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A NEW GENERAL SYNTHESIS OF KETENE THIOACETALS

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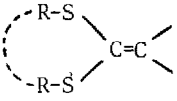
Ketene thioacetals (1) are key intermediates in a wide variety of organic syntheses[1]. Although several methods[1a,2] of synthesis of ketene thioacetals (1) have been reported essentially all have limitations. Of all these methods so far described probably the most widely applicable one is the reaction of carbonyl compounds with the phosphorus ylides (2)[3,4] [the Wittig reaction] or with the lithium derivatives trimethylsilyldithioacetals (3)[1a,5] [the Peterson reaction].



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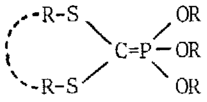
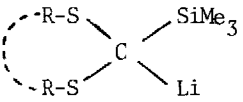


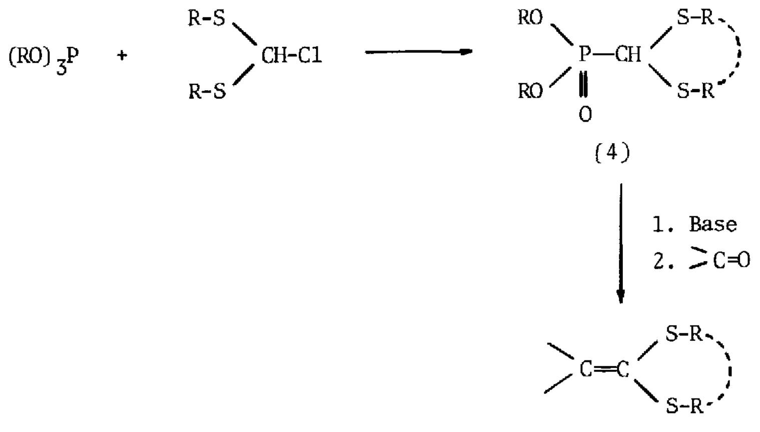
(2)



(3)

The former method employing the phosphite ylid (2) gives satisfactory results only with aldehydes but not with ketones. The latter usually requires long reaction times and gives (1) in a moderate or low yields.

In the course of our studies on α-phosphoryl substituted organosulphur compounds[6] a simple method for the preparation of dithioacetals of formylphosphonates (4) has been elaborated which consists in the Arbuzov reaction of trialkylphosphites with bis-(alkylmercapto)methyl chlorides[7]. Now we wish to report a general and very efficient synthesis of ketene thioacetals (1) based on the Horner PO-olefination reaction using (4) as a reagents of choice.

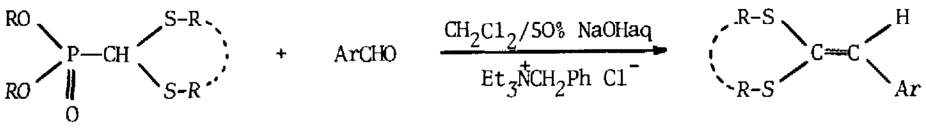


(1)

It has been found that the present method for preparation of (1) has practically no limitations. The carboanion derived from (4) reacts smoothly with cyclic and acyclic, aliphatic and aromatic aldehydes and ketones to afford ketene thioacetals (1) in excellent yields usually exceeding 80% (Table). It is noteworthy that good results have also been obtained with cyclic ketones like cyclopentanone and cyclohexanone.

The generation of the carbanion from (4) may easily be accomplished using n-butyllithium in THF solution at -78^{0} or sodium hydride in boiling dimethoxyethane solution.

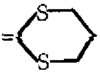
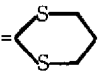
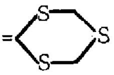
An alternative procedure which circumvents the need for the prior carbanion generation from (4) was also devised. This involves the treatment of (4) with aromatic aldehydes under two-phase system using triethylbenzylammonium chloride as a phase-transfer catalyst[8].



(1)

The following experimental procedures given below are typical.

TABLE. *Synthesis of ketene thioacetals (1)*

Compounds[a]	Experimental procedure[b]	Yield (%)	M.p. (°C), n_D(at °C)	^{1}H-n.m.r. δ(ppm); J(Hz)
$H_2C=C(SMe)_2$	A	96	1.5410(25)	2.25(6H,s,-S-C$\underline{H}_3$); 5.16(2H,s,$\underline{H}_2$C=)
$MeCH=C(SMe)_2$	A	92	1.5308(25)	1.98(3H,d,J=7.0,C$\underline{H}_3$-CH=); 2.38 and 2.40(3H,s,-S-C$\underline{H}_3$); 6.15(1H,q,J=7.0, CH$_3$-C$\underline{H}$=)
$Me_2C=C(SMe)_2$	A	80	1.5205(25)	2.02(6H,s,C$\underline{H}_3$-C=); 2.20(6H,s,-S-C$\underline{H}_3$)
$PhCH=C(SMe)_2$	B	88	1.5628(25)	2.32 and 2.38(3H,s,-S-C$\underline{H}_3$); 6.80(1H, s,Ph-C$\underline{H}$=); 7.25(5H,m,C$_6\underline{H}_5$)
$PhMeC=C(SMe)_2$	A	61	1.6034(25)	2.10(3H,s,C$\underline{H}_3$-C=); 2.32(6H,s,-S-C$\underline{H}_3$) 7.20(5H,m,C$_6\underline{H}_5$)
$Ph_2C=C(SMe)_2$	A	78	83-84	2.20(6H,s,-S-C$\underline{H}_3$); 7.20(10H,m,C$_6\underline{H}_5$)
 =C(SMe)$_2$	A	80	1.5577(25)	1.55 and 2.60(10H,m,(C$\underline{H}_2$)$_5$C=); 2.22(6H,s,-S-C$\underline{H}_3$)
 =C(SMe)$_2$	A	82	1.5606(25)	1.70 and 2.50(8H,m,(C$\underline{H}_2$)$_4$C=); 2.25(6H,s,-S-C$\underline{H}_3$)
PhMeC= 	A	68	1.6270(22)	2.05 and 2.85(6H,m,-S(C$\underline{H}_2$)$_3$-S-); 2.18 (3H,s,C$\underline{H}_3$-C=); 7.25(5H,m,C$_6\underline{H}_5$)
Ph$_2$C= 	A	70	133-134	2.08 and 2.93(6H,m,-S(C$\underline{H}_2$)$_3$-S-); 7.25(10H,m,C$_6\underline{H}_5$)
Ph$_2$C= 	A	66	136-137	4.05(4H,s,S-C$\underline{H}_2$-S); 7.25(10H,m,C$_6\underline{H}_5$)

[a] Satisfactory elemental analyses have been obtained for all compounds.

[b] A - The reaction of carbonyl compound was carried out with the lithium derivative of (4).

B - The reaction was carried out under two-phase conditions.

Synthesis of 1,1-bis-methylthio-ethene.- To a solution of S,S-dimethylthioacetal of O,O-dimethyl formylphosphonate (2.16g, 0.01 mol) in THF (15 ml) a solution of n-butyllithium (0.011 mol) in hexane was added at -78° under argon. The mixture was stirred at this temperature for 1 hr. Then paraformaldehyde (0.3 g, 0.01 mol) was added and the reaction mixture was stirred at -78° for 15 min and for 1 hr at room temperature. After removal of the solvents the residue was dissolved in dichloromethane (50 ml). The solution was washed with ammonium chloride solution, then with water, dried and evaporated to give 1.15 g (96%) of the analyticaly pure 1,1-bis-methylthio-ethene.

Synthesis of 1,1-bis(methylthio)-2-phenyl-ethene.- A solution of S,S-dimethylthioacetal of O,O-dimethyl formylphosphonate (2.16 g, 0.01 mol) and benzaldehyde (1.06 g, 0.01 mol) in dichloromethane (5 ml) was added to the heterogeneous mixture of 50% aqueous sodium hydroxide (10 ml) containing 0.1 g triethylbenzylammonium chloride and dichloromethane (5 ml). The reaction mixture was stirred for 0.5 hr at room temperature. The dichloromethane layer was washed with an aqueous solution of ammonium chloride, dried and concentrated. The residue was distilled in vacuo to give 1.73 g (88%) of 1,1-bis(methylthio)-2-phenyl-ethene (b.p. 105-107°/0.05 torr).

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[8] For other Horner reactions under two-phase conditions see: C.Piechucki, Synthesis, 1974, 869; 1976, 187; M.Mikołajczyk, S.Grzejszczak, W.Midura and A.Zatorski, Synthesis, 1975, 278; 1976 in press; E.D.'Incan, J.Seyden-Penne, Synthesis, 1975, 516.