[CONTRIBUTION FROM THE NOYES CHEMICAL LABORATORY, UNIVERSITY OF ILLINOIS]

1,4-ADDITION OF THE GRIGNARD REAGENT TO ACETYLENIC KETONES

REYNOLD C. FUSON AND JOHN S. MEEK

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In a search for mesitylenic ketones which might undergo 1,2-addition with Grignard reagents, attention was directed to chalcones in which the 4-position is occupied by groups which might be capable of preventing conjugate addition. An attractive route to compounds of the desired type would be provided by the 1,4-addition of Grignard reagents to suitably constituted acetylenic ketones. However, the literature records no example of an addition of this type. On the contrary, there is convincing evidence that ordinary acetylenic ketones condense with Grignard reagents in the 1,2 manner exclusively. For example, benzoylphenylacetylene (I) was shown by Kohler (1) to undergo only 1,2-addition under conditions which brought about chiefly 1,4-addition with the olefinic analog, benzalacetophenone (II).

$C_6H_5COC{\equiv}CC_6H_5$ I

$C_6H_5COCH{=}CHC_6H_5$ II

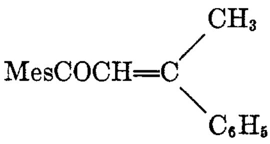
In the present work, the problem of 1,4-addition of the Grignard reagent to acetylenic ketones was reëxamined. It seemed probable that 1,4-addition might be effected in an acetylenic ketone provided the hindrance to 1,2-addition were prohibitive. Acetylenic mesityl ketones such as mesitoylphenylacetylene (III) and mesitoylmesitylacetylene (IV), for example, might be expected to undergo conjugate addition. These two ketones were prepared, therefore, and subjected to the action of Grignard reagents.

Mesitoylphenylacetylene (III)

This acetylenic ketone was made from mesitoyl chloride and sodium phenylacetylide or phenylethynylmagnesium bromide. With methylmagnesium iodide it was found to condense readily in the 1,4 manner, yielding β-methylbenzalacetomesitylene (V). From one gram of the acetylenic ketone the pure ethylenic ketone was isolated in a 73% yield.

$\mathrm{MesCOC{\equiv}CC_6H_5}$ III

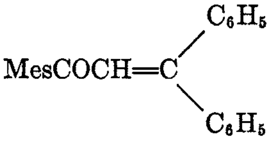
$\mathrm{MesCOC{\equiv}CMes}$ IV

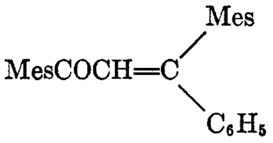


$$\mathrm{MesCOCH{=}C}\begin{array}{l}\diagup\,\mathrm{CH_3}\\ \diagdown\,\mathrm{C_6H_5}\end{array}$$

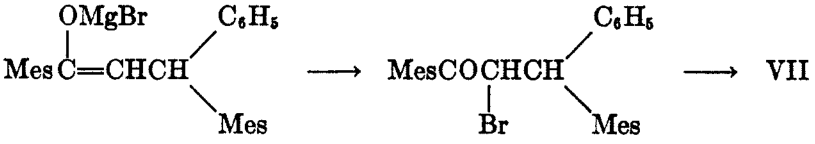
V

Similar results were obtained with phenyl- and mesityl-magnesium bromide; β-phenylbenzalacetomesitylene (VI) and β-phenylmesitalacetomesitylene (VII), were obtained in yields of 20% and 67%, respectively.

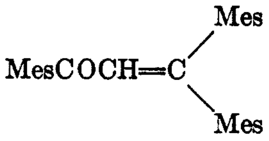

VI


VII

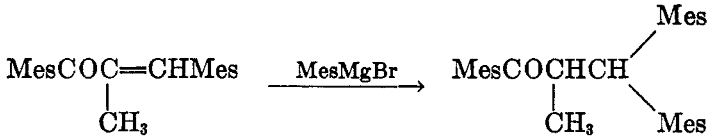
β-Phenylmesitalacetomesitylene was prepared also from mesitalacetomesitylene by a method developed by Kohler (1). When the enolate (VIII) formed by the addition of phenylmagnesium bromide was treated with bromine at 0°, two isomeric bromo ketones (IX) were formed. From these by dehydrobromination were produced the two stereoisomeric forms of β-phenylmesitalacetomesitylene (VII).


VIII IX

β-Mesitylmesitalacetomesitylene (X) was also synthesized in this manner.


X

Its preparation was made possible by the somewhat surprising discovery that mesitylmagnesium bromide could be added smoothly to mesitalacetomesitylene. The presence of a mesityl group and only a hydrogen atom in the 4-position appears to offer no marked hindrance to the introduction of a second mesityl group. Another example of this type of reaction was the addition of mesitylmagnesium bromide to mesitalpropiomesitylene (XI) to yield α-methyl-β,β-dimesitylpropiomesitylene (XII).

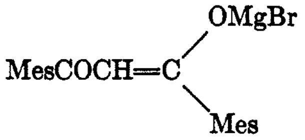

XI XII

Attempts to bring about a reaction of the β-phenyl- or β-mesityl-mesitalacetomesitylenes with phenylmagnesium bromide were fruitless. The unsaturated ketones were recovered accompanied by small amounts of oily materials which could not be identified. With methylmagnesium iodide there was evidence of 1,4-addition, but it could not be confirmed.

These highly hindered chalcones were likewise indifferent towards other reagents. They appeared incapable of forming epoxides and were not reduced under ordinary conditions by an atmosphere of hydrogen and the Adams catalyst.

Subsequent investigation showed that even a methyl group coupled with a mesityl group in the 4-position prevented conjugate addition of the Grignard reagent under ordinary conditions. In an attempt to condense mesitylmagnesium bromide with β-phenylbenzalacetomesitylene there was evidence of reaction but no addition compound could be isolated.

In this connection it may be mentioned that efforts to condense dimesitoylmethane with methylmagnesium iodide, even on long heating, were likewise ineffective. The enolate (XIII) formed but failed to condense with the reagent, showing that the combined influence of the mesityl radical and the -OMgBr group inhibited 1,4-addition.



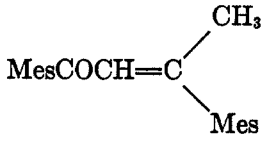
$$\mathrm{MesCOCH{=}C}\begin{matrix}\diagup\,\mathrm{OMgBr}\\ \diagdown\,\mathrm{Mes}\end{matrix}$$

XIII

Mesitoylmesitylacetylene (IV)

Mesitoylmesitylacetylene, prepared from mesitoyl chloride and sodium mesitylacetylide or mesitylethynylmagnesium bromide, was characterized by hydrogenation. The resulting β-mesitylpropiomesitylene was cleaved by treatment with phosphoric acid according to the method of Klages and Lickroth (2) to yield mesitylene and β-mesitylpropionic acid.

Condensation of the acetylenic ketone with methylmagnesium iodide yielded two isomeric products which appeared to be the *cis* and *trans* modifications of β-methylmesitalacetomesitylene (XIV) melting at 104° (A) and 77–78° (B). As is set forth in the experimental part, isomer A could be transformed to isomer B in a number of ways. Ultraviolet absorption curves for the two isomers were found to be almost identical; isomer A had a peak of 2380Å, isomer B at 2400Å.[1]



$$\mathrm{MesCOCH{=}C}\begin{matrix}\diagup\,\mathrm{CH_3}\\ \diagdown\,\mathrm{Mes}\end{matrix}$$

XIV

Attempts to hydrogenate β-methylmesitalacetomesitylene to β-mesitylbutyromesitylene were unsuccessful. This ketone, which had been made by Kohler and Blanchard (3) was reëxamined in anticipation of its use for comparison. Its structure was established by use of the phosphoric acid cleavage (2), which converted it to mesitylene and β-mesitylbutyric acid. The structure was confirmed by preparing the compound by the addition of mesitylmagnesium

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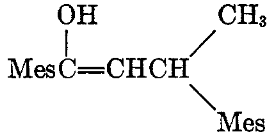
[1] The ultraviolet absorption spectra were measured by Mr. John E. Wilson.

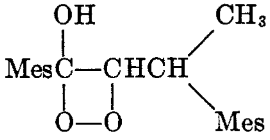
bromide to mesityl propenyl ketone (XVI). The intermediate enol (XVII), whether prepared from XV or XVI, yielded two isomeric peroxides (XVIII).

$MesCOCH{=}CHMes$ XV

$MesCOCH{=}CHCH_3$ XVI



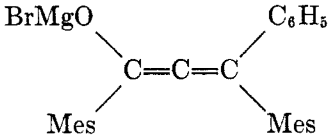
XVII



XVIII

Condensation of mesitoylmesitylacetylene was effected also with the phenyl and mesityl Grignard reagents to yield β-phenyl- (VII) and β-mesityl-mesitalacetomesitylene (X), respectively.

The 1,4-addition reactions of the Grignard reagent to acetylenic ketones derive added interest from the fact that the condensate is an allenic enolate. The enolate obtained by condensing mesitylmagnesium bromide with mesitoylphenylacetylene (or phenylmagnesium bromide with mesitoylmesitylacetylene) (XIX) was especially interesting because it was insoluble in ether and could be isolated readily. It was extremely hygroscopic and was quickly transformed by water to the corresponding α,β-unsaturated ketone; apparently the enol ketonized instantaneously. It is noteworthy that the ketonization took place in such a way as to yield only the high-melting form of the β-phenylmesitalacetomesitylene.



XIX

EXPERIMENTAL

Mesitoylphenylacetylene. Sodium phenylacetylide was condensed with mesitoyl chloride by a procedure similar to that used by Nef to make benzoylphenylacetylene (4). From 10 g. of the acetylene and 25 g. of the acid chloride was obtained 3 g. of the acetylenic ketone. It separated from methanol in white plates; m.p. 51°.

Anal. Calc'd for $C_{18}H_{16}O$: C, 87.06; H, 6.50.

Found: C, 86.86; H, 6.54.

The sodium appeared to reduce phenylacetylene and also to attack the acetylenic ketone, once it was formed. In an effort to improve the method phenylethynylmagnesium bromide, prepared from phenylacetylene and ethylmagnesium bromide, was condensed with mesitoyl chloride. The yield of the crude acetylenic ketone was higher, but the product was extremely difficult to purify.

In another experiment sodium amide was used to convert phenylacetylene to its sodium salt. In this experiment, mesitoic acid, mesitoic anhydride, and phenylacetylene were isolated by suitable manipulations. Also there was a small amount of yellow oil which appeared to be crude mesitoylphenylacetylene and a considerable amount of a colorless solid melting, with decomposition, at 247–248°. It had the composition calculated for mesitimide [$(MesCO)_2NH$]

Anal. Calc'd for $C_{20}H_{23}NO_2$: C, 77.63; H, 7.49; N, 4.53.
Found: C, 77.25; H, 7.50; N, 4.25.

The mesitoic anhydride, obtained as a colorless crystals melting at 106–107°, did not depress the melting point of an authentic sample of the anhydride (5). The anhydride yielded mesitoic acid when subjected to alkaline hydrolysis. The imide, on the other hand, was almost unaffected by long heating with ethanolic potassium hydroxide.

Mesitylacetylene. The procedure was a modification of that of Vaughn and Nieuwland (6). Distillation of the intermediate 2,4,6-trimethyl-α-chlorostyrene yielded tarry materials and was omitted. The amount of sodium amide was doubled. From 56 g. of acetomesitylene was obtained 24 g. (48%) of mesitylacetylene; b.p. 77–78° (5 mm.); n_D^{22} 1.5430.

Mesitoylmesitylacetylene. The procedure was similar to that employed in the synthesis of mesitoylphenylacetylene. The product boiled at 200–205° (3 mm.) and melted at 100–101° after one recrystallization from ethanol; yield 40–60%. The pure acetylenic ketone separated from methanol in white needles; m.p. 102–103°.

Anal. Calc'd for $C_{21}H_{22}O$: C, 86.85; H, 7.64.
Found: C, 86.59; H, 7.70.

Mesitoylmesitylacetylene was made also by condensing mesitoyl chloride with mesitylethynylmagnesium bromide. From 21.6 g. of mesitylacetylene and 28.5 g. of mesitoyl chloride was obtained 20 g. (46%) of slightly discolored mesitoylmesitylacetylene; m.p. 102–103°. An additional 7% of the product was recovered by distillation of the mother liquors.

Hydrogenation by the method of Adams and Voorhees (7) converted the acetylenic ketone to β-mesitylpropiomesitylene. A mixed melting point with a sample of the compound obtained by Fuson and McKeever (8) showed no lowering. A mixture of 1 g. of the saturated ketone with 30 ml. of syrupy phosphoric acid was heated under reflux for two days. The mesitylene was identified by conversion to the trinitro derivative, m.p. 236–237° (9). The β-mesitylpropionic acid, purified by recrystallization from high-boiling petroleum ether, melted at 111–112° (10).

Addition Reactions of Mesitoylphenylacetylene

A. *Methylmagnesium iodide.* A solution of 1 g. of the acetylenic ketone in 10 ml. of dry ether was added to a Grignard reagent prepared from 0.48 g. of magnesium of 3 ml. of methyl iodide. Heat was evolved but no appreciable color developed. The reaction mixture was heated under reflux for fifteen minutes and decomposed with dilute acetic acid. From the ether layer was obtained 0.68 g. (64%) of β-methylbenzalacetomesitylene; m.p. 84–85°. An additional 0.10 g. (9%) was recovered from the residue. A mixture with an authentic specimen (11) showed no lowering of the melting point.

B. *Phenylmagnesium bromide.* The procedure was similar to that used with the methyl Grignard reagent. Mixing of the reagents produced heat and a yellow color. After forty-five minutes of heating under reflux, the mixture was decomposed with a saturated solution of ammonium chloride. The β-phenylbenzalacetomesitylene melted at 101–103°. It did not depress the melting point (102°) of a sample of the compound made by the method of Kohler and Barnes (12).

When hydrogenated by the method of Adams the unsaturated ketone produced β,β-diphenylpropiomesitylene in 87% yield. It separated from methanol in shimmering white plates; m.p. 82.5–83°. Although this compound has long been known (1), the literature fails to record its melting point. Bromination converted the ketone to the known α-bromo-β,β-diphenylpropiomesitylene (1).

C. *Mesitylmagnesium bromide.* A solution of 1 g. of the ketone in 20 ml. of anhydrous ether was added to a Grignard reagent prepared from 0.48 g. of magnesium, 4.5 g. of bromomesitylene, and 20 ml. of dry ether. The addition was accompanied by the evolution of heat and the formation of a precipitate. Stirring and heating under reflux were continued for forty-five minutes during which time a red color developed. The precipitate was collected by filtration, washed with dry ether, and decomposed with a saturated ammonium chloride solution. The product was recrystallized from methanol; m.p. 118.5–119.5°; yield 67%. A mixture with the high-melting isomer of β-phenylmesitalacetomesitylene (see below) showed no lowering of the melting point. No trace of the low-melting isomer could be detected.

Mesitalacetomesitylene. This compound was prepared from mesitaldehyde and acetomesitylene as indicated by Kohler and Blanchard (3). These authors, however, gave no yield or experimental details. In the present work the following procedure was developed. Seventy-four grams of mesitaldehyde was added dropwise to a solution of 78 g. of acetomesitylene in 500 ml. of ethanol. During the three hours required for the addition the reaction mixture was stirred vigorously and maintained at 0°. The mixture was then allowed to come to room temperature and the stirring was continued for eighteen hours. The mesitalacetomesitylene was recrystallized from ethanol; yield 109 g.; m.p. 98.5–100°. An additional 18 g. of product was obtained from the mother liquors by distillation, the total yield being 90% of the theoretical amount. After repeated recrystallization from ethanol the product melted at 101°.

Anal. Calc'd for $C_{21}H_{24}O$: C, 86.25; H, 8.27.
Found: C, 86.46; H, 8.08.

Mesitalacetomesitylene was made also by condensing mesitaldehyde with the bromomagnesium enolate of acetomesitylene by a method patterned after that developed earlier for similar compounds (11, 13, 14).[2] The yields by this method, however, were only 39–50%.

β-Mesitylpropiomesitylene. A mixture of 0.5 g. of mesitalacetomesitylene, 0.2 g. of platinum oxide, and 50 ml. of absolute ethanol was shaken in an atmosphere of hydrogen under ordinary conditions for twenty-four hours. The amount of hydrogen which had been absorbed at the end of this time corresponded to that calculated to produce the saturated ketone. After the catalyst was removed by filtration the solvent was evaporated almost completely. The crude β-mesitylpropiomesitylene remaining as a residue was purified by recrystallization from methanol; m.p. 80–81° (8).

Mesitalpropiomesitylene. This ketone was made from mesitaldehyde and propiomesitylene by a procedure similar to that given for the synthesis of mesitalacetomesitylene from acetomesitylene and mesitaldehyde. The product, obtained in 51% yield, was purified by recrystallization from methanol; m.p. 80–81.5°.

Anal. Calc'd for $C_{22}H_{26}O$: C, 86.23; H, 8.55.
Found: C, 86.01; H, 8.32.

Condensation of mesitalacetomesitylene with methylmagnesium iodide. A Grignard reagent prepared from 2 g. of magnesium, 13 g. of methyl iodide, and 75 ml. of dry ether was added dropwise to a solution of 11.5 g. of mesitalacetomesitylene in anhydrous ether. After the addition was completed, the reaction mixture was heated under reflux for four hours and decomposed with a saturated solution of ammonium chloride. The β-mesitylbutyromesitylene was obtained in high yield as a viscous oil boiling at 200–206° (3 mm.). Kohler and Blanchard (3) had reported it to be a liquid boiling at 194° (1 mm.).

In an active hydrogen determination made on this liquid by use of the Grignard machine (15), 0.89 mole of methane was evolved per mole of compound.

When allowed to stand for a long time the oil crystallized and, after crystallization from dilute methanol, melted at 45–46°.

Anal. Calc'd for $C_{22}H_{28}O$: C, 85.66; H, 9.15.
Found: C, 85.48; H, 9.18.

Synthesis of β-mesitylbutyromesitylene from mesityl propenyl ketone. To a solution of mesitylmagnesium bromide prepared from 1.75 g. of magnesium, 14.6 g. of bromomesitylene, and 50 ml. of anhydrous ether was added dropwise 6.15 g. of mesityl propenyl ketone (16) in 25 ml. of dry ether. The mixture was heated under reflux for two hours and decomposed with ice and hydrochloric acid. The β-mesitylbutyromesitylene was distilled *in vacuo*;

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[2] This experiment was conducted by Dr. Norman Rabjohn.

b.p. 198–205° (3 mm.); yield 7 g. The oil was chilled and seeded with crystals of the product from mesitalacetomesitylene; in the course of several weeks it solidified. The crystals, when recrystallized from methanol, were found to melt at 42–44°; a mixture with the compound prepared in A melted at 44–46°.

β-Mesitylbutyromesitylene was cleaved by treatment with phosphoric acid in a manner similar to that described earlier for β-mesitylpropiomesitylene. Mesitylene was isolated and identified by conversion to its trinitro derivative; m.p. 234–237° (9). The β-mesitylbutyric acid was purified by sublimation at 130° (3 mm.). It crystallized from acetone in white needles; m.p. 86–87°.

Anal. Calc'd for $C_{13}H_{18}O_2$: C, 75.69; H, 8.79.
Found: C, 75.44; H, 8.82.

Synthesis of γ-mesitylbutyric acid. β-Mesitoylpropionic acid, prepared by the method of Meyer (17), was subjected to a Clemmensen reduction. A mixture of 2 g. of the keto acid, 4 g. of amalgamated zinc, 6 ml. of concentrated hydrochloric acid, and 3 ml. of glacial acetic acid was heated under reflux for ten hours, an additional 2 ml. of the hydrochloric acid being added every three hours. After the mixture had cooled, the product was removed by filtration and dissolved in sodium hydroxide solution. It was then reprecipitated, collected on a filter paper, and dried; yield 1.57 g.; m.p. 74–79°. Recrystallization of the crude product from an ethanol-water mixture yielded 0.4 g. of an acid melting at 163–164°. Dilution of the mother liquors caused the precipitation of about 1 g. of flaky white crystals melting at 87.5–89°. The neutralization equivalents of the high- and low-melting acids were, respectively, 207 and 204. The calculated value for γ-mesitylbutyric acid is 206. γ-Mesitylbutyric acid has been reported to melt at 87° (18). A mixture of the γ-mesitylbutyric acid (m.p. 87.5–89°) with the sample of β-mesitylbutyric acid (m.p. 86–87°) obtained by cleavage of β-mesitylbutyromesitylene sintered below 50° and was completely melted before a temperature of 71° was reached.

Unsuccessful attempts were made to prepare β-mesitylbutyric acid by the Grignard method. The addition of mesitylmagnesium bromide to ethyl crotonate and of methylmagnesium iodide to ethyl 2,4,6-trimethylcinnamate failed to yield the desired 1,4-addition products. The ethyl 2,4,6-trimethylcinnamate was prepared from mesitaldehyde and ethyl acetate by the method of Claisen (19) except that powdered sodium ethoxide was used as the catalyst in place of metallic sodium. The yield of ester was 73%; m.p. 39–40°.

1,3-Dimesityl-1-buten-1-ol peroxide. The procedure was similar to that used by Kohler, Tishler, and Potter (13). A solution of 14.6 g. of mesitalacetomesitylene and 110 ml. of dry ether was added slowly to a solution of methylmagnesium iodide prepared from 16 g. of methyl iodide and 2.64 g. of magnesium. After the addition was completed, the reaction mixture was heated under reflux for an hour, cooled, and poured into a mixture of ice and hydrochloric acid. The resulting mixture was extracted with 50-ml. portions of low-boiling petroleum ether until about 500 ml. of solution was obtained. After being washed with ice-water this solution was placed in a graduated cylinder surrounded by ice. Oxygen was bubbled through the solution for eight hours at 0°, cold low-boiling petroleum ether being added from time to time to replace that lost by evaporation. The solution was poured into a beaker and the solvent removed by evaporation in a stream of air. The crystals which formed were triturated with a little cold low-boiling petroleum ether, collected on a filter, and washed with a small amount of the petroleum ether. A yield of 11.2 g. of white solid (m.p. 84–92°) was obtained; yield 66%. Successive recrystallizations from a mixture of low-boiling petroleum ether and ether, from low-boiling petroleum ether, and from a methanol-water mixture yielded white, rhombohedral prisms; m.p. 93–94.5°.

Anal. Calc'd for $C_{22}H_{28}O_3$: C, 77.61; H, 8.29.
Found: C, 77.88; H, 8.36.

From the residues of the first recrystallization of the peroxide was obtained a second peroxide melting, after recrystallization from a methanol-water mixture and from a mixture of low- and high-boiling petroleum ether, at 119°.

Anal. Calc'd for $C_{22}H_{28}O_3$: C, 77.61; H, 8.29.
Found: C, 77.62; H, 8.57.

The high-melting peroxide was obtained in much smaller amount than the low-melting isomer. These compounds separated from solvents very slowly and in dense, well-formed crystals. Gas was evolved slowly when the compounds melted, suggesting that the points observed may have been decomposition points. However, a mixture of the two isomers melted several degrees below the melting point of the low-melting isomer.

The same peroxides were formed from the enolates resulting from the addition of mesitylmagnesium bromide to mesityl propenyl ketone.

Thermal decomposition of the low-melting peroxide yielded a mixture from which only mesitoic acid could be isolated. It was obtained in a yield of 56%.

Addition Reactions of Mesitoylmesitylacetylene

A. *Methylmagnesium iodide.* A solution of 4.39 g. of the acetylene in the minimum quantity of dry ether was added slowly, with stirring, to a Grignard reagent prepared from 1.08 g. of magnesium and 6.5 g. of methyl iodide. The mixture was heated under reflux, with stirring, for one hour and decomposed with a saturated solution of ammonium chloride. The β-methylmesitalacetomesitylene, isolated by conventional procedures, was distilled in a small molecular still. The distillate set to a pale yellow, slightly greasy solid; yield 4.20 g. (91%); m.p. 89–97°. Fractional crystallization from methanol yielded 3.28 g. (72%) of the solid (A) melting at 101–103° and 0.13 g. (2.9%) of a solid (B) melting at 75–76°.

Isomer A was purified by recrystallization from methanol and low-boiling petroleum ether. It formed pale yellow, rectangular plates melting at 104°.

Anal. Calc'd for $C_{22}H_{26}O$: C, 86.23; H, 8.55.
Found: C, 85.88; H, 8.55.

Isomer B crystallized from methanol as white needles; m.p. 77–78°.

Anal. Calc'd for $C_{22}H_{26}O$: C, 86.23; H, 8.55.
Found: C, 86.30; H, 8.63.

Neither isomer gave positive tests for unsaturation with potassium permanganate or bromine in carbon tetrachloride. In the bromine test isomer B gave hydrogen bromide. The isomers were recovered unchanged after being heated at 200° for thirty minutes; at higher temperatures isomer A underwent slow decomposition.

Attempts to reduce isomer A to β-mesitylbutyromesitylene by the Adams method or by the use of Raney nickel at 125 atmospheres were unsuccessful. Isomer B appeared to to undergo hydrogenation very slowly under ordinary conditions in the presence of the Adams catalyst (7), but no product could be isolated.

An attempt to reduce isomer A with zinc and glacial acetic acid by the procedure of Kohler and Thompson (20) converted isomer A to a mixture of isomers A and B. It was then observed that acids converted A to B. When the addition product of methylmagnesium iodide and mesitoylmesitylacetylene was decomposed with hydrochloric acid, isomer B was produced with the virtual exclusion of isomer A.

An attempt to make the oxido derivative of isomer A by the method of Weitz and Scheffer (21) failed; the product was a mixture of isomers A and B.

In the Kohler-Richtmyer apparatus (15) neither isomer gave gas at room temperature, but at higher temperatures enolization appeared to occur with both isomers. In the case of isomer A the amount of methane evolved when heat was applied corresponded to 0.85 mole. More than half of the material was recovered in the form of isomer B, but no addition compound could be detected. When isomer A was treated with methylmagnesium iodide on a larger scale the product was a mixture of isomers A and B.

Attempts to cleave isomer A by ozonolysis failed.

B. *Phenylmagnesium bromide.* The procedure was very similar to that used to condense mesitylmagnesium bromide with mesitoylphenylacetylene and the product, m.p. 119–120°, proved to be the same—the high-melting form of β-phenylmesitalacetomesitylene.

C. *Mesitylmagnesium bromide.* The reaction mixture was heated under reflux for twelve hours and decomposed with ice and hydrochloric acid. The β-mesitylmesitalacetomesitylene, when recrystallized from methanol, formed yellow needles melting at 156–157° (35%).

Anal. Calc'd for $C_{30}H_{34}O$: C, 87.75; H, 8.35.
Found: C, 87.95; H, 8.17.

Along with the yellow needles was obtained a white solid melting, after recrystallization from high-boiling petroleum ether, at 182–183°.

Anal. Calc'd for $C_{30}H_{36}O$: C, 87.33; H, 8.80.
Found: C, 87.26; H, 8.58.

With sulfuric acid this compound gave an intense purple color. It was not investigated further.

Condensation of mesitalacetomesitylene with phenylmagnesium bromide. The procedure was similar to that used with the methyl Grignard reagent. Evaporation of the solvent left a yellow oil which had the odor of phenol. The residue was heated on a steam-bath and simultaneously exposed to a stream of dry air until the odor of phenol had disappeared. When cooled, the crude β-phenyl-β-mesitylpropiomesitylene gradually crystallized. The oily solid was dissolved in 75 ml. of ethanol and the solution chilled; the solid which separated melted at 88–90°. Subsequent recrystallization from 30 ml. of ethanol produced 3.2 g. of white, rhombohedral crystals; m.p. 91.5–92°. The analytical sample melted at 92°.

Anal. Calc'd for $C_{27}H_{30}O$: C, 87.52; H, 8.16.
Found: C, 87.66; H, 8.50.

Synthesis of β-phenyl-β-mesitylpropiomesitylene from benzalacetomesitylene. A solution of 5 g. of benzalacetomesitylene in 25 ml. of dry ether was added slowly, with stirring, to a Grignard reagent made from 0.96 g. of magnesium, 8 g. of bromomesitylene, and 30 ml. of dry ether. The reaction mixture was heated under reflux for five hours and decomposed with 5 ml. of saturated ammonium chloride solution. The β-phenyl-β-mesitylpropiomesitylene was isolated by a procedure similar to that described earlier and was found to be identical with the product obtained from mesitalacetomesitylene.

Condensation of mesitalacetomesitylene with mesitylmagnesium bromide. A solution of 8.42 g. of mesitalacetomesitylene, 20 ml. of benzene, and 10 ml. of dry ether was added over a period of ten minutes to a Grignard solution containing approximately 0.1 mole of mesitylmagnesium bromide in 100 ml. of ether. After the addition was completed the solution was heated under reflux for one hour and decomposed with 13.5 ml. of a saturated solution of ammonium chloride. The organic layer was decanted from precipitated magnesium salts, washed, dried, and concentrated by evaporation of the solvents in a stream of air. The residual oil was dissolved in 40 ml. of methanol and the solution chilled. The crystals which formed were collected on a filter and washed with methanol; m.p. 90–94°; yield 46%. Recrystallization successively from methanol, ethanol, low-boiling petroleum ether, and nitromethane finally yielded pure β,β-dimesitylpropiomesitylene in the form of colorless, rectangular prisms; m.p. 98–100°.

Anal. Calc'd for $C_{30}H_{36}O$: C, 87.33; H, 8.80.
Found: C, 87.14; H, 8.68.

Condensation of mesitalpropiomesitylene with mesitylmagnesium bromide. A solution of 8.9 g. of mesitalpropiomesitylene in 25 ml. of benzene was added to 0.08 mole of mesitylmagnesium bromide in 100 ml. of ether. The solution was heated under reflux for one hour and decomposed with ice and hydrochloric acid. An unsuccessful attempt was made to prepare the peroxide by use of the procedure described earlier for 1,3-dimesityl-1-butenol peroxide. Removal of solvents left a viscous yellow oil which in the course of two days set to a pasty mass. It was cooled and triturated with 25 ml. of low-boiling petroleum ether. The solid α-methyl-β,β-dimesitylpropiomesitylene was collected on a filter, washed twice with 10-ml. portions of petroleum ether, and dried; m.p. 142.5–144.5°; yield 46%. The ketone was contaminated with a yellow substance, possibly α-methyl-β-mesitylmesitalacetomesitylene produced by oxidation of the enol, which could be removed only by repeated recrystallization. The crude product gave a red color with concentrated sulfuric acid, which is characteristic of *beta* diaryl chalcones and also of peroxides such as the one sought. The pure ketone was colorless and gave no color with sulfuric acid; m.p. 146–147°.

Anal. Calc'd for $C_{31}H_{38}O$: C, 87.27; H, 8.98.
Found: C, 87.32; H, 9.01.

The isomeric α-bromo-β-phenyl-β-mesitylpropiomesitylenes. These ketones were prepared by a method developed by Kohler (1) to make similar compounds. To the ice-cold solution of the enolate prepared from 14.6 g. (0.05 mole) of mesitalacetomesitylene and 0.15

mole of phenylmagnesium bromide was added 0.15 mole of bromine in carbon tetrachloride solution. The white crystalline product was collected on a filter; yield 19.2 g. (86%); m.p. 134–140°. The two isomers were separated by recrystallization from dioxane and purified by recrystallization from ethanol. The less soluble and less abundant isomer melted at 150–151°.

Anal. Calc'd for $C_{27}H_{29}BrO$: C, 72.15; H, 6.50.
Found: C, 71.90; H, 6.59.

The more soluble isomer, even after repeated recrystallization, was not entirely pure; m.p. 139–141°.

Anal. Calc'd for $C_{27}H_{29}BrO$: C, 72.15; H, 6.50.
Found: C, 69.79; H, 6.41.

The isomeric β-phenylmesitalacetomesitylenes. A mixture of the high-melting form of α-bromo-β-mesityl-β-phenylpropiomesitylene and 2 g. of potassium hydroxide (dissolved in 1 ml. of water and 20 ml. of absolute ethanol) was heated under reflux for thirty-one hours. The unsaturated ketone was precipitated by the addition of water and recrystallized from methanol as yellow needles; yield 0.69 g.; m.p. 97–98.5°. After repeated recrystallization the compound melted at 99.5–101.5°.

Anal. Calc'd for $C_{27}H_{28}O$: C, 88.00; H, 7.66.
Found: C, 87.79; H, 7.55.

A similar treatment converted the low-melting bromo ketone to an isomeric β-phenylmesitalacetomesitylene in approximately the same yield. This isomer separated from methanol as square, yellow plates; m.p. 120.5–121°.

Anal. Calc'd for $C_{27}H_{28}O$: C, 88.00; H, 7.66.
Found: C, 87.87; H, 7.79.

In one experiment this isomer was obtained by isomerization of the low-melting isomer during recrystallization from methanol. Both isomers gave a characteristic red color with concentrated sulfuric acid. Attempts to hydrogenate the high-melting isomer by the method of Adams and Voorhees (7) were unsuccessful; the compound was recovered unchanged.

β-Mesitylmesitalacetomesitylene. The procedure was similar to that used for β-phenylmesitalacetomesitylene. From 29.6 g. of mesitalacetomesitylene was obtained a 62% yield of the colorless bromo ketone; m.p. 120–124°. It proved to be very difficult to purify and was used in crude form (m.p. 124–126°) to prepare the unsaturated ketone. It separated from methanol as yellow needles; yield 40%; m.p. 150–153°. After repeated recrystallization from methanol the compound melted at 156–157°; a mixture melting point with the sample made earlier showed the two to be the same.

In attempts to condense β-mesitylmesitalacetomesitylene with mesitylmagnesium bromide a reddish-brown color developed but the unsaturated ketone was recovered unchanged. In one run, in which a few drops of methyl iodide had been added to start the formation of the Grignard reagent, colorless, rectangular plates were obtained; m.p. 173.5–175°. They gave an intense color with sulfuric acid.

Anal. Calc'd for $C_{31}H_{38}O$: C, 87.27; H, 8.98.
Found: C, 87.25; H, 9.18.

The amount of this product was too small to permit identification and it could not be made again even when methylmagnesium iodide was used in excess. The composition, however, does correspond to that of the expected β,β-dimesitylbutyromesitylene.

Attempted addition of mesitylmagnesium bromide to β-phenylbenzalacetomesitylene. When the unsaturated ketone was added to a solution of mesitylmagnesium bromide a bright red color developed. When the mixture was heated for two days in a benzene-ether solvent reaction appeared to take place and the major part of the unsaturated ketone could not be recovered. Yet no crystalline product could be isolated.

Reaction of dimesitoylmethane with methylmagnesium iodide. A mixture of the diketone with eight equivalents of the Grignard reagent in ether was heated under reflux for eight hours. Although the enolate remained in solution, the diketone was recovered when the mixture was decomposed. The diketone was recovered unchanged also after long treatment with the reagent at 130–140° in *n*-butyl ether.

SUMMARY

1,4-Addition of the Grignard reagent to acetylenic ketones has been realized. Mesitoylphenylacetylene has been found to undergo 1,4-addition with the methyl, phenyl, and mesityl Grignard reagents.

It has been demonstrated, further, that a mesityl group in the *beta* position does not prevent 1,4-addition of the Grignard reagent to this type of ketone. Methyl, phenyl, and even mesityl Grignard reagents have been added to mesitoylmesitylacetylene in this manner.

URBANA, ILL.

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