Organic
Syntheses

A Publication
of Reliable Methods
for the Preparation
of Organic Compounds

Working with Hazardous Chemicals

The procedures in *Organic Syntheses* are intended for use only by persons with proper training in experimental organic chemistry. All hazardous materials should be handled using the standard procedures for work with chemicals described in references such as "Prudent Practices in the Laboratory" (The National Academies Press, Washington, D.C., 2011; the full text can be accessed free of charge at http://www.nap.edu/catalog.php?record_id=12654). All chemical waste should be disposed of in accordance with local regulations. For general guidelines for the management of chemical waste, see Chapter 8 of Prudent Practices.

In some articles in *Organic Syntheses*, chemical-specific hazards are highlighted in red “Caution Notes” within a procedure. It is important to recognize that the absence of a caution note does not imply that no significant hazards are associated with the chemicals involved in that procedure. Prior to performing a reaction, a thorough risk assessment should be carried out that includes a review of the potential hazards associated with each chemical and experimental operation on the scale that is planned for the procedure. Guidelines for carrying out a risk assessment and for analyzing the hazards associated with chemicals can be found in Chapter 4 of Prudent Practices.

The procedures described in *Organic Syntheses* are provided as published and are conducted at one's own risk. *Organic Syntheses, Inc.*, its Editors, and its Board of Directors do not warrant or guarantee the safety of individuals using these procedures and hereby disclaim any liability for any injuries or damages claimed to have resulted from or related in any way to the procedures herein.

These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.

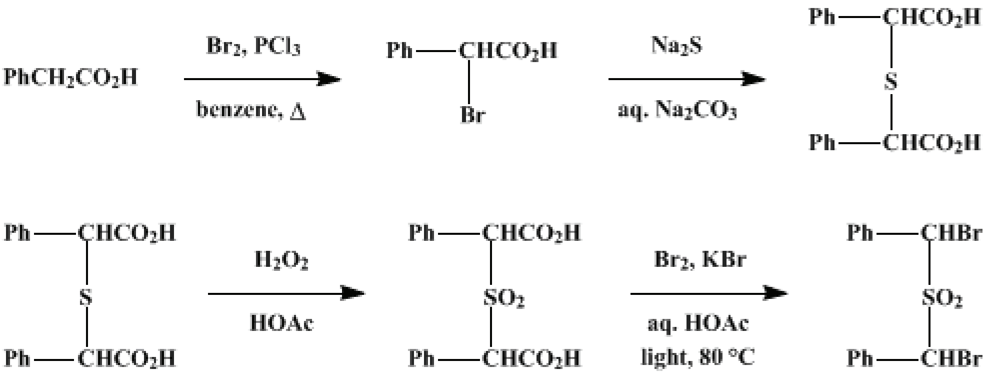
DOI:10.15227/orgsyn.050.0031

Organic Syntheses, Coll. Vol. 6, p.403 (1988); Vol. 50, p.31 (1970).

α,α'-DIBROMODIBENZYL SULFONE

[Benzene, 1,1-[sulfonylbis(bromomethylene)]bis-]

[METHOD 1]



Submitted by Louis A. Carpino[1] and Louis V. McAdams III.
Checked by Timothy P. Higgs and Ronald Breslow.

1. Procedure

Caution! Benzene has been identified as a carcinogen; OSHA has issued emergency standards on its use. All procedures involving benzene should be carried out in a well-ventilated hood, and glove protection is required.

A. *α-Bromophenylacetic acid.* A 3-l., round-bottomed flask fitted with a mechanical stirrer and an efficient reflux condenser (Note 1) is charged with 750 ml. of benzene, 230 g. (1.69 moles) of phenylacetic acid (Note 2), 15 g. (0.12 mole) of phosphorus trichloride and 288 g. (1.80 moles) of bromine (Note 3). The resulting solution is heated at gentle reflux for 2–3 days until the initial bromine color is discharged. The solution is allowed to cool to room temperature and after 1 hour is decanted from some polymeric material into a 2-l. distilling flask. Removal of the solvent by distillation at water bath temperatures with the aid of a water aspirator gives a black oil which is poured into 250–300 ml. of ligroin (b.p. 90–120°). The mixture is heated, dissolving the oil, and the solution is stored at −25° in a freezer for 12 hours. Filtration on a sintered-glass funnel followed by washing with 200 ml. of cold (10°) ligroin (b.p. 90–120°) gives 243 g. (67%) of α-bromophenylacetic acid as a white solid, m.p. 73–83°. Recrystallization from about 400 ml. of ligroin (b.p. 90–120°) with 15 g. of decolorizing carbon affords 217–233 g. (60–62%) of the purified acid, m.p. 80.5–84°.

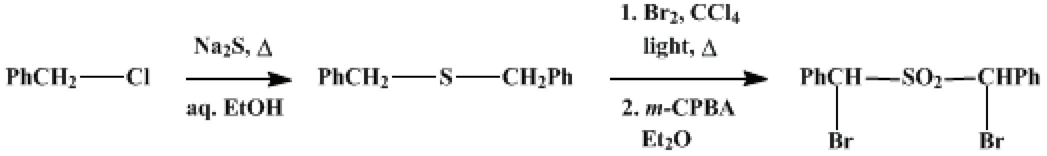
B. *α,α'-Diphenylthiodiglycolic acid.* In a 4-l. Erlenmeyer flask a suspension of 223 g. (1.04 moles) of α-bromophenylacetic acid in 1.25 l. of water is brought into solution by addition of a solution of 157 g. (1.48 moles) of sodium carbonate in 700 ml. of water. A solution of 104 g. (0.8 mole) of sodium sulfide (60–62% pure fused flakes) (Note 4) in 700 ml. of water is added, and the resulting mixture is stirred mechanically at room temperature for 3 hours, heated to the boiling point, filtered while hot, cooled, and cautiously acidified (in a hood) with 3 *N* hydrochloric acid. Filtration followed by washing with 200 ml. of water yields 135–140 g. (86–89%) of crude acid, m.p. 130–140°, which is sufficiently pure for use in the next step (Note 5).

C. *α,α'-Dibromodibenzyl sulfone*. To a solution of 24.9 g. (0.0824 mole) of crude α,α'-diphenylthiodiglycolic acid in 250 ml. of glacial acetic acid contained in a 500-ml., three-necked, round-bottomed flask fitted with a bulb condenser is added 37.4 g. (0.33 mole) of 30% hydrogen peroxide over a 30-minute period, with ice bath cooling and magnetic stirring. The mixture is allowed to come to room temperature (Note 6), and after 3 days 30 g. (0.19 mole) of bromine is added in one portion, followed by 30 g. of potassium bromide in 150 ml. of water. A sunlamp (Note 7), focused on the reaction mixture from a distance of 1 in., causes the solution to warm to 80° (Note 8). After heating at 80° for 30 minutes the mixture is cooled, and the solid is filtered and washed with water and ethanol, yielding 9–10 g. (27–30%) of crude α,α'-dibromodibenzyl sulfone, m.p. 135–150°. The mixture of diastereomers is pure enough to be used directly in the synthesis of 2,3-diphenylvinylene sulfone (Note 9).

2. Notes

1. An efficient bulb condenser (Allihn) was used to prevent loss of bromine.
2. The phenylacetic acid was used as supplied by the Eastman Kodak Co.
3. The bromine was washed just before use in a separatory funnel with 200 ml. of concentrated sulfuric acid.
4. The sodium sulfide was dissolved in the aqueous solution by warming, but the solution was cooled to room temperature before addition. The checkers used 192 g. (0.800 mole) of sodium sulfide nonahydrate.
5. After repeated crystallization from nitromethane the *meso* isomer, m.p. 177–180°, was obtained in a pure state in low yield.
6. After a few hours a precipitate appeared but it usually redissolved after 1.5 days. If the precipitate had not dissolved, it could be brought into solution by heating. The solution was then cooled before addition of bromine.
7. A General Electric 275-watt sunlamp was used.
8. The heat of the sunlamp maintained the temperature near 80°. For larger runs a heating mantle must be used to keep the temperature near 80°.
9. By recrystallization from ethanol it was possible to separate two isomeric dibromides, m.p. 155–157.5°, and 162–164°, in low yield.

[METHOD II]



1. Procedure

A. *Dibenzyl sulfide.* A solution of 25.8 g. (0.212 mole) of benzyl chloride in 75 ml. of 95% ethanol contained in a 250-ml., round-bottomed flask equipped with an efficient bulb condenser (Allihn) and a magnetic stirrer is brought to gentle reflux with a heating mantle. With stirring and heating, a solution of 36 g. (0.15 mole) of sodium sulfide nonahydrate in 50 ml. of water is added with a dropping funnel over a 4-hour period. The solution is heated at reflux for 3 days, after which the ethanol is removed by distillation at atmospheric pressure. The hot aqueous solution is poured with stirring into a 250-ml. beaker half-filled with chipped ice. After the ice has melted, the resulting yellow solid is filtered on a Büchner funnel and washed with 50 ml. of water. After air-drying, the solid is distilled from an ordinary 50-ml. Claisen flask, yielding 17.6 g. (80%) of dibenzyl sulfide, b.p. 120° (0.15 mm.) (Note 1), which is pure enough to use directly in the next step. Recrystallization from 70% ethanol gives a pure sample, m.p. 46–48°.

B. *α,α'-Dibromodibenzyl sulfone*. To a gently refluxing solution of 11.35 g. (0.05304 mole) of dibenzyl sulfide in 150 ml. of carbon tetrachloride (Note 2) contained in a three-necked, round-bottomed flask is added, dropwise over a period of 1.5 hours, a solution of 17.6 g. (0.0978 mole) of bromine in 50 ml. of carbon tetrachloride, while a sunlamp (Note 3) is focused on the reaction mixture from a distance of 1 in. The solution is refluxed with a heating mantle for 3 hours, and the carbon tetrachloride removed at a water bath temperature of 50° with the aid of a water aspirator. To the residual dark oil is added 25 ml. of anhydrous diethyl ether (Note 4), and after cooling in an ice bath a solution of 32.5 (0.189 mole) of *m*-chloroperbenzoic acid (Note 5) in 150 ml. of anhydrous ether is added dropwise over a 30-minute period. The mixture is allowed to warm to room temperature and stirred for 2 days.

The solvent is evaporated with an air jet at room temperature, and to the residual solid is added saturated sodium hydrogen carbonate solution until effervescence ceases. Filtration of the remaining solid followed by washing with water and cold ethanol gives 6.5 g. (30%) of crude α,α'-dibromodibenzyl sulfone, m.p. 142–158°. This mixture of diastereomers is pure enough for use in conversion to 2,3-diphenylvinylene sulfone (Note 6).

2. Notes

1. The submitters report a similar percent yield on twenty times the scale.
2. Carbon tetrachloride was freshly distilled over phosphorus pentoxide.
3. A General Electric 275-watt sunlamp was used.
4. The ether was dried over sodium metal.
5. *m*-Chloroperbenzoic acid (assay: 85%) was used either as supplied by FMC Corporation or prepared as described in *Org. Synth.*, **Coll. Vol. 6**, 276 (1988).
6. Repeated fractional crystallization from ethanol gave, in low yield, pure samples of the same two diastereomeric dibromides, m.p. 155–157.5° and 162–164°, obtained previously through application of Method I.

3. Discussion

α-Bromophenylacetic acid has been prepared by the bromination of phenylacetic acid with elemental bromine at high temperature[2] or under UV irradiation,[3] or with *N*-bromosuccinimide,[4] and by treatment of mandelic acid with phosphorus and bromine[5] or fuming hydrobromic acid.[6] α,α'-Diphenylthiodiglycolic acid has been prepared by reaction of α-bromophenylacetic acid with sodium sulfide.[7] Dibenzyl sulfide has been obtained from the reaction of benzyl chloride with potassium sulfide[8] or benzylmercaptide.[9] α,α'-Dibromodibenzyl sulfone has been obtained by oxidation and subsequent brominative decarboxylation of α,α'-diphenylthiodiglycolic acid[10] or by bromination and subsequent oxidation of dibenzylsulfide.[10]

Both methods of preparation represent general techniques for the synthesis of α,α'-dibromodibenzyl sulfones which are key intermediates in the synthesis of the vinylene sulfones.

This preparation is referenced from:

- Org. Syn. Coll. Vol. 6, 190
- Org. Syn. Coll. Vol. 6, 555

References and Notes

1. Department of Chemistry, University of Massachusetts, Amherst, Massachusetts 01003.
2. B. Radziszewski, *Ber. Dtsch. Chem. Ges.*, **2**, 207 (1869).
3. Distillers Co., Ltd., Belg. Pat. 622,439 (March 13, 1963) [*Chem. Abstr.*, **59**, 11352 (1963)].
4. I. M. Panaiotov, *Izv. Khim. Inst. Bulg. Akad. Nauk.* **5**, 183 (1957) [*Chem. Abstr.*, **55**, 16500 (1961)].
5. C. Hell and S. Weinzweig, *Ber. Dtsch. Chem. Ges.*, **28**, 2445 (1895).
6. A. Darapsky and M. Prabhakar, *J. Prakt. Chem.*, **96**, 280 (1917).
7. T. Mazonski and B. Prajsnar, *Zesz. Nauk. Politech. Slask. Chem.*, No. 7, 17 (1961) [*Chem. Abstr.*, **62**, 13079d (1965)].
8. R. L. Shriner, H. C. Struck, and W. J. Jorison, *J. Am. Chem. Soc.*, **52**, 2060 (1930).
9. T. S. Price and D. F. Twiss, *J. Chem. Soc.*, **97**, 1179 (1910).
10. L. A. Carpino and L. V. McAdams III, *J. Am. Chem. Soc.*, **87**, 5804 (1965); L. V. McAdams III,

Ph.D. Thesis, University of Massachusetts, 1966.

Appendix
Chemical Abstracts Nomenclature (Collective Index Number); (Registry Number)

ligroin

2,3-Diphenylvinylene sulfone

α,α'-Diphenylthiodiglycolic acid

ethanol (64-17-5)

sulfuric acid (7664-93-9)

hydrochloric acid (7647-01-0)

acetic acid (64-19-7)

Benzene (71-43-2)

ether,
diethyl ether (60-29-7)

Mandelic acid (90-64-2)

sodium hydrogen carbonate (144-55-8)

HYDROBROMIC ACID (10035-10-6)

sodium carbonate (497-19-8)

bromine (7726-95-6)

PHOSPHORUS (7723-14-0)

carbon tetrachloride (56-23-5)

decolorizing carbon (7782-42-5)

sodium (13966-32-0)

benzyl chloride (100-44-7)

Phenylacetic acid (103-82-2)

phosphorus trichloride (7719-12-2)

potassium bromide (7758-02-3)

hydrogen peroxide (7722-84-1)

sodium sulfide (1313-82-2)

potassium sulfide (1312-73-8)

Nitromethane (75-52-5)

α-Bromophenylacetic acid (4870-65-9)

sodium sulfide nonahydrate (1313-84-4)

N-bromosuccinimide (128-08-5)

Dibenzyl sulfide,
dibenzylsulfide (538-74-9)

Benzene, 1,1-[sulfonylbis(bromomethylene)]bis-,
α,α'-Dibromodibenzyl sulfone (21966-50-7)

benzylmercaptide (538-74-9)

phosphorus pentoxide (1314-56-3)

m-Chloroperbenzoic acid (937-14-4)