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# Synthesis of (Pyridinio-phenoxide) Zwitterions

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*Key Words:* $S_{RN}1$; hydroxyphenylpyridine; tosylate substituted branched chains;(pyridinio-phenoxide) zwitterions.

*Abstract: New tosylate substituted branched chains are synthesized from the parent alcohols. These reactants as well as n-alkyl or n-perfluoroalkyl halides are used for the quaternarization of 4-(3,5-dipentyl-4-hydroxyphenyl)pyridine.*

The interest of pyridinio-phenoxide molecules for non linear optics has already been demonstrated.[1-2] The non linear optics efficencies of two such zwitterions (**A** and **B**)[3] have been measured by the EFISH[3] technique and are rather high: $\mu\beta = -1050.\ 10^{-48}$ e.s.u. at 1.34µm in acetone for both molecules (µ: ground state dipole moment, β: hyperpolarizibility).[2,4] The high values of the dipole moments can be explained by the zwitterionic structure and the high values of hyperpolarizabilities are due to the large charge transfer between phenoxide and pyridinium which are respectively among the best electron-releasing and electron-withdrawing groups. In order to prepare materials, a non-centrosymmetrical monocristal has been obtained with (**A**)[2] and copolymers have been obtained with a derivative of (**A**).[4,5] Here, we describe the synthesis of homologous zwitterions which could have other applications. These zwitterions are substituted by two n-pentyl groups, and by a long chain on the pyridinium moiety. This chain is either a linear (alkyl or perfluoroalkyl) chain or a branched one. Such molecules could present mesomorphic properties and be soluble in polymers such as polymethylmethacrylate, which is not the case for (**A**). Their orientation in an electric field should be easy, because of their large ground state dipole moment.

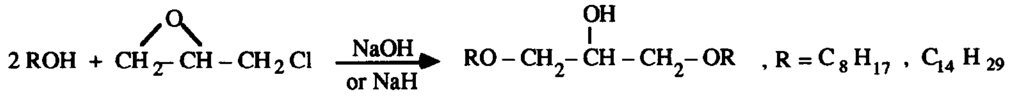
## I. Synthesis of the precursors.

The zwitterions were obtained by quaternarization of 4-(3,5-dipentyl-4-hydroxyphenyl)pyridine (**1**) by a Menschutkin reaction using different quaternarization reactants, followed by deprotonation by a strong base. **1** was synthesized in liquid ammonia by an electro-induced $S_{RN}1$ reaction.[6,7] The experimental conditions and results obtained with linear alkyl reactants (R= $CH_3$ (**2a**), $C_8H_{17}$ (**2b**), $C_{14}H_{29}$ (**2c**)) were described in a previous paper.[7]

In this paper, we describe the quaternarization reaction with a perfluoroalkyl chain (R=$(CH_2)_2C_8F_{17}$ (**2d**)) or a branched alkyl chain (R=$CH(CH_2OC_8H_{17})_2$ (**2e**), $CH(CH_2OC_{14}H_{29})_2$ (**2f**)). We have used an iodo derivative when commercially available (**2d**). In the case of (**2e**) and (**2f**), as no commercially available derivative existed, we have synthesized two quaternarization reactants, whose syntheses are first described.

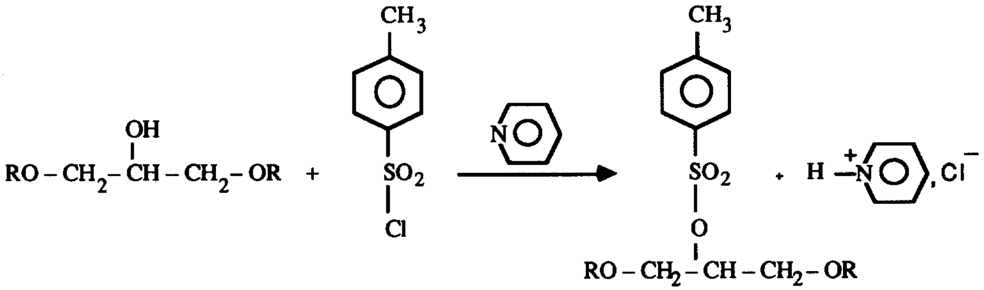
Few examples of quaternarization reactants substituted by secondary branched chains are described because elimination competes with substitution. Isopropyl bromide[8] and tosylates of cholesterol derivatives[9] can however be mentioned. As the 4-toluenesulfonate group is a better leaving group than halides, we have synthesized tosylate derivatives for **2e** and **2f** by a two-step reaction: first, the synthesis of the corresponding alcohol, secondly, the substitution of the hydrogen of the hydroxy group by a tosyl group.

Williamson reaction on epichlorhydrin was first performed to give 2-propanol substituted by two alcoxy chains :



The yield of isolated product (2'e) or (2'f) was 65% in both cases.

Substitution of hydrogen by a p-toluenesulfonyl group was achieved by paratoluenesulfonyl chloride[12,13] in pyridine:



The yield of isolated product (2e) and (2f) was 95% in both cases.

## II. Quaternarization and deprotonation of 4-(3,5-dipentyl-4-hydroxyphenyl)pyridine

We have chosen acetonitrile or acetone (in case of solubility problems) to perform the Menschutkin reaction .

The same procedure was used in all the cases. Compound **1** (0.225 mmol, 70 mg) was dissolved in an excess of compound **2** (between 2 and 4 ) and 4 mL solvent (acetonitrile or acetone or isopropanol). The mixture was heated under 100°C in an autoclave for some time, depending on the reaction rate. In the case of long alkyl chains (**2e-f**), when the reaction was stopped, some starting product remained. The organic solvent was then evaporated.

In the case of (**2d**), the pyridinium salt was precipitated in diethyl oxide. In the case of (**2e,f**), it was obtained by column chromatography: after elution by ethyl acetate of the starting product and the tosylate degradation products, the salt was eluted by methanol.

The pyridinium salt was deprotonated with NaOH 1M (0.5 mL) and the obtained zwitterion was extracted with diethyloxide. After decantation, washing of the organic phase with water, drying over $MgSO_4$ and evaporation of the solvent, compound (**3**) was obtained. Compound (**3d**) , which was solid was recrystallized in pentane. Compounds (**3e,f**), which were liquid were not further purified.

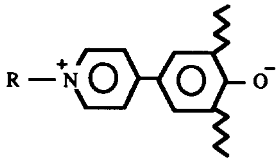
Specific experimental conditions for the Menschutkin reaction and the results of the quaternarization and deprotonation reactions are given in Table I, in which the results obtained with linear alkyl reactants (**2a-c**) are also mentioned

**Table I.**

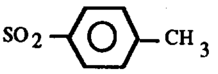
Experimental Conditions of the Quaternization Reaction and Results

| RX | Amount (eq) | Solvent | Heating time (h) | Yield[a] |
|---|---|---|---|---|
| $CH_3I$<br>( **1a** ) | 2 | acetonitrile | 4 | 60%<br>( **3a** ) |
| $CH_3(CH_2)_7I$<br>(**1b** ) | 2 | acetonitrile | 8 | 65%<br>( **3b** ) |
| $CH_3(CH_2)_{13}Br$<br>(**1c** ) | 5 | acetone | 24 | 45%<br>( **3c** ) |
| $CF_3(CF_2)_7(CH_2)_2I$<br>( **1d** ) | 2 | acetonitrile, acetone (50/50, V/V) | 22 | 80%<br>( **3d** ) |
| $(CH_3(CH_2)_7OCH_2)_2CHOTs$[b]<br>(**1e** ) | 4 | isopropanol | 16 | 45%<br>( **3e** ) |
| $(CH_3(CH_2)_{13}OCH_2)_2CHOTs$[b]<br>( **1f** ) | 4 | acetone | 48 | 15%<br>( **3f** ) |

[a] yield of isolated



(3) ; [b] Ts =



Yields higher than 60% were observed for small chains (**1a, b, d**). The corresponding products were solid. For the other compounds (**1c, e, f**), the yields were lower, certainly because the reaction took more time and was not complete when it was stopped.

The analogy of the charge transfer properties of the different zwitterions was clearly demonstrated by their UV spectra.[14] The intense charge transfer band of (**1**) (doublet, 265 and 292 nm) shifted largely towards the large wavelengths for the zwitterionic derivatives because of the increase of both the electron-releasing character of phenoxide compared to phenol and the electron-withdrawing character of pyridinium compared to pyridine. The UV spectra were the same for (**3a-f**) (doublet, 491±1 nm, 523±2 nm).

The existence of mesomorphic properties of these zwitterions and their solubility in polymers such as polymethylmethacrylate are going on at present.

Acknowledgements: Professor J. Simon is gratefully thanked for helpful discussions.

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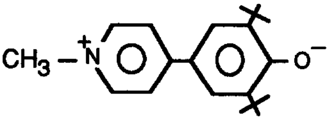
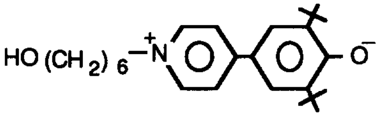
3 **A** =



**B** =



EFISH: Electric Field Induced Second Harmonic generation technique.

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14\. Product analyses:

**2e** Liquid at room temperature. $^1$H NMR (90 MHz, $CDCl_3$), δ (ppm): 0.9 (t, 6H), $1.1_5$-1.7 (m, 24H), 2.4 (s, 3H), 3.3 (t, 4H), $3.5_5$ (d, 4H), 4.7 (t, 1H), 7.3 and $7.8_5$ (AA'BB', $J_{app}$=9 Hz, 4H).

**2f** m.p.: 35°C. $^1$H NMR (90 MHz, $CDCl_3$), δ (ppm): 0.85 (t, 6H), 1.1-1.8 (m, 48H), $2.4_5$ (s, 3H), $3.3_5$ (t, 4H), 3.6 (d,4H), 4.7 (t, 1H), 7.3 and $7.8_5$ (AA'BB', $J_{app}$=9 Hz, 4H). Anal. Calcd. for $C_{38}H_{70}O_5S$: C, 71.42; H, 11.04; Found: C, 71.39; H, 11.03.

**3d**:4-(N-1,1,2,2-tetrahydroperfluorodecylpyridinio)-3,5-dipentylphenoxide. m.p.: 148°C. UV (THF), λ(nm): 492, 525. $^1$H NMR (90 MHz, $CDCl_3$), δ (ppm): 0.8 (br. t, 6H), 1.1-1.8 (m, 12H), 2.3-2.9 (m, 6H), 4.3 (br. t, 2H), 7.3 (s, 2H), 7.2 and $7.5_5$ (AA'BB', $J_{app}$=9 Hz, 4H). $^{13}$C NMR (250 MHz, acetone D6), δ (ppm): 14.42 ($2CH_3$), 23.36 ($2CH_2$), 30.42 ($2CH_2$), 32.31 ($2CH_2$), 32.77 ($2CH_2$), 51.28 ($N\text{-}CH_2$), 116.98 (C), 119.52 (2CH), 128.59 (2CH), 133.70 (2C), 142.96 (2CH), 154.17 (C), 171.26 (C), MS (FAB, CI, m/z): 758 (M+1). Anal. Calcd. for $C_{31}H_{32}F_{17}NO$: C, 49.15; H, 4.26; N, 1.85; Found: C, 49.20; H, 4.30; N, 1.79.

**3e**:4-(N-1,3-dioctyloxy-isopropyl)-3,5-dipentylphenoxide. Liquid at room temperature. UV (THF), λ(nm): 490, 522. $^1$H NMR (90 MHz, $CCl_4$), δ (ppm): 0.9 (br. t, 12H), 1.0-1.8 (m, 36H), 2.5 (br. t, 4H), 3.3 (t, J=8Hz, 4H), $3.8_5$ (m, 4H), $5.0_5$ (m, 1H), 7.3 (s, 2H), 7.4 and 8.4 (non resolved AA'BB', 4H).

**3f**:4-(N-1,3-ditetradecyloxy-isopropyl)-3,5-dipentylphenoxide. Liquid at room temperature. UV (THF), λ(nm): 492, 523. $^1$H NMR (90 MHz, $CDCl_3$), δ (ppm): $0.8_5$ (br. t, 12H), 1.0-1.8 (m, 60H), $2.4_5$ (m, 4H), 3.4 (m, 4H), 3.8 (m, 4H), 4.9 (m, 1H), 7.2 (s, 2H), 7.3 and 8.3 (non resolved AA'BB', 4H).

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