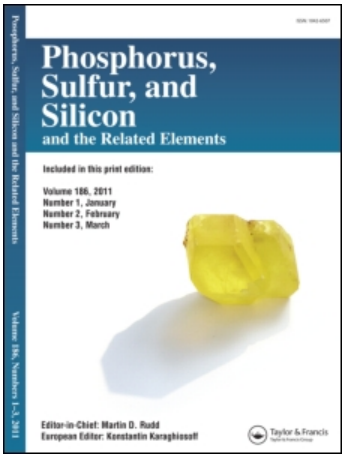

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KETOKETEN gem-DITHIOLS: SYNTHESIS OF SEVERAL SULFUR HETEROCYCLES

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KETOKETEN gem-DITHIOLS: SYNTHESIS OF SEVERAL SULFUR HETEROCYCLES

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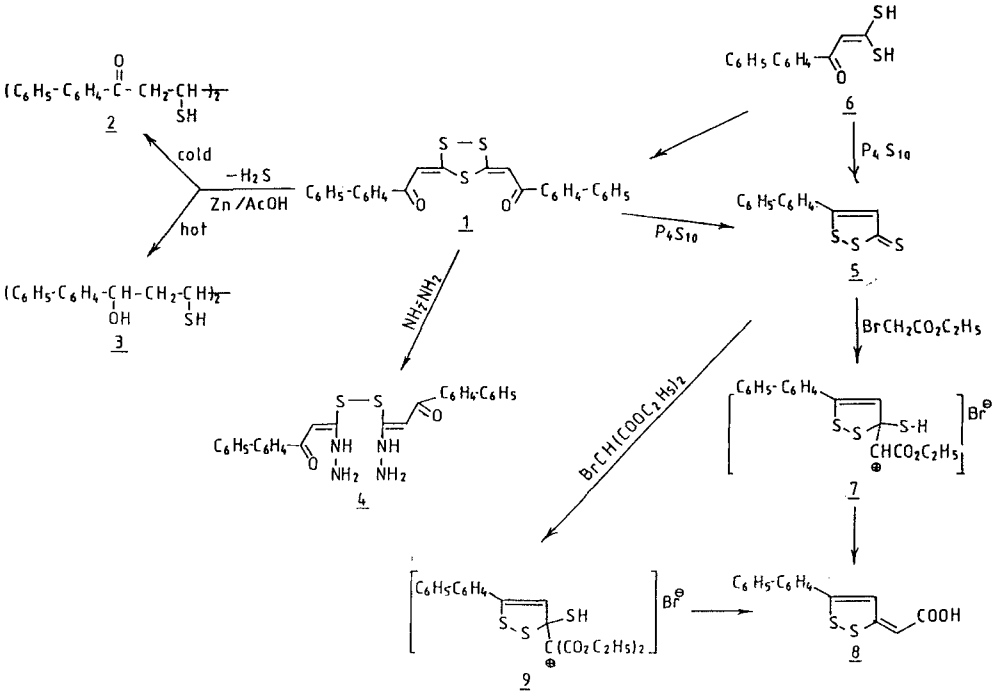
Reduction of the disaurine 1 in two different reaction conditions gave products **2** and **3**. Hydrazine hydrate reacted with **1** to give the adduct **4**. Sulfurization of **1** or **6** with P_4S_{10} yielded the trithione **5**. Reaction of **5** and **6** with several reagents yielded the products **7–17**.

Key words: Ketoketen gem-dithiols; disaurines; gem-dithiols; haloquinones.

Formation of compounds containing two and three sulfur atoms has been previously reported.[1–7] The chemical behavior of these compounds towards different reagents[6,7] is still little investigated, however, it is currently receiving considerable attention.

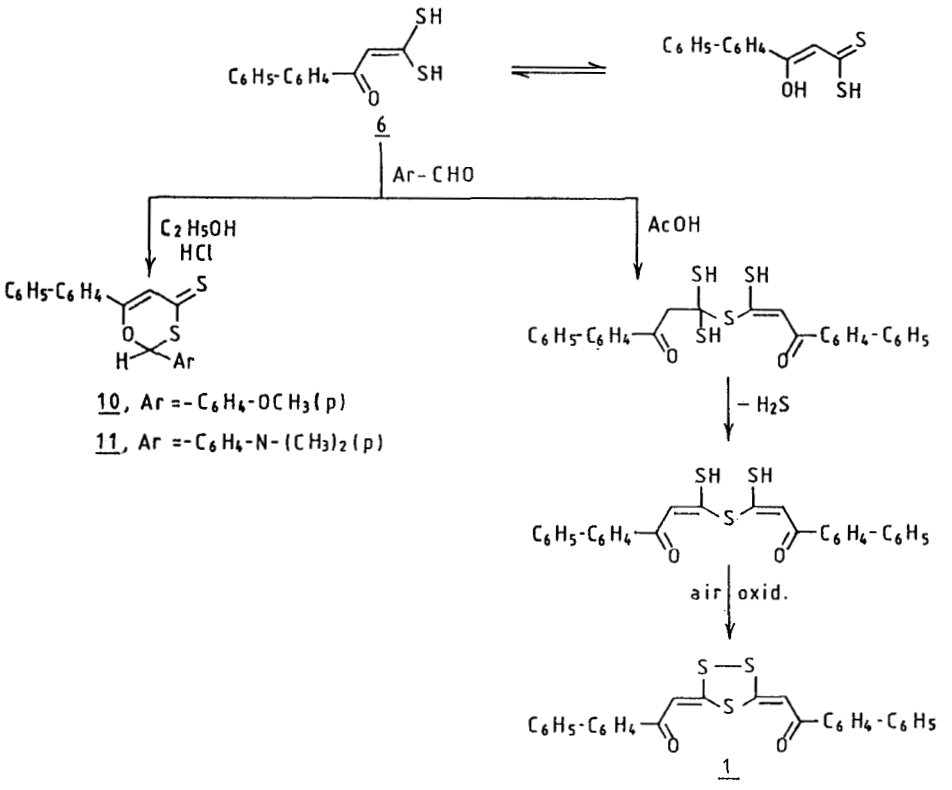
In the course of investigation of heterocycles containing two or three sulfur atoms, the three sulfur atom containing heterocycle **1** (disaurine) was reduced using zinc



powder and glacial acetic acid under two different reaction conditions. At room temperature the reaction product was assigned structure **2**. This product is formed via partial reduction of the molecule and elimination of hydrogen sulfide. Reduction in hot glacial acetic acid resulted in the formation of **3** through complete reduction of the unsaturated positions and elimination of hydrogen sulfide. Structure confirmation of **2** and **3** is based on microanalytical and spectral data. The i.r. spectrum of **3** indicates the disappearance of carbonyl group. Hydrazine hydrate reacted with **1** to give **4** via ring opening and hydrogen sulfide elimination. This was confirmed by microanalytical and spectral measurements.

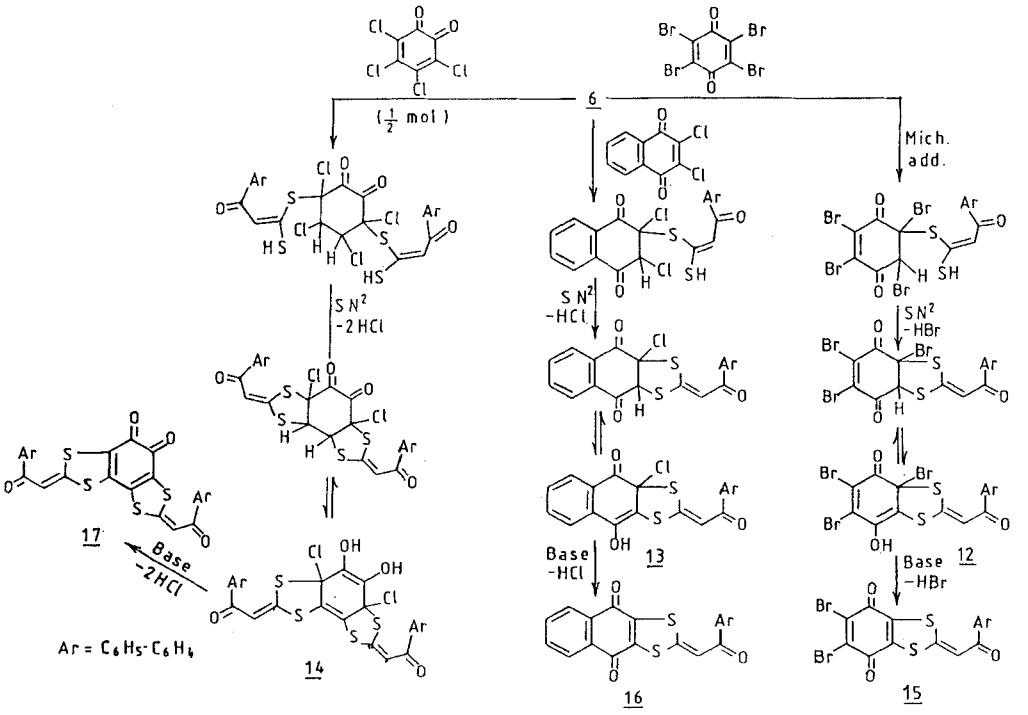
1,2-Dithiacyclopenten-3-thione 5 (prepared from **6** or **1**)[1,2,7] reacted with ethyl monobromoacetate or with diethyl bromomalonate to give **8** via the intermediates **7** and **9**. Formation of **8** and **9** is suggested to proceed via addition of these reagents to the thione group at **C-5** followed by an ester hydrolysis and subsequent hydrogen sulfide elimination under the influence of sodium carbonate in the presence of DMF.

The ketoketen gem-dithiol **6** (prepared via reaction of 4-acetylbiphenyl with CS_2[8,9] in the presence of a base) was also investigated for its reactivity towards aromatic aldehydes. This reaction was done under two different reaction conditions, in boiling ethanol and hydrochloric acid. The products **10** and **11** were obtained, while in boiling glacial acetic acid, a product agreeing with the molecular formula $C_{30}H_{20}O_2S_3$ was obtained (heterocycle **1**). This assignment is based on its GCMS



spectrum which shows a molecular ion (m/e: 508). The proposed mechanism for formation of **1** is a nucleophilic attack of a sulfohydryl group on the ethylenic double bond in a second molecule followed by elimination of hydrogen sulfide. A subsequent oxidation (autoxidation) led to the formation of the more stable product **1**. Boiling **6** in glacial acetic acid gave the same product **1**. Structure of the products **10** and **11** were proved by i.r and H-nmr spectra. The i.r spectrum indicates disappearance of the carbonyl group.

The reactivity of the gem-dithiol-3,3-dimercopo 1. (P. tolyl)-2-propen-1-one towards quinones was reported recently.[10] In the present work the reactivity of the gem-dithiol **6** towards halogenated quinones is investigated. Reaction of **6** with tetrabromo *p*-benzoquinone or with 2,3-dichloronaphthoquinone in equimolar ratio resulted in the formation of **12** and **13**, respectively, while two moles of **6** when treated with one mole of tetrachloro-*o*-benzoquinone gave **14**. Formation of the products **12–14** is assumed to proceed via an additional elimination mechanism. The first step presumably involves a Michael addition of the nucleophile **6** to the haloquinones followed by elimination of hydrogen sulfide under SN2 condition. Tautomerization to the end product occurred. It has been reported that the enol forms were preferred when 2,3-dichloro-1,4-naphthaquinone reacts with active methylene groups.[11,12] The same phenomenon was observed when 1,2-quinones reacted with aromatic amines.[13,14] This was explained by the expected intramolecular hydrogen bonding. The existence of the compounds **12–14** in the enolized form may be due to a weak intramolecular hydrogen bond with the sulfur atom,[15–17] consequently, boiling the isolable products **12–14** in pyridine or in aqueous



potassium carbonate eliminates hydrogen halide molecules and afforded the more stable products **15–17**. Spectral measurements proved formation of the products **12–14**. IR spectra for the products **12–14** showed significant peaks characteristic for carbonyl and hydroxyl groups.

EXPERIMENTAL

MPS uncorrected (electrothermal apparatus). IR spectra, Unicam SP 1000 Spectrometer (KBr) ^{1}H-NMR-90 and 200 MHz spectrometers, and GCMS-QP 1000 Ex. Shamatzu instrument.

Di-(1-(biphenyl)2-propen 1-one)1,3,4. trithiacyclopentan, (disaurine) **1**. The product **1** was obtained in 92% yield as golden yellow crystals by boiling the gem-dithiol **6** in glacial acetic acid or in benzene for 2 hours, m.p. 256°C. $C_{30}H_{20}S_3O_2$ (508.48) Calc. C, 70.9; H, 3.9; S, 18.9% Found. C, 70.8, H, 4.0; S, 18.9%.

Reduction of **1**

A) *At room temperature: 2-mercoptoethane 1-(4-biphenyl) ketone dimer* **2**. To the disaurine **1** (0.01 mol) in glacial acetic acid (100 ml), (0.02 mol) zinc powder was added gradually while stirring over a period of one hour at room temperature. After complete addition, stirring was continued for 3 hours. Filtration and concentration gave orange crystals, yield 86%, m.p. 215°C. $C_{30}H_{26}O_2S_2$ (482.53) Calc. C, 74.7; H, 5.4; S, 13.3%. Found. C, 74.6; H, 5.5; S, 13.3%.
I.R./cm^{-1}, 2580 (SH), 3000 (CH_2), 1670 (C=O) ^{1}H-NMR (DMSO) S. 1.2 (s, 1H, S$\underline{H}$), 4.2 (d, 2H, C$\underline{H}_2$) 4.3 (d, 2H, C$\underline{H}_2$), 6.4–6.6 (td, 2H, CH_2—C$\underline{H}$—SH), 7.2–8.0 (m. 18H, 2-$C_6\underline{H}_5$–$C_6\underline{H}_4$).

B) *In boiling glacial acetic acid: 3-mercopto-1-hydroxy propane 1-(4-biphenyl) dimer* **3**. A mixture of the disaurine **1** (0.01 mol) and zinc powder (0.03 mol) in glacial acetic acid was stirred at room temperature for 1/2 hour then heated under reflux for 4 hours. After cooling, filtration and concentration of the solvent, the separated product was collected and crystallized from benzene to give lemon yellow crystals, yield 83%, m.p. 85°C. $C_{30}H_{30}O_2S_2$ (486.57). Calc. C, 74.0; H, 6.2; S, 13.2%. Found. C, 74.1; H, 6.2; S, 13.1%.
I.R. 1 cm^{-1}, 3500 (OH), 2580 (SH).
^{1}H-NMR (DMSO) δ. 1.45–1.6 (S, S. 2H, 2CHS$\underline{H}$); 4.5–4.6 (dd, 4H, 2C$\underline{H}_2$), 6.0–6.45 (td, 2H, 2C$\underline{H}$—SH), 7.1–8.1 (m, 18H, 2$C_6\underline{H}_5$–C6$\underline{H}_4$), 14.1 (S, 1H, O$\underline{H}$).

Di-3-hydrazino-1-(4-biphenyl)2-propen-1-one-3-disulfide **4**. To disaurine **1** (0.01 ml) in absolute ethanol (B.H.D) (100 ml), hydrazine hydrate (0.023 mol) was added in portions with shaking at room temperature. After complete addition, the reaction mixture was refluxed until evolution of hydrogen sulfide ceased (2 hours). After cooling, the separated solid was collected and crystallized from ethanol to give pale yellow crystals, yield 78%, m.p. 214°C. $C_{30}H_{26}N_4O_2S_2$ (538.55) Calc. C, 66.9; H, 4.86; N, 10.4; S, 11.9%. Found. C, 66.9; H, 4.9; N, 10.5 S, 11.9%.
I.R./cm^{-1}, 1665 (C=O), 3450–3190 (NH + NH_2).
^{1}H-NMR ($CDCl_3$)δ. 3.7–3.9 (b, 4H, 2N$\underline{H}_2$), 4.2 (b, 2H, 2N$\underline{H}$), 7.0 (s, 1H—C$\underline{H}$=C), 7.2–8.0 (m, 18H, 2-$C_6\underline{H}_5$–$C_6\underline{H}_4$).

5-(4-Biphenyl)-1,2-dithiacyclopenten-3-thione **5**. To the disaurine **1** (0.01 mol) in benzene (100 ml) or to the gem-dithiol **6** (0.01 mol) in xylene (100 ml) phosphorus pentasulfide (0.015 mol) was added. Heating the reaction mixture under reflux for 4 hours followed by filtration and concentration of the filtrate, gave red crystals from benzene, yield 76%, m.p. 209°C. $C_{15}H_{10}S_3$ (286.26), Calc. C, 62.9; H, 3.5; S, 33.5%. Found. C, 62.9; H, 3.5; S, 33.6%

Reaction of 5- with ethyl bromoaectate and with diethyl bromomalonate synthesis of the adducts **7** *and* **9**. Equimolar quantities of **5** and ethyl bromoacetate or diethyl bromomalonate in dry benzene (100 ml) were stirred at room temperature for 4 hours. Excess benzene was evaporated and the residual products were triturated with petroleum ether (40/60°C) to give the adducts **7** and **9** which were crystallized from benzene to give pale brown crystals.

Adduct **7**. Yield 86%, m.p. 174°C. $C_{19}H_{17}BrO_2S_3$ (453.24). Calc. C, 50.3; H, 3.8; Br, 17.6, S, 21.2%. Found. C, 50.4; H, 3.8; Br, 17.6; S, 21.3%.
I.R./cm^{-1}, 2530 (SH); 1730 (C=O, ester). ^{1}H-NMR (DMSO) δ. 2.8 (t, 3H, C$\underline{H}_3$); 4.4 (q, 2H, C$\underline{H}_2$), 6.8 (S, 1H, —C$\underline{H}$-cyclic), 5.1 (S, 1H, C$\underline{H}$-acyclic), 7.1–8.0 (m, 9H, $C_6\underline{H}_5$)–$C_6\underline{H}_4$).

Adduct **9**. Yield 83%, m.p. 151°C. $C_{22}H_{22}BrO_4S_3$ (526.29) Calc. C, 50.0; H, 4.2; Br, 15.2; S, 18.2%. Found. C, 50.0; H, 4.2; Br, 15.3; S, 18.4%.
I.R./cm^{-1}, 2530 (SH), 1745 (C=O, ester) ^{1}H-NMR (DMSO) δ. 2.9–3.2 (t, 6H, 2C$\underline{H}_3$), 4.3 (q, 4H, 2C$\underline{H}_2$), 6.9 (1H, C$\underline{H}$-cyclic). 7.1–8.0 (m, 9H, $C_6\underline{H}_5$–$C_6\underline{H}_4$).

5-(4-Biphenyl) 1,2-dithiacyclopenten-3-methincarboxylic acid **8**. To **7** or **9** (0.01 mol) in DMF (100 ml), solid sodium carbonate (2 g) was added. The reaction mixtures were heated under reflux for 5 hours. After cooling, the separated solids were filtered and washed with water. Crystallization of the two products from benzene gave two identical m.p. 102°C, yield 54%, pale yellow crystals. $C_{17}H_{12}O_2S_2$ (312.27), Calc. C, 65.4; H, 3.9; S, 20.5%, Found. C, 65.4; H, 3.8; S, 20.6%.
^{1}H-NMR (DMSO) δ. 4.8 (S, 1H, C$\underline{H}$-acyclic), 6.8 (S, 1H, C$\underline{H}$-cyclic). 7.2–8.0 (m, 9H, $C_6\underline{H}_5$–$C_6\underline{H}_4$), 11.9 (S, 1H, O$\underline{H}$, COOH).

2-Substituted aryl 4-(4-biphenyl)-1,3-thioxa-4-ene 5-thione **10**, **11**. To **6** (0.01 mol; 2.72 g) in ethanol (100 ml) the required aromatic aldehyde (0.01 mol) was added followd by concentrated hydrochoric acid (20 ml). The reaction mixtures were shaken for half an hour and left at room temperature overnight. Neutralization with aqueous sodium carbonate solution gave products **10** and **11**.

Product **10**. Faint red crystals, from benzene yield 87%, m.p. 143°C. $C_{23}H_{18}O_2S_2$ (390.38) Calc. C, 70.7; H, 4.6; S, 16.3%) Found. C, 70.8; H, 4.5; S, 16.5%.

Product **11**. Yellow crystals from ethanol, yield 68%, m.p. 179°C. $C_{24}H_{21}NOS_2$ (403.44) Calc. C, 71.4; H, 5.2; S, 15.9%. Found. C, 71.4; H, S.2; S, 16.1%.

2-(4-Phenyl benzoylmethylene) 4-hydroxy-5,6,7 a-tribromo-7-7a-dihydrobenzo-1,3-dithiolane 7-one **12** *and 2-(4-phenyl benzoyl-methylene) 3a-chloro-9-hydroxynaphtho) (b) 1,3 dithiolane 4-one* **13** *and 2,7-di(4-phenyl benzoylmethylene) 8a,8b-dichloro-4,5. dihydroxy 8a,8b-dihydrobenzo [1,2-d: 3,4-d]bis-1,3-dithiolane-***14**. A mixture of **6** (0.01 mol, 2–72 g) and the haloquinones (tetrabromobenzoquinone, (4.26 g, 0.01 mol) 2,3-dichloronaphthaquinone, (2.27 g, 0.01 mol) tetrachloro-*o*-benzoquinone (1.23 g, 0.005 mol) in absolute ethanol (100 ml) were heated under reflux for 8 hours. After cooling, the separated products were collected and recrystallized from benzene in the form of brown crystals.

Product **12**. Yield 76%, m.p. 295°C. $C_{21}H_{11}Br_3O_3S_2$ (615.02). Calc. C, 41.0; H, 1.8, S, 10.4; Br, 39.9%. Found. C, 41.0; H, 1.9, S, 11.0; Br, 40.0%.
I.R./cm^{-1}, 3480 (OH), 1640 (C=O) ^{1}H-NMR (DMSO) δ. 6.9 (S, 1H, C$\underline{H}$=C), 7.2–8.3 (m, 9H, $C_6\underline{H}_5$–$C_6\underline{H}_4$), 10.6 (S, 1H, O$\underline{H}$).

Product **13**. Yield 86%, m.p. 243°C. $C_{25}H_{15}Cl_3S_2$ (462.86). Calc. C, 64.8; H, 3.3; Cl, 7.6; S, 13.8%. Found. C, 64.8 H, 3.2; Cl, 7.8; S, 14.0%.
I.R./cm^{-1}, 3475 (OH), 1710 (C=O), 1650 (C=O). ^{1}H-NMR (DMSO) δ. 6.8 (S, 1H, C$\underline{H}$=C), 7.3–8.2 (m, 9H, $C_6\underline{H}_5$–$C_6\underline{H}_4$), 10.6 (S, 1H, O$\underline{H}$)

Product **14**. Yield 64%, m.p. 302°C. $C_{36}H_{22}ClO_2S_4$ (717.57) Calc. C, 60.2; H 3.0; Cl, 9.9; S, 17.8%. Found. C, 60.2, H 3.1; Cl, 10.0; S, 18.0%. I.R./cm^{-1}, 1650 (C=O), 3480 (OH). ^{1}H-NMR (DMSO) S. 6.8 (S, 2H, 2CH=C).
I.R./cm^{-1}, 1650 (C=O), 3480 (OH). ^{1}H-NMR (DMSO) δ. 6.8 (S, 2H, 2-C$\underline{H}$=C), 7.1–8.3 (m, 18H, 2-$C_6\underline{H}_5$-$C_6\underline{H}_4$). 12.1 (S, 2H, 2O$\underline{H}$).

2-(4-Phenyl benzoylmethylene) 5,6-dibromo-5, 5a; 7,7a-tetrahydrobenzo-1,3-dithiolane 5,7-dione **15** *and 2-(4-phenyl benzoylmethylene) 4,4a: 9,9a-tetrahydronaphtho (b)-1,3-dithiolane 4,9-dione,* **16** *and 2,7-di(4-phenyl benzoylmethylene) 7,7a: 8,8a-tetrahydrobenzo [1,2-d–3,4-d]bis-1,3-dithiolane 7,8-dione* **17**. Compounds **12–14** (0.01 mol) in dry pyridine (100 ml) were heated under reflux for 4 hours. After cooling, the separated products were collected and recystallized from DMF to give the products **15–17** respectively.

Product **15**. Yield 73%, brown crystals, m.p. 241°C. $C_{21}H_{10}Br_2O_3S_2$ (534.0) Calc. C, 47.2; H, 1.9; Br, 29.9; S, 11.9%. Found. C, 47.3; H, 2.0; Br, 30.0 S, 12.%.
I.R./cm^{-1}, 1715 (C=O) 1630 (C=O). ^{1}H-NMR (DMSO) δ. 7.0 (S, 1H—C$\underline{H}$=C) 7.2–8.0 (m, 9H, C6 $\underline{H}_5$–$C_6\underline{H}_4$).

Product **16**. Yield 81%, dark brown crystals, m.p. 192°C. $C_{25}H_{14}O_3S_2$ (426.37) Calc. C, 70.4; H, 3.3; S, 15.0%. Found. C, 70.4; H, 3.3; S, 15.4%.
I.R./cm^{-1} 1715 (C=O), 1635 (C=O). ^{1}H-NMR (DMSO) δ. 7.0 (S, 1H, C$\underline{H}$=C), 7.2–8.1 (m, 13H, aromatic protons).

Product **17**. Yield 68%, deep brown crystals, m.p. 201°C. $C_{36}H_{20}O_4S_4$ (644.54). Calc. C, 67.0; H, 3.1; S, 19.8%. Found. C, 67.1; H, 3.1; S, 20–0%.

I.R./cm^{-1}, 1725 (C=O), 1620 (C=O). ^{1}H-NMR (DMSO) δ. 6.9 (S, 2H, 2C<u>H</u>=C), 7.1–8.2 (m, 18H, 2 $C_6\underline{H}_5$-$C_6\underline{H}_4$).

REFERENCES

1. G. Wenzel, *Ber.*, **34,** 1043 (1901).
2. P. Yates and T. R. Lynch, *Canad. J. Chem.*, **49,** 1477 (1971).
3. C. Kelber, *Chem. Ber.*, **43,** 1252 (1910).
4. R. Gompper and W. Topfl, *Ber.*, **95,** 2861 (1962).
5. K. Peseke, *Z. Chem.*, **16,** 16 (1976).
6. H. Minato and T. Nagasaki, *J. Chem. Soc. (c)*, 377 (1966).
7. R. S. Spendt, D. R. Stevens and W. E. Baldwin, *J. Am. Chem. Soc.*, **73,** 3693 (1951).
8. J. Ritter and M. U. Cover, *J. Am. Chem. Soc.*, **74,** 5546 (1952).
9. J. Raoul and J. Vialle, *Bull. Soc. Chem. (France)*, **750,** 1670 (1959).
10. S. E. Zayed, A. A. Harb and S. A. Metwally, *Egypt. J. Chem.*, **31,** 1 (1988).
11. G. A. Reynolds, J. A Van Allen and R. E. Adel, *J. Org. Chem.*, **300,** 3819 (1965).
12. B. Suryanarayana and B. D. Talek, *Proc. Indian Acad. Sci.*, **38,** 384 (1953).
13. W. M. Horspool, P. I. Smith and J. M. Tedder, *Chem. Commun.*, 222 (1971).
14. W. M. Horspool, P. I. Smith and J. M. Tedder, *J. Chem. Soc. Perkin I*, 1024 (1972).
15. I. V. Zuika and Yu. A. Bankovski, *Russ. Chem. Rev.*, **42,** 22 (1973).
16. G. C. Vogel and R. S. Drago, *J. Am. Chem. Soc.*, **92,** 5347 (1970).
17. A. D. Sherry and K. F. Purcell, *J. Am. Chem. Soc.*, **94**, 1848 (1972).