A New and Facile Synthesis of Sulfonyl Chlorides

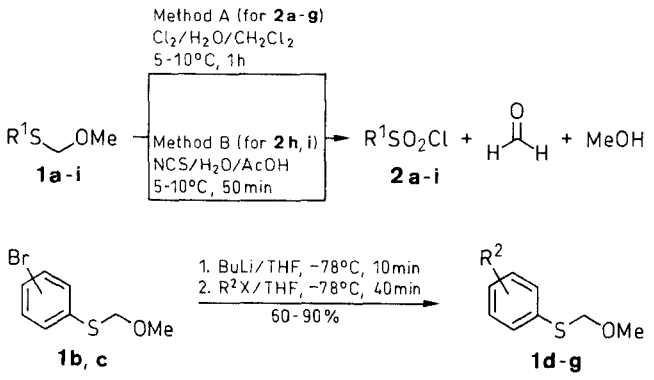
Dae-Whang Kim,* Young Kwan Ko, Sung Hoon Kim
Korea Research Institute of Chemical Technology, P.O. Box 9 Daedeog-Danji, Daejeon, South Korea
Received 28 January 1992

Several benzenesulfonyl and arylmethanesulfonyl chlorides **2** are synthesized in excellent yields by the aqueous chlorination of aryl (or benzyl) methoxymethyl sulfides **1**. Functionalized sulfides **1d–g** can be prepared easily from bromophenyl methoxymethyl sulfides **1b,c**.

Sulfonyl chlorides find extensive uses in organic synthesis, industrial and agricultural chemistry.[1,2] Especially, substituted arenesulfonyl chlorides have been utilized as key intermediates in the synthesis of many biologically active herbicides.[2] The synthesis of sulfonyl chlorides from thiols or thiol derivatives such as sulfides, disulfides, thiocyanates, thioacetates, Bunte salts, isothiouronium salts and *S,S*-dialkyl dithiocarbonates has been known and widely utilized.[1–3] For sulfonyl chlorides containing various functional groups, most of the above methods have some disadvantages such as relatively low yields, restrictions in starting materials and difficulties in introducing functional groups.

We now report a new and facile procedure for the synthesis of sulfonyl chlorides **2**, which has potential for the preparation of a broad range of substituted aryl derivatives, from the corresponding sulfides **1**. *O,S*-Hemithioacetals have been developed to protect thiols from various reagents (acids, bases and organometallic reagents).[4] Thus, various functional groups such as alkyl, ester and haloketone could be easily introduced into the aromatic ring of methoxymethyl sulfides **1b,c** by metal–halogen exchange reaction followed by treatment with various electrophiles (Table 1). Finally, methoxymethyl sulfides **1a–g** were converted to the corresponding sulfonyl chlorides **2a–g** in excellent yield by reaction with chlorine gas in water/dichloromethane at 5–10 °C (Method A). With benzyl methoxymethyl sulfides **1h,i**, the use of aqueous acetic acid as solvent and *N*-chlorosuccinimide (NCS) as chlorinating agent gives high yield of the corresponding arylmethanesulfonyl chlorides (Method B) (Table 2). In these procedures the resulting formaldehyde was identified as its dimedone adduct.[5]

In conclusion, the present method is simple and especially suitable for substituted arylsulfonyl chlorides.



1,2	R^1	1,2	R^1	1,2	R^1
a	Ph	**d**	2-MeC_6H_4	**g**	4-$(FCH_2CO)C_6H_4$
b	2-BrC_6H_4	**e**	2-$(FCH_2CO)C_6H_4$	**h**	$PhCH_2$
c	4-BrC_6H_4	**f**	2-$(MeO_2C)C_6H_4$	**i**	4-$BrC_6H_4CH_2$

R^2X = MeI, FCH_2CO_2Et, $ClCO_2Me$

NMR spectra were recorded on a Varian Gemini 200 spectrometer. IR spectra were recorded on a Shimadzu IR-435 spectrophotometer. High resolution mass spectra (HRMS) were obtained using a Jeol JMS-DX 303 spectrometer. Microanalyses were obtained using a Perkin-Elmer 240C elemental analyzer.

2-(Fluoroacetyl)phenyl Methoxymethyl Sulfide (1e); Typical Procedure:

In a dried, N_2-filled round-bottomed flask fitted with a stirrer, a rubber septum and N_2 ballon was placed a solution of 1-bromo-2-[(methoxymethyl)thio]benzene (**1b**; 1.17 g, 5 mmol) in THF

Table 1. Methoxymethyl Sulfides **1d–g** Prepared from **1b**[a],**c**

Starting Material	R^2X	Product	Yield (%)	mp or bp (°C)/Torr	Molecular Formula[b] or Lit. bp (°C)/Torr	IR (KBr) (C=O) ν (cm^{-1})	^1H NMR ($CDCl_3$/TMS) δ, J (Hz)
1b	MeI	**1d**	83	87–88/3.2	113/12[7]		2.40 (s, 3H), 3.44 (s, 3H), 4.94 (s, 2H), 7.07–7.59 (m, 4H)
1b	FCH_2CO_2Et	**1e**	85	64–65	$C_{10}H_{11}FO_2S$ (214.3)	1680	3.44 (s, 3H), 4.98 (s, 2H), 5.42 (d, 2H, J = 47), 7.29–7.35 (m, 1H), 7.47–7.60 (m, 2H), 7.75–7.81 (m, 1H)
1b	$ClCO_2Me$	**1f**	70	47–48	$C_{10}H_{12}O_3S$ (212.3)	1695	3.44 (s, 3H), 3.94 (s, 3H), 5.02 (s, 2H), 7.18–7.28 (m, 1H), 7.43–7.53 (m, 1H), 7.75–7.81 (m, 1H), 7.93–7.99 (m, 1H)
1c	FCH_2CO_2Et	**1g**	60	44–45	$C_{10}H_{11}FO_2S$ (214.3)	1685	3.44 (s, 2H), 5.05 (s, 2H), 5.49 (d, 2H, J = 47)

[a] New compound prepared by known method[6] in 90% yield. bp 121–123 (°C)/Torr; HRMS: m/z, C_8H_9BrOS calc.: 231.9557; found: 231.9567; ^1H NMR ($CDCl_3$/TMS): δ = 3.44 (s, 3H), 5.01 (s, 2H), 6.98–7.08 (m, 1H), 7.21–7.31 (m, 1H), 7.49–7.62 (m, 2H).
[b] Satisfactory HRMS obtained: $m/z \pm 0.001$.

Table 2. Sulfonyl Chlorides **2a–i** Prepared

Product	Method	Yield (%)	mp (°C) or bp (°C)/Torr	Molecular Formula or Lit. Data	IR (KBr) ν (cm^{-1})	^1H NMR ($CDCl_3$/TMS) δ, J (Hz)
2a	A	94	251–252/760	251–252/760[8]	1370, 1185	7.58–7.82 (m, 3H), 8.01–8.11 (m, 2H)
2b	A	95	127–128/3.6	113–117/2.5[9]	1370, 1180	7.52–7.61 (m, 2H), 7.82–7.91 (m, 1H), 8.16–8.25 (m, 1H)
2c	A	95	75–76	75–76[8]	1370, 1185	7.73–7.97 (m, 4H)
2d	A	90	100–102/2.3	116–117/4[9]	1365, 1175	2.79 (s, 3H), 7.37–8.11 (m, 4H)
2e	A	90	83–84	$C_8H_6FClO_3S$[a] (236.7)	1720, 1370, 1180	5.26 (d, 2H, J = 47), 7.45–7.51 (m, 1H), 7.73–7.90 (m, 2H), 8.14–8.20 (m, 1H)
2f	A	96	64–65	64–65[10]	1735, 1370, 1180	4.01 (s, 3H), 7.68–7.87 (m, 3H), 8.15–8.22 (m, 1H)
2g	A	90	94–95	$C_8H_6FClO_3S$[a] (236.7)	1705, 1365, 1165	5.54 (d, 2H, J = 47), 7.13–8.15 (m, 4H)
2h	A; B	29; 89	90–92	92–93[3]	1365, 1160	4.82 (s, 2H), 7.45 (s, 5H)
2i	B	84	116–118	$C_7H_6BrClO_2S$[a] (269.5)	1480, 1350, 1151	4.82 (s, 2H), 7.36 (d, 2H, J = 9), 7.62 (d, 2H, J = 9)

[a] Satisfactory microanalyses obtained: C ± 0.06, H ± 0.04.

(50 mL). The solution was cooled to − 78 °C and a solution of BuLi in hexane (2.3 M; 2.2 mL, 5 mmol) was added dropwise by syringe over 10 min. A solution of ethyl fluoroacetate (0.53 mL, 5.5 mmol) in THF (5 mL) was added dropwise over 10 min. The mixture was stirred at − 78 °C for 30 min, warmed to − 30 °C, quenched with sat. NH_4Cl solution (15 mL), diluted with H_2O (20 mL) and extracted with EtOAc (60 mL). The extract was washed with H_2O (20 mL) and brine (20 mL), dried ($MgSO_4$), and concentrated at reduced pressure. The crude product was purified by column chromatography over 70–230 mesh silica gel (hexane/EtOAc, 4:1) to afford the pure product **1e** (Table 1).

2-(Fluoroacetyl)benzenesulfonyl Chloride (2e); Typical Procedure for Method A:

In a round-bottomed flask fitted with a stirrer was placed a solution of 2-(fluoroacetyl)phenyl methoxymethyl sulfide (**1e**; 1.07 g, 5 mmol) in H_2O (5 mL) + CH_2Cl_2 (5 mL). Cl_2 gas was bubbled through the solution at 5–10 °C for 1 h. Excess Cl_2 was removed by air bubbling. The mixture was diluted with CH_2Cl_2 (50 mL), washed with cold 5% aq $NaHCO_3$ (10 mL), H_2O (3 × 10 mL) and dried ($MgSO_4$). After evaporation of the solvent, the residue was purified by short silica gel column (10 × 2 cm, 70 × 230 mesh) using EtOAc as eluant to afford the pure product **2e** (Table 2).

Phenylmethanesulfonyl Chloride (2h); Typical Procedure for Method B:

To a solution of benzyl methoxymethyl sulfide (**1h**: 1.01 g, 6 mmol) in AcOH (15 mL) + H_2O (5 mL) on an ice bath was added NCS (2.64 g, 19.8 mmol) at once. The mixture was stirred at 5–10 °C for 50 min, diluted with CCl_4 (60 mL), washed with cold H_2O (3 × 30 mL), dried ($MgSO_4$) and concentrated at reduced pressure. The crude product was recrystallized from hexane to afford the pure product **2h** (Table 2).

This work was supported by the Ministry of Science and Technology of the Republic of Korea.

(1) March, J. *Advanced Organic Chemistry*, John Wiley & Sons: New York, 1985; p 1340, and references therein.
Langler, R.F.; Marini, Z.A.; Spalding, E.S. *Can. J. Chem.* **1979**, *57*, 3193, and references therein.
Olivannan, M.S.; Nayudamma, Y. *J. Sci. Ind. Res.* **1969**, *28*, 293; *Chem. Abstr.* **1969**, *71*, 114168.
(2) Levitt, G. In *Synthesis and Chemistry of Agrochemicals II*; Baker, D.R.; Fenyes, J.G.; Moberg, W.K., Eds.; American Chemical Society: Washington, D.C., 1991; pp 16–31, and references therein.
Hay, J.V. *Pestic. Sci.* **1990**, *29*, 247.
(3) Barbero, M.; Cadamuro, S.; Degani, I.; Fochi, R.; Regondi, V. *Synthesis* **1989**, 957.
(4) Green, T.W. *Protective Groups in Organic Synthesis*; John Wiley & Sons: New York, 1981; p 204, and references therein.
(5) Horning, E.C.; Horning, M.G. *J. Org. Chem.* **1946**, *11*, 95.
(6) Fukuyama, T.; Nakatsuka, S.; Kish, Y. *Tetrahedron Lett.* **1976**, 3393.
(7) Dardoize, F.; Gaudemar, M.; Goasdoue, N. *Synthesis* **1977**, 567.
(8) *Handbook of Chemistry and Physics*; 59th ed., CRC Press: 1979.
(9) Prinsen, A.J.; Cerfontain, H. *Rec. Trav. Chim. Pays-Bas* **1965**, *84*, 24.
(10) Meerwein, H.; Dittmar, G.; Gollner, R.; Hafner, K.; Mensch, F.; Steinfort, O. *Chem. Ber.* **1957**, *90*, 841.