SYNTHESIS OF 2-(4-CYANOPHENYL)-5-(4-n-ALKYL- AND ALKOXYPHENYL) PYRIDINES

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New liquid-crystalline 2-(4-cyanophenyl)-5-(4-alkyl- and alkoxyphenyl)pyridines were obtained by condensation of 1-dimethylamino-3-dimethylimmonia-2-(4-alkyl- or alkoxyphenyl)-1-propene perchlorates with 4-cyanoacetophenone and subsequent conversion of the 1-dimethylamino-2-(p-alkyl- or alkoxyphenyl)-4-(p-cyanobenzoyl)-1,3-butadienes to 5-(4-alkyl- or alkoxyphenyl)-2-(4-cyanophenyl)pyrylium perchlorates and refluxing of the latter with ammonium acetate in acetic acid.

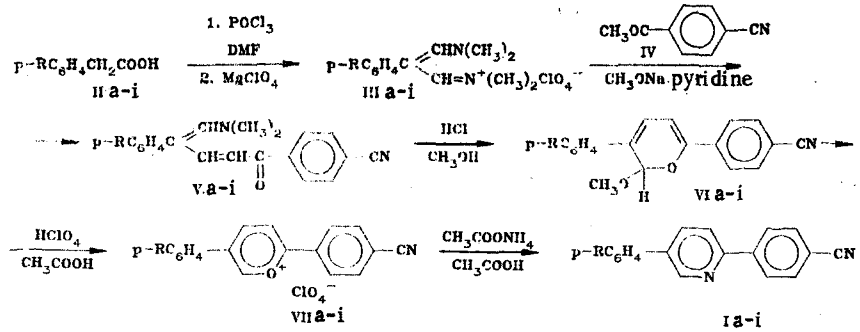
2,5-diphenylpyridine is a compound that is relatively difficult to obtain; it is usually obtained in low yields (no higher than 26%) from 3-phenylpyridine through ogranometallic compounds [1-3].

A multistep method for the synthesis of substituted 2,5-diphenylpyridines from the rather difficult-to-obtain p-substituted phenyl β-chlorovinyl ketones [5, 6] and sodium phenylcyanoacetate with cyclization to 2,5-diphenyl-6-pyridones has been proposed [4]. Treatment of the 2,5-diphenyl-6-pyridones with phosphorus oxychloride converts them to the corresponding 6-chloro-substituted derivatives, which are dehalogenated by hydrogenation on a palladium catalyst.

It is known [7] that treatment of 1-dimethylamino-2-phenyl-4-benzoyl-1,3-butadiene, obtained by condensation of 1-dimethylamino-3-dimethylimmonia-2-phenyl-1-propene perchlorate with acetophenone, with dilute hydrochloric acid in methanol gives a 2-methoxy-2H-pyran derivative, which is converted to a pyrylium salt by treatment with perchloric acid.

We used these results in the synthesis of 2-cyano-5-(p-alkyl- or p-alkoxyphenyl)pyridines [8] and 2-thienyl-5-phenylpyridines [9].

The method was also found to be convenient in a preparative respect for the synthesis of 2,5-diphenylpyridines, which were obtained via the scheme



I—III, V—VII a R=C_4H_9; b R=C_5H_{11}; c R=C_6H_{13}; d R=C_7H_{15}; e R=C_8H_{17}; f R=C_4H_9O; g R=$C_6H_{13}O$; h R=$C_7H_{15}O$; i R=$C_8H_{17}O$

1-Dimethylamino-2-(p-alkyl- or alkoxyphenyl)-4-(p-cyanobenzoyl)-1,3-butadienes V were obtained by condensation of trimethylidyne salts III [10] with p-cyanoacetophenone (IV). Compounds V were treated with dilute hydrochloric acid in methanol, and the resulting substituted 2-methoxy-2H-pyrans VI were converted to pyrylium salts VII. 2-(4-Cyanophenyl)-5-(4-alkyl- or 4-alkoxyphenyl)pyridines I were obtained by refluxing salts VII in acetic acid with ammonium acetate.

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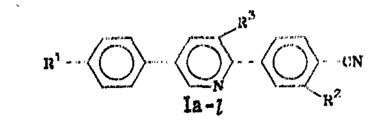
TABLE 1. 5-(4-Alkyl-, alkoxyphenyl)-2-(4-cyanophenyl)pyridines



Ia-*l*

Compound	R^1*	T,** °C			Found, %			Empirical formula	Calc., %			Yield, %
		sm.	nem.	isotr.	C	H	N		C	H	N	
Ia	C_4H_9		95	233	84,5	6,3	9,2	$C_{22}H_{20}N_2$	84,6	6,4	9,0	42
Ib	C_5H_{11}		76	232	84,7	6,9	8,4	$C_{23}H_{22}N_2$	84,6	6,8	8,6	40
Ic	C_6H_{13}	72	166	221	84,7	7,2	8,1	$C_{24}H_{24}N_2$	84,7	7,1	8,2	38
Id	C_7H_{15}	69	193	217	84,7	7,4	7,9	$C_{25}H_{26}N_2$	84,7	7,4	7,9	40
Ie	C_8H_{17}	67	200	210	84,6	7,4	8,0	$C_{26}H_{28}N_2$	84,7	7,7	7,6	46
If	C_4H_9O		117	265	80,3	6,1	8,3	$C_{22}H_{20}N_2O$	80,5	6,1	8,5	45
Ig	$C_6H_{13}O$	80	182	251	80,8	6,8	7,9	$C_{24}H_{24}N_2O$	80,9	6,8	7,8	42
Ih	$C_7H_{15}O$	83	218	243	81,1	7,3	7,6	$C_{25}H_{26}N_2O$	81,0	7,1	7,6	39
Ii	$C_8H_{17}O$	89	226	235	81,1	7,4	7,5	$C_{26}H_{28}N_2O$	81,2	7,3	7,3	40
Ij	C_6H_{13}		62	93	76,8	6,3	7,6	$C_{24}H_{23}ClN_2$	76,9	6,2	7,5	42
Ik	C_4H_9O		107	150	72,6	5,3	7,8	$C_{22}H_{19}ClN_2O$	72,8	5,3	7,7	39
I*l*	C_4H_9O		137	158	88,0	6,6	8,1	$C_{23}H_{22}N_2O$	88,1	6,5	8,2	36

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*For Ia, *l*, R^2 = H; for Ij, k, R^2 = Cl; for Ia-k, R^3 = H; for II, R^3 = CH_3.

†Transition temperatures: "sm." denotes transition from the crystalline state to the smectic state, "nem." denotes transition from the crystalline or smectic state to the nematic state, and "isotr." denotes transition to an isotropic liquid.

A similar scheme with the utilization of 3-chloro-4-cyanoacetophenone, 4-cyanopropiophenone, or 2-cyano-5-acetylthiophene in place of p-cyanoacetophenone gave, respectively, Ij-m, which display liquid-crystalline properties (Table 1). In contrast to the analogs of p-alkyl-p'-cyanoterphenyls [11], they have lower melting points and higher positive dielectric anisotropies and can be successfully used in the creation of new liquid-crystalline materials.

EXPERIMENTAL

The PMR spectra of solutions of the compounds in CCl_4 were measured with a Perkin-Elmer 12B spectrometer (60 MHz) with tetramethylsilane (TMS) as the internal standard. The purity of the substances was monitored by thin-layer chromatography (TLC) on Silufol UV-254. The temperatures of the phase transitions were measured with an MIN-8 polarization microscope equipped with an FP-52 heating stage.

1-Dimethylamino-2-(p-alkyl- or alkoxyphenyl)-4-(p-cyanobenzoyl)-1,3-butadienes V. A 0.02-mole sample of a solution of sodium methoxide (2.5 moles/liter) was added dropwise at room temperature to a stirred solution of 0.02 mole of trimethylidyne salt III [10] and 0.02 mole of p-cyanoacetophenone [12] in 15 ml of absolute pyridine, and the mixture was stirred for 1 h at room temperature and for 1 h at 40°C. It was then allowed to stand for 12 h, after which the pyridine and methanol were removed by distillation in vacuo, and the residue was decomposed with water. The aqueous mixture was extracted with chloroform, and the organic layer was filtered with a 5-cm-high column packed with neutral Al_2O_3. The chloroform was removed by vacuum distillation, and the residue was used in the next step without purification.

5-(p-Alkyl- or Alkoxyphenyl)-2-(p-cyanophenyl)pyridines Perchlorates VII. A 5-10 ml sample of 2 N hydrochloric acid was added with stirring to V in 30 ml of methanol. After a few minutes, the red color of the solution vanished, and a yellow precipitate formed. The reaction mixture was allowed to stand for 4 h, after which it was cooled to 0°C, and the precipitate was removed by filtration, washed with water and 10 ml of cold methanol, and air dried. It was then placed in 10 ml of acetic acid, and 5 ml of 70% perchloric acid was added slowly dropwise. After 1 h, the mixture was diluted with 150 ml of ether, and the resulting mixture was cooled to 0°C and filtered. The precipitate was squeezed on the filter, dried, washed several times with dry ether, and used without recrystallization in the next step. The yields ranged from 60% to 65%.

5-(4-Alkyl- or Alkoxyphenyl)-2-(4-cyanophenyl)pyrimidines I. A mixture of 0.03 mole of pyrylium salt VII, 0.3 mole of anhydrous ammonium acetate, and 98 ml of glacial acetic acid was refluxed for 1 h, after which it was cooled and poured into 300 ml of cold water. The precipitate was removed by filtration, washed with water, air dried, and recrystallized from methanol, hexane, and acetone until it had the necessary electrical conductivity and a constant melting point. Compound I, with Rf 0.26 (benzene), was isolated in 70-75% yield. PMR spectrum of Id ($CDCl_3$): 0.87 (3H, t, J = 7 Hz, CH_3), 1.1-1.7 (11H, m, CH_2), 2.6 (2H, t, J = 7 Hz, $PhCH_2$), 7.30 (2H, 2'-H, 5'-H) and 7.56 (2H, 2'-H, 6'-H) (AA'BB' system), 7.75 (2H, 2-H, 6-H) and 8.17 (2H, 3-H, 5-H) (AA'BB' system), 7.80 (1H, broad d, β-H), 7.98 (1H, dd, $J_{\alpha\gamma}$ = 2.4 Hz, $J_{\beta\gamma}$ = 8.4 Hz, γ-H), 8.95 ppm (1H, broad d, α-H). Compounds Ij,k were similarly obtained by condensation of trimethylidyne salts III with 3-chloro-4-cyanoacetophenone; II was obtained by condensation with 4-cyanopropiophenone. 2-(5-Cyanothienyl)-5-(4-amylphenyl)-pyridine (Im) was obtained by condensation of trimethylidyne salt III with 2-cyano-5-acetylthiophene and had a smectic transition temperature of 98°C, a nematic transition temperature of 126°C, and an isotropic transition temperature of 175°C. Found: C 75.8; H 6.2; N 8.2%. $C_{21}H_{20}N_2S$. Calculated: C 75.9; H 6.1; N 8.4%.

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