365,1275,1190, 1150,1090,1005, 970,955,920,880, 800,740,645
7i	1.00(s,6H,(p,q));1.40 (s,9H,(a));1.68(s,3H, (g));2.84(s,3H,(r);3.40 (s,1H,OH);5.64(d,2H, J=15Hz,(h,i));6.50(s, 2H,(d))	142.81(c);139.26;136.85 (j);133.01(d);127.91; 125.76;72.88(f);60.27(b); 44.04(e);39.39(n);33.91 (o);32.62(l);29.17;28.81; 23.54(a);21.45(r);19.25(m)	3500,2980,2940, 2880,1620,1445, 1390,1360,1330, 1280,1200,1095, 1030,970,960,910, 800,750,740,685
7j	1.40(s,9H,(a));1.76(la, 4H,(i,j));2.00(la,2H, (k));2.74(s,2H,(e)); 2.86(s,1H,OH);5.84(m,2H, (h,g));6.45(s,1H,(Hd trans/SO$_2$));6.47(s,1H, (Hd cis/SO$_2$))	c	3530,3100,2900, 2830,1640,1620, 1470,1430,1380, 1365,1340,1280, 1170,1150,1100, 1020,995,965,945, 920,885,865,850, 800,735,680
7k	1.2(s,3H,(g));1.4(s,9H, (a));2.7(m,2H,(e));3.4 (la,4H,(h,2OH));6.36(s, 1H,(Hd trans/SO$_2$);6.41 (s,1H,(Hd cis/SO$_2$)	142.6(c);133.67(d);7.82 (f);68.74(h);60.61(b); 40.01(e);23.84(g);23.54 (a)	c
7l	0.94(t,3H,J=6.5Hz,(i)); 1.38(s,9H,(a));1.66(hex, 2H,J=6.5Hz)(h);2.58(t, 2H,J=6.5Hz,(g));3.66(s, 2H,(e));6.30(s,1H,Hd trans/SO$_2$));6.52(s,1H, Hd trans/SO$_2$))	204.30(f);140.07(c); 133.51(d);60.31(b);44.81 (e);44.45(g);23.33(a); 16.98(h);13.58(i)	3090,2960,2880, 1715,1625,1480, 1415,1395,1365, 1290,1195,1160, 1100,1050,1015, 980,950,890,800, 740,660

1.36(1s,9H,(a));1.80(1a, 6H);2.50(1a,1H,(g)); 3.68(s,2H,(e));6.18(s, 1H,(Hd trans/SO₂);6.42 (s,1H,(Hd cis/SO₂)
7 m

206.77(f);140.04(c); 133.45(d);59.92(b);50.29 (e);42.73(g);28.33;25.80; 25.44;23.24(a)

2970,2925,2850, 1715,1625,1480, 1450,1395,1365, 1320,1290,1195, 1140,1100,1065, 1000,950,875,800, 735,690

0.90(t,3H,J=6.5Hz)(k)); 1.40(1s,9H,(a));2.56(t, 2H,J=6.5Hz,(g));3.62 (s,2H,(e));6.26(s,1H, Hd trans/SO₂));6.54(s,1H, Hd cis/SO₂))
7 n

204.69(f);139.79(c); 133.51(d);60.33(b);44.57 (e);42.75(g);31.22;23.45 (a);23.29;22.40;13.88(k)

c

1.32(s,9H,(a));2.90(d, 2H,J=6.5Hz,(e));4.70(,m, 1H,NH);6.14(s,1H,(Hd trans/SO₂);6.22(s,1H, Hd trans/SO₂));6.6- 7.5(m,10H,(phenyls))
7 o

160.00;147.34;143.55; 143.05;128.98(d);128.77; 128.59;128.36;127.02; 126.48;125.79;120.73; 116.38;112.83;59.86(b); 57.45(f);40.36(e);20.27 (a)

3380,3060,3020, 2980,2960,2930, 2860,1620,1600, 1510,1450,1400, 1390,1360,1350, 1315,1280,1240, 1190,1180,1150, 1090,1020,985,945, 910,870,800,760, 750,720,700,690,

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a/ All spectra were obtained in CDCl₃ with tetramethylsilane as an internal standard ;
b/ Infrared spectra were recorded as film (liquids) or KBr plates (solids) ;
c/ Not recorded

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