quantities of reagents, the refluxing and stirring being continued for five hours. There is obtained from the aqueous layer 0.10 g. of an acidic oil which could not be crystallized. It forms an S-benzylthiuronium salt of m. p. 134° after recrystallization from alcohol.

From the ether-soluble material is obtained 1.4 g. (54% yield) of the **dimethyl acetal of α-benzyl-α-hydroxyacetone**, b. p. 119–121° (6 mm.); $n^{20}D$ 1.5080; $d^{24.5}_{24.5}$ 1.067; mol. ref.: calcd., 58.8; found, 58.6.

Anal. Calcd. for $C_{12}H_{18}O_3$: C, 68.55; H, 8.63. Found: C, 68.53; H, 8.68.

This hydroxyacetal gives no precipitate after twenty minutes in the cold with 2,4-dinitrophenylhydrazine reagent,[13] but reacts readily on warming. Hydrolysis in alcohol containing a small amount of hydrochloric acid followed by treatment with freshly distilled phenylhydrazine gives the phenylosazone of benzylmethylglyoxal,[14] m. p. 169.5–171° after recrystallization from dilute alcohol.

Anal. Calcd. for $C_{22}H_{22}N_4$: C, 77.16; H, 6.48. Found: C, 77.31; H, 6.47.

On standing for six weeks, an ether solution of the hydroxyacetal deposited a white solid which recrystallizes from methanol as short, glistening needles, m. p. 180–182.5°. This is apparently a lactolide analogous to the one obtained by Bergmann and Miekeley.[4]

Anal. Calcd. for $C_{22}H_{28}O_4$: C, 74.13; H, 7.92. Found: C, 74.05; H, 8.01.

S-Benzythiuronium γ-Phenylbutyrate.—The general method of Donleavy[15] was followed in preparing the salts used for identification. This example illustrates the procedure. One gram (0.0061 mole) of γ-phenylbutyric acid is dissolved in 3 cc. of 50% ethanol, neutralized with 10% potassium hydroxide solution, and made weakly acidic with a drop of dilute hydrochloric acid. To this warmed solution is added 1.60 g. (0.0078 mole) of S-benzylthiuronium chloride dissolved in 10 cc. of hot alcohol. The salt begins to separate within a few seconds. On cooling and filtering there is obtained 1.77 g. (88% yield) of the S-benzylthiuronium salt, m. p. 140–141°. Recrystallization from alcohol raises the m. p. to 141–141.5°.

Anal. Calcd. for $C_{18}H_{22}N_2O_2S$: C, 65.42; H, 6.72. Found: C, 65.64; H, 6.93.

S-Benzylthiuronium α-Methylhydrocinnamate.—Prepared as above, it melts at 144–144.5°.

Anal. Calcd. for $C_{18}H_{22}N_2O_2S$: C, 65.42; H, 6.72. Found: C, 65.51; H, 6.99.

Summary

1. On treatment with sodium methoxide in methanol, benzyl chloromethyl ketone gives an 80% yield of methyl hydrocinnamate; α-chloro-α-phenylacetone gives a mixture of the same ester, the free acid, and the dimethyl acetal of α-hydroxy-α-phenylacetone.

2. Under similar conditions chloromethyl β-phenylethyl ketone gives hydroxymethyl β-phenylethyl ketone, its dimethyl acetal, and a small quantity of γ-phenylbutyric acid; α-benzyl-α-chloroacetone gives the dimethyl acetal of α-benzyl-α-hydroxyacetone.

ROCHESTER, N. Y. RECEIVED FEBRUARY 8, 1944

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[14] Müller and v. Pechmann, *Ber.*, **22**, 2132 (1889), report the m. p. of this compound as 172–173°.

[15] Donleavy, THIS JOURNAL, **58**, 1004 (1936).

[CONTRIBUTION FROM THE CANCER CLINIC AND LABORATORY, DEPARTMENT OF PREVENTIVE MEDICINE AND PUBLIC HEALTH OF THE UNIVERSITY OF TEXAS MEDICAL BRANCH AND THE M. D. ANDERSON HOSPITAL FOR CANCER RESEARCH]

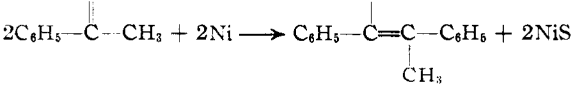
Thiocarbonyls. I. Condensation of Thioacetophenone with Activated Nickel

BY J. K. CLINE,[1] E. CAMPAIGNE[2] AND J. W. SPIES[3]

In a search for simpler methods of synthesizing stilbene derivatives to test for possible carcinogenic action, it was thought that the reaction of Raney nickel with the readily available arylthioaldehydes and alkylarylthioketones might furnish a quick and convenient mode of preparation. To avoid complicating side reactions, the production of the simpler stilbenes was used initially as a model for further experimentation.

Recently Mozingo, Wolf, Harris and Folkers[4] postulated two courses by which Raney nickel might react with an organic sulfur compound to split out sulfur. In one case a Wurtz-type reaction might occur, in which the two organic radicals combined, and in the second case the hydrogen present in the nickel might replace the sulfur. These investigators found that, using organic sulfides, disulfides, sulfoxides, and sulfones, the reaction with Raney nickel took the second course, in which the carbon–sulfur bond was replaced by a carbon–hydrogen bond.

An instance in which the alternate path of the reaction was followed, has been found. The thiocarbonyl group in thioacetophenone was found to react with Raney nickel in a Wurtz-type reaction to form a carbon–carbon double bond.



$$2C_6H_5{-}\overset{\overset{\large S}{\|}}{C}{-}CH_3 + 2Ni \longrightarrow C_6H_5{-}\underset{}{\overset{\overset{\large CH_3}{|}}{C}}{=}\underset{\underset{\large CH_3}{|}}{C}{-}C_6H_5 + 2NiS$$

Reactions of this type with arylthioaldehydes and copper powder[5] and with diarylthioketones and copper-bronze[6] have previously been reported. Copper powder was found to be ineffective as a condensing agent for alkylarylthioketones. The investigation of this type of condensation is being extended to other alkylarylthioketones.

The authors are indebted to Mr. H. Morris for the microanalyses.

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[3] Present address: Los Angeles Tumor Institute, Los Angeles, California.

[4] Mozingo, Wolf, Harris and Folkers, THIS JOURNAL, **65**, 1013 (1943).

[5] Richtzentrain and Van Hofe, *Ber.*, **72**, 1890 (1939); Wood, Bacon, Meibohm, Throckmorton, and Turner, THIS JOURNAL, **63**, 1334 (1941).

[6] Schonberg, Schutz and Nickel, *Ber.*, **61B**, 1375 (1928).

Experimental

Trithioacetophenone.—This compound was used as a source of thioacetophenone. It dissociates to the monomer above its melting point. Trithioacetophenone was prepared by the method described by Baumann and Fromm.[7] The product was readily recrystallized from a mixture of equal volumes of alcohol and acetone, yielding hexagonal bars, m. p. 121–122.1° cor. The yield was 21 g., or 37%.

Anal. Calcd. for $C_{24}H_{24}S_3$: C, 70.58; H, 5.88; S, 23.53. Found: C, 70.49; H, 5.97; S, 23.31.

Raney Nickel.—The Raney nickel was prepared in the usual way[8] and stored under absolute alcohol. When needed it was shaken up, and a portion of the alcohol suspension transferred to a 50-ml. centrifuge tube and centrifuged. The alcohol was decanted, and 20 ml. of dry xylene was added. The nickel was again shaken up, and the suspension centrifuged. The washing with dry xylene was repeated 5 or 6 times to remove alcohol, and the nickel was then used as a xylene suspension.

α,α'-Dimethylstilbene.—Fifty ml. of this xylene suspension containing approximately 8 g. of Raney nickel (4 times the calculated quantity) was placed in a small flask, and 4 g. of trithioacetophenone added. The mixture was heated in an atmosphere of nitrogen at 145–150° on an oil-bath for ninety minutes. After cooling, the residue was removed by filtering through a sintered glass plate. Hydrogen sulfide was evolved when this nickel residue was treated with hydrochloric acid, indicating the presence of nickel sulfide. The clear xylene solution was distilled under vacuum to remove most of the xylene, and the residual brown oil (about 5 ml.) was stored overnight in the refrigerator. Flat colorless plates of a sulfur-free compound were deposited. These were filtered, washed with cold petroleum ether and dried. They melted at 105–106° cor. The *trans* form of α,α'-dimethylstilbene is reported to melt at 107°, while the *cis* form melts at 67°.[9] A second crop of crystals was recovered by the addition of alcohol to the mother liquor. The total yield was 0.55 g., or 18%.

Anal. Calcd. for $C_{16}H_{16}$: C, 92.3; H, 7.7. Found: C, 92.06; H, 7.68.

In cold carbon tetrachloride this compound forms a dibromide which can be recrystallized from methanol in white needles, m. p. 152.5–153° cor., corresponding to the dibromide reported by Levy.[10]

Anal. Calcd. for $C_{16}H_{16}Br_2$: C, 52.2; H, 4.3. Found: C, 51.9; H, 3.8.

Attempted Condensation with Copper Powder.—Copper powder was used in the place of Raney nickel in one experiment. Approximately 7 g. of freshly reduced copper powder (4 times the calculated quantity) were refluxed in xylene with 4 g. of trithioacetophenone. The mixture was stirred vigorously. After three hours the copper was not markedly discolored. After six hours, refluxing and stirring were stopped. The mixture was cooled and filtered. The copper residue contained some sulfur. Approximately 50% of the trithioacetophenone was recovered unchanged when the xylene solution was concentrated. The mother liquor yielded a small amount of an intractable, sulfur-containing oil.

Summary

trans-α,α'-Dimethylstilbene has been prepared by the reaction of thioacetophenone with Raney nickel.

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[7] Baumann and Fromm, *Ber.*, **28**, 895 (1895).

[8] "Organic Syntheses," **21**, 15 (1941).

[9] Von Wassely and Wellaba, *Ber.*, **74B**, 777 (1941).

[10] Levy, *Bull. soc. chim.*, **29**, 878 (1921).

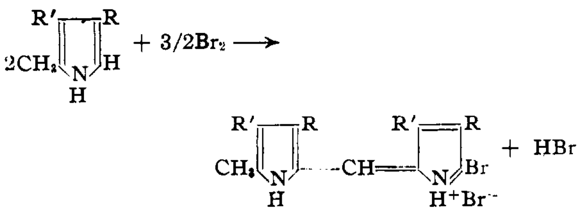
BLOOMINGTON, INDIANA RECEIVED MARCH 24, 1944

[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE JOHNS HOPKINS UNIVERSITY]

The Condensation of Pyrroles with Bromine. A Self-Oxidation and a New Type of Displacement Reaction[1,2]

BY ALSOPH H. CORWIN AND PAUL VIOHL[3]

One of the reactions exploited frequently by Hans Fischer and his collaborators in the synthetic proofs of the structures of porphyrin derivatives is the unorthodox condensation of α-free-α'-methyl pyrroles by means of bromine. This condensation generally gives 5-bromo-5'-methyldipyrrylmethene hydrobromides in yields of about 50%.



Reactions of this type have no analogy outside the field of pyrrole chemistry and their course is not thoroughly understood. Fischer and Scheyer[4] have shown that in one case this condensation led mainly to a product of unknown constitution.[5] Fischer and Bäumler[6a] cite another example of the more or less unpredictable course of the condensation[7] and also present a surprising case in which the substitution of an ethyl group in the β-position completely blocks the reaction. All the foregoing facts prompt an inquiry into the mechanism of the condensation and its impor-

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[1] Studies in the Pyrrole Series, XII; Paper XI, Brunings and Corwin, THIS JOURNAL, **66**, 337 (1944).

[2] This paper is from the doctoral dissertation of Paul Viohl, The Johns Hopkins University, 1939. A part of it was presented at the Baltimore Meeting of the American Chemical Society, April, 1939. Original manuscript received November 17, 1943.

[3] Present address, U. S. Rubber Co., Detroit, Mich.

[4] Fischer and Scheyer, *Ann.*, **434**, 242 (1923).

[5] This article undoubtedly contains an accidental error since the tentative structural formula advanced on p. 242 corresponds to a hydrobromide with the empirical formula $C_{14}H_{18}ON_2Br_6$ while the empirical formula calculated for the analytical data on p. 251 is $C_{14}H_{16}ON_2Br_6$.

[6] Fischer and Bäumler, *ibid.*, **468**, (a) 60, (b) 73, (c) 63 (1929).

[7] Curiously enough, this paper contains the converse error to that mentioned in note 5. The tentative structural formula advanced on p. 60 corresponds to the empirical formula $C_{16}H_{19}ON_2Br_6$ while the empirical formula calculated for analysis on p. 72 is $C_{16}H_{17}ON_2Br_5$.