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SOME NEW 1,7-DISUBSTITUTED FLUORENONES

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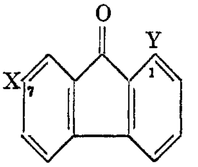
In a recent publication in this Journal, the direct nitration of fluorenone-1-arsonic acid was described (1). The principal product was thought to be 7-nitrofluorenone-1-arsonic acid (I) although no conclusive structure proof was offered. Subsequently it was established (2) that the nitration of fluorenone-1-carboxylic acid resulted in the formation of 7-nitrofluorenone-1-carboxylic acid (II). The present research describes the transformation of this nitrocarboxylic acid into some new 1,7-disubstituted fluorenones and the indirect synthesis of 7-nitrofluorenone-1-arsonic acid of unequivocal structure.

By the standard route proceeding through the acid chloride (III) and the acid amide (IV), 1-amino-7-nitrofluorenone was obtained by the Hofmann degradation. This nitroamine was then transformed into the corresponding arsonic acid (I) which, when treated with phosphorus trichloride, gave 7-nitrofluorenone-1-dichloroarsine (VI), a yellow crystalline compound melting at 215–217°. This melting point is identical with that of the nitrodichloroarsine obtained from the direct nitration product of fluorenone-1-arsonic acid (1), and a mixture melting point of the two showed no depression.



I. X = NO_2 Y = AsO_3H_2
II. X = NO_2 Y = COOH
III. X = NO_2 Y = COCl
IV. X = NO_2 Y = $CONH_2$
V. X = NO_2 Y = NH_2
VI. X = NO_2 Y = $AsCl_2$
VII. X = NH_2 Y = COOH
VIII. X = $NHCOCH_3$ Y = COOH
IX. X = Br Y = COOH
X. X = NO_2 Y = $NHCOCH_3$
XI. X = NO_2 Y = Br
XII. X = NH_2 Y = NH_2
XIII. X = NO_2 Y = $COOCH_3$
XIV. X = NO_2 Y = $COOC_2H_5$

Reduction of 7-nitrofluorenone-1-carboxylic acid with sodium sulfide or ferrous hydroxide gave 7-aminofluorenone-1-carboxylic acid (VII) of unexpected color. The purified material is a gray-black solid, giving a magenta solution in ethanol in which it is sparingly soluble. Now 2-aminofluorenone is a purple solid showing a red color in alcohol; and fluorenone-1-carboxylic acid is yellow-orange, dissolving in alcohol to give a yellow solution. Apparently, the resonance contribution of the two functional groups located in the separate aromatic rings makes for a wide-range color absorption. The fluorenone series is a notorious case of wide variation in color, extreme differences resulting from the change

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in the position of a single functional group in the aromatic ring. For example, 2-aminofluorenone is a purple solid, while 1-aminofluorenone is a deep yellow.

Acetylation of the aminocarboxylic acid with acetic anhydride gave 7-acetaminofluorenone-1-carboxylic acid (VIII) while diazotization of the amine followed by decomposition in cuprous bromide-hydrochloric acid medium gave 7-bromofluorenone-1-carboxylic acid (IX). This bromo compound has been previously prepared (3) by the addition of fluorenone-1-carboxylic acid to elemental bromine. Our melting point was two degrees higher than that previously reported.

Acetylation of 1-amino-7-nitrofluorenone in acetic anhydride gave the corresponding acetamino derivative (X), while diazotization of the nitroamine followed by treatment with cuprous bromide and hydrobromic acid produced 1-bromo-7-nitrofluorenone (XI). Reduction of the nitroamine with sodium sulfide in alkaline ethanol resulted in the formation of 1,7-diaminofluorenone (XII).

Finally, the methyl and ethyl esters (XIII, XIV) of 7-nitrofluorenone-1-carboxylic acid were prepared.

EXPERIMENTAL

Note: Analyses for aminoid nitrogen were made by micro Kjeldahl procedures of Niederl and Niederl (4). Nitro nitrogen determinations were made by micro Kjeldahl procedures of Elek and Sobotka (5). Halogen determinations were done by Parr Bomb methods (6). Melting points were obtained with a calibrated thermometer using an aluminum block.

7-Nitrofluorenone-1-carboxylic acid. This was prepared by the reaction of fluorenone-1-carboxylic acid (7, 8) with mixed acid as described by Garascia, Fries, and Ching (2).

The corresponding *acid chloride* was obtained by refluxing the acid with five times its weight of purified thionyl chloride (9) for eight hours. The resulting solution was cooled, diluted to twice its volume with petroleum ether (b.p. 55–70°), and the resulting slurry was filtered, washed with petroleum ether, and dried. The compound melted at 206–210° and was obtained in 95% yield.

Anal. Calc'd for $C_{14}H_6ClNO_4$: Cl, 12.33. Found: Cl, 12.34.

The *acid amide* was prepared by mixing 10 g. (0.034 mole) of the acid chloride with 250 ml. of concentrated ammonium hydroxide, and allowing the mixture to stand overnight. After filtering, washing with water, and drying, the crude amide was obtained in quantitative yield melting at 262–270°. Recrystallized from chlorobenzene, it melted at 282°.

Anal. Calc'd for $C_{14}H_8N_2O_4$: N, 10.44. Found: N, 10.35.

1-Amino-7-nitrofluorenone. The chlorine gas evolved from the addition of an excess of conc'd hydrochloric acid to 1.08 g. (0.0068 mole) of potassium permanganate was passed into an ice-cold solution of 4.32 g. of sodium hydroxide in 80 ml. of water. Then 5 g. (0.018 mole) of 7-nitrofluorenone-1-carboxamide was added to this solution, kept ice-cold, in small portions with vigorous stirring. After two hours the mixture was kept at 80° for three more hours, cooled, and then made strongly basic by the addition of 50% sodium hydroxide solution. The reaction mixture was then filtered, and the crude amine was washed with hot water and recrystallized from 80% acetic acid to give 2.9 g. of the orange product, melting at 207–208°, 66.5% yield.

Anal. Calc'd for $C_{13}H_8N_2O_3$: N, 11.60. Found: N, 11.70.

7-Nitrofluorenone-1-arsonic acid. 1-Amino-7-nitrofluorenone (5 g., 0.021 mole) was dissolved in 75 ml. of acetic acid and added, with stirring, to 160 ml. of 12 *N* hydrochloric acid. To the cooled suspension (0–10°) was added, over a period of one hour with stirring, a solution of 1.7 g. (0.026 mole) of sodium nitrite dissolved in 50 ml. of water, and stirring was continued at 10° for 90 more minutes. This cold solution was added, in small portions, to a chilled solution of 4.1 g. (0.021 mole) arsenic trioxide, 4.1 g. of sodium bicarbonate, 70 g. of sodium hydroxide, and 1 g. of $CuSO_4 \cdot 5H_2O$ in 200 ml. of water, and stirring was continued for another two hours. The mixture was then warmed to drive out nitrogen, filtered, and the filtrate was acidified with 6 N hydrochloric acid. The free arsonic acid was filtered, washed with water, dissolved in a dilute solution of sodium bicarbonate, treated with decolorizing carbon, and recovered by acidification. The purified compound weighed 1.0 g. (14% yield).

Anal. Calc'd for $C_{13}H_8AsNO_6$: N, 4.01. Found: N, 4.21.

7-Nitrofluorenone-1-dichloroarsine. One gram (0.0026 mole) of 7-nitrofluorenone-1-arsonic acid was suspended in 10 ml. of glacial acetic acid, warmed to 100°, and a solution of 1 ml. (0.008 mole) of phosphorus trichloride in 5 ml. of acetic acid was added slowly with swirling, a clear solution resulting. The material was then heated near reflux for 5 minutes, treated with decolorizing carbon, filtered hot, and allowed to cool. The dichloroarsine was obtained in yellow needles, 60% yield, 0.6 g., melting at 215–217°.

Proof of structure of x-nitrofluorenone-1-dichloroarsine. A melting point was taken of a mixture of 7-nitrofluorenone-1-dichloroarsine and the nitrodichloroarsine prepared from the nitration product of fluorenone-1-arsonic acid. The recorded melting point of the latter dichloroarsine is 215–217° (1). No depression of the melting point was observed.

7-Aminofluorenone-1-carboxylic acid. 7-Nitrofluorenone-1-carboxylic acid (5 g., 0.0186 mole) was added to a solution of 60 ml. of ammonium hydroxide, 180 ml. of water, 30 ml. of ethanol, and 1 g. of ammonium chloride. The mixture was warmed until solution of the nitrocarboxylic acid was complete, and a solution of 20 g. (0.026 mole) of $Na_2S \cdot 9H_2O$ in 100 ml. of water was slowly added. After one hour, the solution was acidified, filtered to remove sulfur, and the filtrate was treated with decolorizing carbon, and the aminocarboxylic acid precipitated by careful acidification with hydrochloric acid. Recrystallization from dilute sodium hydroxide gave 2.5 g. (56.3% yield) of the black 7-aminofluorenone-1-carboxylic acid. The compound decomposes without melting. Placing the compound on a metal block at a temperature of 194° causes the compound to melt with decomposition.

Alternately, the nitro compound can be reduced by heating on the water-bath for one hour with an aqueous solution of 8 parts of technical ferrous sulfate made alkaline with sodium hydroxide. Gravity filtration of the mixture followed by thorough washing of the sludge gave a deeply colored solution from which the aminocarboxylic acid (45.5% yield) could be recovered by acidification.

Anal. Calc'd for $C_{14}H_9NO_3$: N, 5.87. Found: N, 5.70.

7-Acetaminofluorenone-1-carboxylic acid. 7-Aminofluorenone-1-carboxylic acid (0.2 g.) was added to 10 ml. of acetic anhydride and the mixture was heated on a boiling water-bath, with stirring, for two hours. The clear red solution was poured into water, filtered, and recrystallized from ethanol to give 0.2 g. (83% yield) of red 7-acetaminofluorenone-1-carboxylic acid. The compound decomposed without melting. The compound would melt when placed on a metal block heated to 277–278°.

Anal. Calc'd for $C_{16}H_{11}NO_4$: N, 4.97. Found: N, 4.95.

7-Bromofluorenone-1-carboxylic acid. 7-Aminofluorenone-1-carboxylic acid (5 g., 0.022 mole) was dissolved in 150 ml. of water and 10.8 ml. of hydrobromic acid (48%, 0.066 mole), cooled to 0°, and a solution of 1.517 g. (0.022 mole) of sodium nitrite in 50 ml. of water was added with stirring over a period of one-half hour. Stirring was continued for one-half hour and the cold diazonium solution then was added to a cold suspension of 6.314 g. (0.022 mole) of cuprous bromide in approximately 100 ml. of concentrated hydrobromic acid. The mixture was stirred for three hours and warmed to 50°, then filtered. The solid was dissolved in a warm sodium bicarbonate solution, treated with decolorizing carbon, filtered hot, and acidified to give 4.0 g. of crude material. Two recrystallizations from dioxane-water gave 2.7 g. (40.4%) melting at 228–230°.

Anal. Calc'd for $C_{14}H_7BrO_3$: Br, 26.36. Found: Br, 26.54.

1-Acetamino-7-nitrofluorenone. 1-Amino-7-nitrofluorenone (0.2 g.) was refluxed for two hours with 15 ml. of acetic anhydride. After cooling, the mixture was poured into water, and the precipitate was filtered, washed, and dried to give 0.1 g. (41% yield) of a yellow product. The compound, recrystallized from acetic acid, decomposed at 196–198° without melting.

Anal. Calc'd for $C_{15}H_{10}N_2O_4$: N, 9.92. Found: N, 9.95.

1-Bromo-7-nitrofluorenone. 1-Amino-7-nitrofluorenone (5 g., 0.0208 mole) was dissolved in 200 ml. of glacial acetic acid by warming, and 150 ml. of a 48% solution of hydrobromic acid was added. The solution was then cooled to 0° and 1.45 g. (0.021 mole) of sodium nitrite dissolved in 30 ml. of water was added over one hour to the well-stirred solution and the stirring was continued for four hours. The mixture was then added, slowly with stirring, to a suspension of 6.03 g. (0.021 mole) of cuprous bromide in approximately 100 ml. of concentrated hydrobromic acid at 0°. After two hours, the mixture was warmed to evolve nitrogen, and filtered. The solid was washed with water, warm aqueous sodium carbonate, and hot 6 *N* hydrochloric acid, and recrystallized from dilute acetic acid. The resultant yellow material (2.9 g., 46% yield) melted at 215–218°.

Anal. Calc'd for $C_{13}H_6BrNO_3$: Br, 26.25. Found: Br, 26.35.

1,7-Diaminofluorenone. 1-Amino-7-nitrofluorenone (5 g., 0.0208 mole) was suspended in a mixture of 150 ml. of ethanol, 30 ml. of ammonium hydroxide (*d.* 0.9), and 1 g. of ammonium chloride. The suspension was refluxed while a solution of 20 g. (0.083 mole) of $Na_2S \cdot 9H_2O$ dissolved in 100 ml. of water was added over a period of three hours. Heating was continued for three hours and the mixture was poured into water and allowed to stand overnight. The separated solid was filtered and was dissolved in hot 3 *N* hydrochloric acid, filtered, cooled, and neutralized. The resulting orange-red crystals, (1.25 g., 28.6% yield) melted at 216–217° with decomposition.

Anal. Calc'd for $C_{13}H_{10}N_2O$: N, 13.28. Found: N, 13.12.

Methyl and ethyl esters of 7-nitrofluorenone-1-carboxylic acid. Methanol (50 ml.) saturated with hydrogen chloride and 2 g. of 7-nitrofluorenone-1-carboxylic acid were refluxed for a total of 30 hours. The suspension was filtered hot, and the insoluble material was extracted with hot methanol. The filtrates were combined and cooled to give 0.7 g. of the ester melting at 183°. An additional 0.7 g. was recovered from the filtrate. The total yield was 1.4 g. (67%).

A sample of the methyl ester was also prepared by warming 0.2 g. of 7-nitrofluorenone-1-carboxylic acid chloride with 10 ml. of methanol for ten minutes. Addition of water gave a light yellow compound melting at 183°.

Anal. Calc'd for $C_{15}H_9NO_5$: N, 4.95. Found: N, 4.85.

In a similar manner, using ethanol, the ethyl ester was prepared in 57% yield, melting at 149°.

Anal. Calc'd for $C_{16}H_{11}NO_5$: N, 4.72. Found: N, 4.60.

SUMMARY

1. Experimental proof is offered to confirm the claim that direct nitration of fluorenone-1-arsonic acid gives the 7-nitro derivative.

2. The preparation of eleven new 1,7-disubstituted derivatives of fluorenone has been described.

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REFERENCES

(1) RAY AND GARASCIA, *J. Org. Chem.*, **15**, 1233 (1950).
(2) GARASCIA, FRIES, AND CHING, *J. Org. Chem.*, **17**, 226 (1952).
(3) CAMPBELL, EASTON, RAYMENT, AND WILSHIRE, *J. Chem. Soc.*, 2784 (1950).
(4) NIEDERL AND NIEDERL, *Quantitative Organic Analysis*, 2nd ed., John Wiley and Son, New York, N. Y., 1942.
(5) ELEK AND SOBOTKA, *J. Am. Chem. Soc.*, **48**, 501 (1926).
(6) Parr Instrument Co., *Manual No. 116. Peroxide Sulfur Bombs*, p. 11.
(7) FIESER AND SELIGMAN, *J. Am. Chem. Soc.*, **57**, 2174 (1935).
(8) BERGMANN AND ORCHIN, *J. Am. Chem. Soc.*, **71**, 1111 (1941).
(9) VOGEL, *Textbook of Practical Organic Chemistry*, Longmans, Green and Co., London, 1947, p. 185.