

PREPARATION OF 2,5-DIACYLSELENOPHENES BY CONDENSATION OF α,α' -DIKETO
SELENIDES WITH GLYOXAL

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Abstract—The reaction of selenium oxychloride with 2 equiv. of ketones affords α,α' -diketo selenide dichlorides (1) in excellent yields. Portionwise addition of 1 to a stirred two-phase mixture of an aqueous sodium dithionite solution and benzene gives α,α' -diketo selenides (2) in good yields. The base-catalyzed condensation of 2 with glyoxal provides 2,5-diacylselenophenes (3) in moderate yields.

The Hinsberg thiophene synthesis in which diethyl thiodiglycolate is condensed with a 1,2-dicarbonyl compound presents a classical but useful route to functionalized thiophenes.¹ Surprisingly, however, only one example of the application of the Hinsberg reaction to selenophene synthesis appears to have been reported.² In a modified Hinsberg thiophene synthesis, the use of α,α' -diketo sulfides instead of diethyl thiodiglycolate satisfactorily leads to 2,5-diacylthiophenes on condensation with glyoxal.³ However, no application of this reaction to the synthesis of 2,5-diacylselenophenes (3) has been reported probably because practical method for the preparation of α,α' -diketo selenides (2) is not available. Herein we report a modified synthetic method for 2 and its condensation with glyoxal leading to 3.

α,α' -Diketo selenide dichlorides (1) were prepared by reaction of selenium oxychloride with 2 equiv. of ketones in anhydrous ether.⁴ The reaction is complete on standing the mixture overnight at room temperature and 1 precipitate in excellent yields (see Table 1) as practically pure near-white crystals which are scarcely soluble in ordinary organic solvents. The dichlorides 1 were described as more or less unstable compounds,⁴ but seem to be stabler than previously

reported, though they are moisture-sensitive.⁵

Only two α,α' -diketo selenides were previously prepared by dechlorination of 1.⁶ The reported method, however, requires prolonged refluxing (3 days) of 1 with zinc powder in a large amount of hazardous carbon disulfide. We now found that portionwise addition of 1 to a stirred two-phase mixture of an aqueous solution of sodium dithionite ($\text{Na}_2\text{S}_2\text{O}_4$) and benzene affords 2 in good yields (Table 1). For example, dichlorodiphenacylselenium (29.1 g, 75 mmol) was added in small portions to a stirred mixture of an aqueous solution of sodium dithionite (225 mmol in 400 ml of water) and benzene (400 ml) over a period of 0.5 h at room temperature. After the completion of the addition,⁷ the benzene layer was separated, washed with water, and dried over anhydrous sodium sulfate. Evaporation of the solvent leaves pale yellow crystalline solid of diphenacyl selenide (21.2 g, 89%), which contains a small amount of acetophenone as impurity. One recrystallization from ethanol furnishes the pure selenide. Potassium metabisulfite ($\text{K}_2\text{S}_2\text{O}_5$) and sodium sulfide nonahydrate can also be satisfactorily used instead of sodium dithionite. However, the use of these reducing agents results in the formation of the original ketones as by-product in somewhat increased yields and hence desired 2 in somewhat decreased yields.

The following is a typical procedure for the preparation of 2,5-diacylselenophenes (3) by the base-catalyzed condensation of 2 with glyoxal. Glyoxal trimeric dihydrate (0.67 g, 9.6 mmol) was heated in boiling methanol (30 ml) for 1 h to obtain a homogeneous solution of glyoxal monomer. To this hot solution was dissolved 1.27 g (4 mmol) of diphenacyl selenide. The solution was refluxed and to this was added a solution of potassium hydroxide (244 mg, 4.3 mmol) in methanol (10 ml) during 10 min. The mixture was refluxed for 0.5 h and cooled. The resulting crystalline precipitate was collected by filtration and washed with methanol until the washing became nearly colorless. 2,5-Dibenzoylselenophene thus obtained contains selenium powder as impurity, which was removed by washing with methylene chloride. Selenium is practically insoluble in methylene chloride, while the selenophene is soluble, and thus evaporation of the solvent from the filtrate leaves the selenophene (0.87 g, 64%) in a pure form. Dilution of the original filtrate with water, collection of the resulting precipitate, and recrystallization affords some selenophene, if necessary. Results thus obtained are summarized in Table 1. In every case, the cleavage of the carbon-selenium bond

was observed as side reaction, which results in the formation of the original ketones and selenium and made the yield of selenophenes 3 moderate.

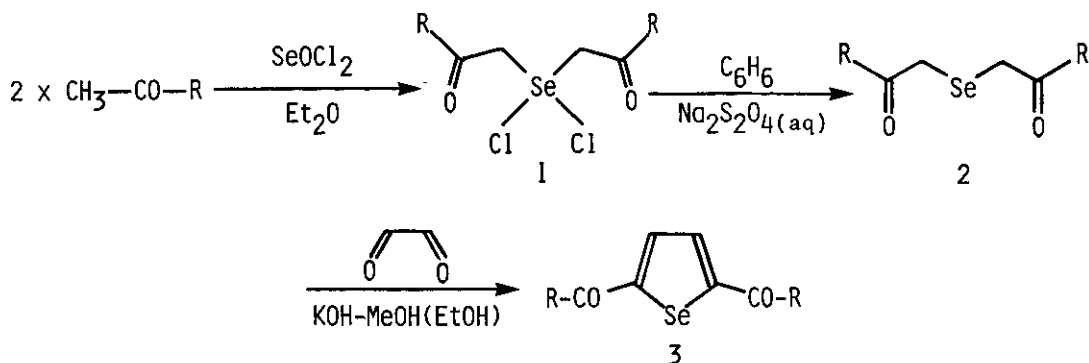


Table 1 Preparation of 2,5-Diacylselenophenes (3)

run	R	Yield of <u>1</u> (%)	Yield of <u>2</u> (%) ^a	Mp of <u>2</u> (°C)	Yield of <u>3</u> (%) ^{f,g}	Mp of <u>3</u> (°C) ^d
1	C ₆ H ₅	99	89	72-73 ^b	73	117-118
2	4-ClC ₆ H ₄	71	77	117-118.5 ^c	70 ^h	229-230
3	4-MeC ₆ H ₄	97	93	105.5-107 ^d	69	156-157
4	4-MeOC ₆ H ₄	94	97	84.5-85.5 ^d	45	185-186
5	1-naphthyl	83	99	viscous oil ^d	65 ^h	138-139
6	2-thienyl	88	89	78-78.5 ^d	58	185.5-186.5
7	CH ₃	83	56	(100 °C/0.4 mmHg) ^{d,e}	13 ⁱ	133-134
8	(CH ₃) ₃ C	77	95	27.5-29 ^d	13	117-118.5

a. Yield based on crude products which contain a small amount of the original ketones as impurity. b. Reported mp 73 °C.^{6a} c. Reported mp 108-110 °C.^{6b} d. These are new compounds and fully characterized in a usual manner. e. Boiling point of bulb-to-bulb distillation. f. 2.5 Equiv. of glyoxal monomer was used unless otherwise stated. g. Methanol was used as solvent for condensation unless otherwise stated. h. Ethanol was used as solvent for condensation. i. 5.0 Equiv. of glyoxal monomer was used.

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5. Dichlorodiacetylselenium obtainable from acetone is unstable. The reaction of acetone with selenium oxychloride proceeds quickly, and the yield of the dichloride is 83% when the precipitate was collected after 2 h, but the yield decreased to 61% on standing the mixture overnight because the dichloride decomposes on standing and redissolves in ether. The dichloride obtainable from 4-acetylpyridine is unstable hygroscopic compound and could not be isolated in a pure form.
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7. Since decomposition of the dichloride to acetophenone and selenium (selenium dioxide)^{6a} occurs as side reaction, a small amount of selenium powder may precipitate during the addition.

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