# GRIGNARD REACTIONS OF MESITYL 2-NAPHTHYL KETONES

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The outstanding example, from the standpoint of ease, of conjugate addition of a Grignard reagent to a diaryl ketone was observed in the naphthalene series. 1-Methyl-1,2-dihydro-2-naphthyl mesityl ketone (II,  $R = CH_3$ ) was obtained from mesityl 2-naphthyl ketone (I) and methylmagnesium iodide in a 74% yield (1).



This paper reports the results of attempts to determine whether the ease with which the reaction occurs is general for Grignard reagents. Further, it seemed that methoxyl replacement, already observed with mesityl 2-methoxy-1naphthyl ketone (2), might be achieved with corresponding ease with mesityl 1-methoxy-2-naphthyl ketone (III).



We have found that the methoxy ketone (III) reacts readily with both aliphatic and aromatic Grignard reagents and that the corresponding alkyl or aryl ketones (IV) are formed in yields varying from 56 to 91%. The results, summarized in Table I, give support to the idea that methoxyl group replacement occurs more readily in the naphthalene than in the benzene series. The reactions proceed rapidly and appear to be complete within a few minutes.



The hydroxy ketone (V) was made by heating 1-naphthyl mesitoate (VI) with aluminum chloride. Treatment of the phenol with methyl sulfate in the presence of sodium hydroxide converted it to the corresponding methyl ether

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(III). The structure of the methoxy compound was established by treatment with methylmagnesium iodide, which produced the known mesityl 1-methyl-2-naphthyl ketone (2).

Conjugate addition of various Grignard reagents to mesityl 2-naphthyl ketone (I) proved to be more difficult to effect. The most satisfactory results were obtained with phenylmagnesium bromide, mesityl 1,2-dihydro-1-phenyl-2-naphthyl ketone (II,  $R = C_6H_5$ ) being isolated in an 84% yield.

The *p*-tolyl and *p*-isopropylphenyl derivatives were obtained also. In these experiments the reaction products were heated with hydrochloric acid to bring about ketonization, and the resulting dihydro compounds were dehydrogenated over a palladium-charcoal catalyst.

Excepting methylation, which had been accomplished earlier (1), alkylation gave negative or anomalous results. A benzyl derivative was obtained but could not be dehydrogenated. It gave a derivative with methylmagnesium iodide, which suggested that it had an olefinic bond in conjugation with the carbonyl group as in structure VII.



The melting points of the benzyl compound and its methyl derivatives were high; it may be that they are binaphthyl derivatives.

#### EXPERIMENTAL

1-Naphthyl mesitoate. This ester was prepared by treating 1-naphthol with mesitoyl chloride. From 42.7 g. of the chloride and 34 g. of the naphthol there was obtained 60.8 g. (89.5%) of the ester. When recrystallized from ethanol, 1-naphthyl mesitoate forms white plates, m.p. 90-91°.

Anal.<sup>2</sup> Calc'd for C<sub>20</sub>H<sub>12</sub>O<sub>2</sub>: C, 82.73; H, 6.25.

Found: C, 82.85; H, 6.34.

1-Hydroxy-2-naphthyl mesityl ketone. A mixture of 15 g. of 1-naphthyl mesitoate and 6.3 of anhydrous aluminum chloride was powdered in a mortar and placed in a flask set in an oil-bath at 100°. The mixture was stirred, and the temperature of the bath was raised to 150° over a period of 10 minutes. Heating was accompanied by the evolution of hydrogen chloride and softening of the mixture to a viscous tar which prevented stirring. The temperature of the mass was held at 150° for 30 minutes. Then glacial acetic acid (50 ml.) and 15 ml. of water were added, and the mixture was heated under reflux, with stirring. The hardened mass was gradually converted to a yellow, crystalline solid. The hydroxy ketone weighed 12.5 g. (83%), m.p. 153-155°. It was recrystallized from ethanol; m.p. 156-156.5°.

Anal. Calc'd for C20H18O2: C, 82.73; H, 6.25.

Found: C, 82.62; H, 6.22.

In a number of runs involving the use of larger amounts of the catalyst small amounts of a yellow solid were obtained. After recrystallization from glacial acetic acid, this compound melted at 211.5–212.5°. Its solution in a chloroform-ethanol mixture (1:1 by volume) gave

<sup>&</sup>lt;sup>2</sup> The microanalyses were carried out by Miss Emily Davis and Miss Rachel Kopel.

a deep brown color when treated with a drop of 5% ferric chloride solution. It has the composition of 4,4'-dihydroxy-2,2'-dimesitoyl-1,1'-binaphthyl.

Anal. Calc'd for C<sub>40</sub>H<sub>34</sub>O<sub>4</sub>: C, 83.02; H, 5.92.

Found: C, 83.26; H, 5.81.

Mesityl 1-methoxy-2-naphthyl ketone. A mixture of 12.5 g. of 1-hydroxy-2-naphthyl mesityl ketone, 125 ml. of methanol, 2 g. of sodium hydroxide, and 25 ml. of water was heated until it began to reflux gently. To the mixture, which was homogeneous and light red in color, 6.3 g. of methyl sulfate was added in portions over a period of 5 hours. The solution was maintained at reflux temperature and was stirred vigorously during the reaction. A precipitate appeared within an hour after addition of the sulfate was begun. Additional portions of 10% sodium hydroxide solution were added from time to time during the addition of the sulfate. After 5 more hours at reflux temperature the mixture contained a heavy suspension of yellow solid and was still basic. An additional gram of methyl sulfate was added and later two additional portions of sodium hydroxide solution were introduced. The total reaction time was 23 hours and the total amounts of sodium hydroxide and methyl sulfate were 2.9 g. and 7.3 g., respectively.

The solid, which was a mixture of the ether and unchanged phenol, was treated with a hot mixture of methanol and 10% sodium hydroxide solution to convert the phenol to its sodium salt, most of which appeared as a precipitate. Dilution of the methanol solution with water precipitated the remainder of the salt along with the ether. The mixture of solids was dried and boiled with high-boiling petroleum ether, which removed the methoxy compound. The highest yield of the ether was 41%. The pure compound was obtained by recrystallization from ethanol; m.p.  $134-135^{\circ}$ .

Anal. Cale'd for C<sub>21</sub>H<sub>10</sub>O<sub>2</sub>: C, 82.86; H, 6.62.

Found: C, 82.89; H, 6.87.

Mesityl 1-methyl-2-naphthyl ketone. The method was patterned after that of Fuson and Speck (2). A solution of 0.5 g. of mesityl 1-methoxy-2-naphthyl ketone in a mixture of 15 ml. of ether and 20 ml. of benzene was added to a Grignard reagent prepared from 1.2 g. of methyl iodide, 0.2 g. of magnesium, and 35 ml. of dry ether. After being stirred at reflux temperature for 2.5 hours, the mixture was decomposed with ice and hydrochloric acid. The product, separated by conventional procedures, crystallized from ethanol in colorless needles; m.p. 98.5-99.5°. A mixture melting point with an authentic specimen of mesityl 1-methyl-2-naphthyl ketone (1) showed no depression.

Reaction of Grignard reagents with mesityl 1-methoxy-2-naphthyl ketone. The procedure employed in these reactions is illustrated by that with benzylmagnesium chloride. A solution of 1.1 g. of the ketone in a mixture of 25 ml. of ether and 25 ml. of benzene was added, with stirring, to a Grignard reagent prepared from 0.2 g. of magnesium, 0.9 of redistilled benzyl chloride, and 70 ml. of ether. The mixture, which was first greenish-yellow in color and then yellow, was heated under reflux for 1 hour. The 1-benzyl-2-naphthyl mesityl ketone was isolated by conventional procedures. Information relative to this and other ketones made by this method is summarized in Table I.

1,2-Dihydro-1-phenyl-2-naphthyl mesityl ketone. A solution of 13.7 g. of mesityl 2-naphthyl ketone in 75 ml. of anhydrous benzene was introduced over a 15-minute interval into a well-stirred Grignard reagent made from 2.4 g. of magnesium, 15.7 g. of bromobenzene, and 75 ml. of dry ether. The mixture, initially dark green and finally wine-red in color, was heated for 6 hours under reflux under a stream of oxygen-free nitrogen. The mixture was cooled, and 75 ml. of 2.4 N hydrochloric acid was added. The organic layer was light yellow in color and the aqueous layer was colorless. The two-phase system was heated under reflux for 15 hours, with stirring, in an atmosphere of nitrogen. The 1,2-dihydro-1-phenyl-2-naphthyl mesityl ketone, isolated by conventional procedures, was recrystallized from methanol; m.p. 140-141°; 84% yield.

Anal. Calc'd for C26H24O: C, 88.60; H, 6.86.

Found: C, 88.35; H, 6.98.

Mesityl 1-phenyl-2-naphthyl ketone. A mixture of 10 g. of mesityl 1,2-dihydro-1-phenyl-

2-naphthyl ketone and 1.5 g. of 10% palladium-charcoal catalyst was heated in a nitrogenswept vessel at 300°. The temperature was raised gradually over a period of 45 minutes and was held at 295-305° for 25 minutes. The reaction mass was leached with warm benzene and the solution filtered. After removal of the solvent the residual, colorless oil was dissolved in warm ethanol. A mass of white needles weighing 8.5 g. formed when the mixture was allowed to stand in the refrigerator. They softened at 55°, then became jelly-like, and finally liquefied completely near 64°. No definite melting point was observed after the compound had been recrystallized repeatedly from ethanol. The composition corresponds to that calculated for the expected ketone solvated with ethanol.

Anal. Calc'd for  $C_{26}H_{22}O \cdot \frac{2}{3}C_{2}H_{5}OH: C, 86.13; H, 6.88.$ 

Found: C, 86.39; H, 7.07.

A sample, after being heated above its melting point for 12 hours in an evacuated drying pistol, was recrystallized from low-boiling petroleum ether. It formed colorless prisms, m.p. 78-79°. Another sample of the solvated, white needles was dissolved in 200 ml. of

SUBSTITUENT	м.р., °С.	YIELD, %	ANALYSES			
			Calc'd		Found	
			С	H	С	н
1-Methyl <sup>a</sup>	98.5-99.5	74				
1-Ethyla	122	73	87.37	7.33	87.34	7.51
1-Benzyl <sup>a</sup>	154.5 - 155	91	88.97	6.64	88.96	6.77
1-Phenyl <sup>b</sup>	78-79	69	89.11	6.32	89.36	6.42
1-p-Tolyla	137-138	75	88.97	6.64	88.90	6.52
1-p-Isopropylphenyl <sup>c</sup>	186 - 188.5	56	88.73	7.19	88.87	7.29

TABLE I

SUBSTITUTED MESITYL 2-NAPHTHYL KETONES

• Recrystallized from ethanol. • Recrystallized from petroleum ether. • Recrystallized from nitromethane.

high-boiling petroleum ether and the solvent evaporated in an open beaker on a hot plate. The residue, recrystallized from low-boiling petroleum ether, melted at 78–79°. Mixture melting points of these samples with that from mesityl 1-methoxy-2-naphthyl ketone showed no depression.

Anal. Cale'd for C<sub>28</sub>H<sub>22</sub>O: C, 89.11; H, 6.32.

Found: C, 89.36; H, 6.42.

When the ketone was recrystallized from ethanol the solvated form (m.p.  $55-64^{\circ}$ ) was produced.

Treatment of mesityl 2-naphthyl ketone with other Grignard reagents. p-Tolyl and p-isopropylphenyl Grignard reagents gave dihydro derivatives which were oils. Dehydrogenation, however, converted the dihydro derivatives to the corresponding aromatic compounds. 1-(p-Tolyl)-2-naphthyl mesityl ketone, obtained in 48% yield, melted at 130-134°. After four recrystallizations from ethanol, the compound melted at 137-138°. 1-p-(Isopropylphenyl)-2-naphthyl mesityl ketone, obtained in 44% yield, melted at 182-185°. It was purified by recrystallization from nitromethane and from ethanol; m.p. 186-188.5°. These compounds were shown by the method of mixture melting points to be identical with those obtained from the methoxy ketone.

Attempts to prepare cyclohexyl, benzyl, and *p*-chlorobenzyl derivatives by the procedure outlined for the phenylated ketone proved unavailing, the products being intractable oils.

Benzylmagnesium chloride reacted with the ketone to yield a small quantity of a solid

646

product, which was recrystallized from methanol. However, it did not have a reproducible melting point, the highest being 188.5–189.5°.

Anal. Calc'd for C<sub>27</sub>H<sub>26</sub>O: C, 88.48; H, 7.15.

Found: C, 88.66; H, 6.88.

Attempts to dehydrogenate the compound gave an oily product which could not be identified. Reaction with methylmagnesium iodide yielded a solid, which was recrystallized from a benzene-ethanol mixture and then from a mixture of chloroform and methanol; m.p. 245-246°.

Anal. Calc'd for C<sub>28</sub>H<sub>30</sub>O: C, 87.91; H, 7.91.

Found: C, 87.91; H, 7.66.

The infrared spectrum indicated a singly conjugated ketone group and no hydroxyl group.<sup>3</sup>

## SUMMARY

Mesityl 1-methoxy-2-naphthyl ketone has been prepared and treated with Grignard reagents. In this way the methoxyl group has been replaced by methyl, ethyl, benzyl, phenyl, *p*-tolyl, and *p*-isopropylphenyl radicals.

Efforts to prepare the same derivatives by dehydrogenation of products obtained by the action of Grignard reagents on mesityl 2-naphthyl ketone were successful only with the three aryl derivatives.

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### REFERENCES

(1) FUSON, MCKUSICK, AND SPANGLER, J. Am. Chem. Soc., 67, 597 (1945).

(2) FUSON AND SPECK, J. Am. Chem. Soc., 64, 2446 (1942).

<sup>3</sup> The infrared spectra were determined and interpreted by Miss Elizabeth Petersen and Mrs. J. L. Johnson.