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Liquid Crystals

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Synthesis and properties of new ferroelectric liquid crystalline compounds having a 1, 2-diphenylethane structure

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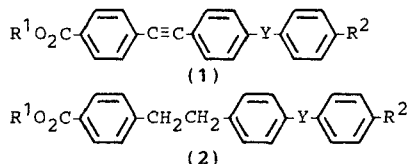
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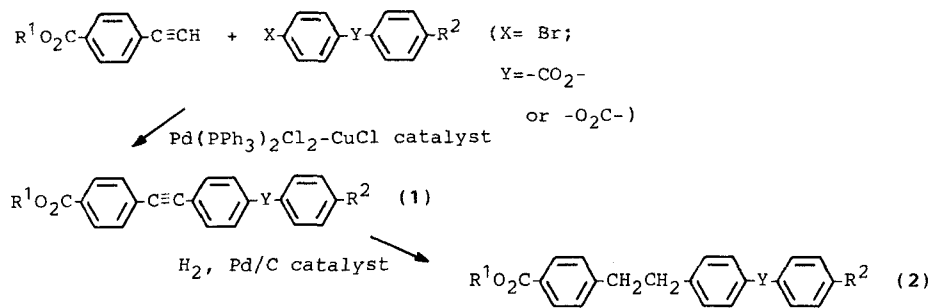
Chiral 1, 2-diphenylethane derivatives have been synthesized and found to form stable chiral S_c phases exhibiting ferroelectric properties. Comparison with diphenylacetylene derivatives revealed that flexibility of the bridging groups between two benzene nuclei strongly influences the stability of mesophases as well as transition temperatures.

We have previously reported [1] a new series of chiral diphenylacetylene derivatives (1) having a rigid core and conjugated structure which form stable chiral S_c phases exhibiting ferroelectric properties. Recently much attention is being paid to the flexibility and polarizability of liquid crystalline compounds in terms of theory [2] and application [3]. Thus, we have attempted to synthesize 1, 2-diphenylethane derivatives (2) which have the same molecular structure as the diphenylacetylene



derivatives (1) except the bridging group. Here we report the synthesis and thermal properties of (2) and the influence of structural flexibility on liquid crystalline properties.

The synthetic route to compound (2) is shown in Scheme 1.



Scheme 1.

Compound (**2a**: $R^1 = (R)\text{-CH}_3(\text{CH}_2)_5\text{CH}(\text{CH}_3)\text{-}$, $[\alpha] = -16.2$) was prepared by the hydrogenation of compound (**1a**: $R^1 = (R)\text{-CH}_3(\text{CH}_2)_5\text{CH}(\text{CH}_3)\text{-}$, $[\alpha] = -30.1$) using 5 per cent Pd/C catalyst in ethyl acetate under atmospheric pressure of hydrogen. The reaction temperature was kept at $25 \pm 5^\circ\text{C}$. The reaction was traced by TLC and the product (**2a**) was obtained quantitatively after the complete reaction. Similarly compounds (**2b-d**) were prepared from the corresponding (**1b-d**) and characterized by spectral analyses including mass I.R., and N.M.R. spectra. The thermal properties and phase sequences of compound (**2**) were examined visually with an optical microscope and by the thermal analyses. The results are summarized in the table along with transition temperatures of compound (**1**) for comparison.

Transition temperatures ($T/^\circ\text{C}$) of compound (**1**) and (**2**).

	R^1 †	Y	R^2	m.p.	S_1 §- S_C *	S_C *- S_A	S_A -Ch	S_A -I	Ch-I
(2a)	1 MH	CO ₂	$n\text{-C}_8\text{H}_{17}\text{O}$	77		89		97	
(2b)	2 MB	CO ₂	$n\text{-C}_{10}\text{H}_{21}\text{O}$	64		88		133	
(2c)	2 MB	O ₂ C	$n\text{-C}_{10}\text{H}_{21}\text{O}$	60		107		131	
(2d)	2 MB	—	$n\text{-C}_{10}\text{H}_{21}\text{O}$	-30	112	124		137	
(1a)	1 MH	CO ₂	$n\text{-C}_8\text{H}_{17}\text{O}$	84		90		117	
(1b)	2 MB	CO ₂	$n\text{-C}_{10}\text{H}_{21}\text{O}$	91		122	158		168
(1c)	2 MB	O ₂ C	$n\text{-C}_{10}\text{H}_{21}\text{O}$	90		(74)‡	157		172
(1d)	2 MB	—	$n\text{-C}_{10}\text{H}_{21}\text{O}$	87	123	168		193	

† 1 MH = $(R)\text{-CH}_3(\text{CH}_2)_5\text{CH}(\text{CH}_3)\text{-}$. 2 MB = $(S)\text{-C}_2\text{H}_5\text{CH}(\text{CH}_3)\text{CH}_2\text{-}$.

‡ A monotropic transition temperature.

§ The phase has not been identified yet.

Compound (**2**) shows a lower melting point due to the flexible structure than known ferroelectric liquid crystals having a structure composed of three ring systems. The conversion of compound (**1**) to (**2**) results in complete disappearance of chiral N (cholesteric) phases. However S_A , chiral S_C , and S_1 phases remained, though the thermal stabilities were depressed with an exception of the chiral S_C phase of (**2c**). It should be noted that compound (**2a**) showed a larger spontaneous polarization, P_s , of -90 nC/cm^2 than (**1a**; $P_s = -68\text{ nC/cm}^2$) [4].

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