

Crystalline-liquid ferro-electric derivatives
of branched acyclic α -chlorocarboxylic acids

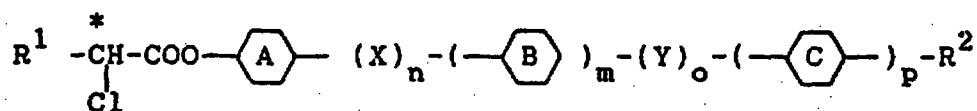
The invention relates to new ferro-electric crystalline-liquid derivatives of branched acyclic α -chlorocarboxylic acids, a process for the production of the compounds and their use in liquid crystal mixtures which are used in fast-switching displays in optoelectronics for the representation of numbers, signs and illustrations.

Ferro-electric crystalline-liquid compounds are described in literature. They are optically active compounds which are predominantly derivatives of optically active amyl alcohol and optically active α -chloropropanol (P. Keller, S. Juge, L. Liebert, L. Strzelecki: C.R. Acad. Sci., Ser. 282 C, 639 (1976); P. Keller : Ann. Phys. 139-44 (1978); M.V. Loseva, B.I. Osrtowskii, A.Z. Rabinovich, A.S. Sonin, B.A. Strukov, N.I. Chernova: Pis'ma Zh. Eksp. Teor. Fiz, 28, 404 (1978); A. Hallsby, M. Nilsson, B. Otterholm: Mol. Cryst. 82, 61-8 (1982); P. Keller: Ferroelectrics 1984; J.W. Goodby, T.M. Leslie: Mol. Cryst. Liq. Cryst. 110, 175 (1984)).

However in use in displays with storage properties these substances display a series of disadvantages, such as very high fusion temperatures, instability to heat, light or chemical influences or very low dipole moments causing low values of the spontaneous polarisation. However the substances produced according to the invention are new and therefore methods for their production are not known.

It is the problem of the invention to find substances which possess good stability to heat, light and chemical influences, have low melting points and display sufficiently high dipole moments.

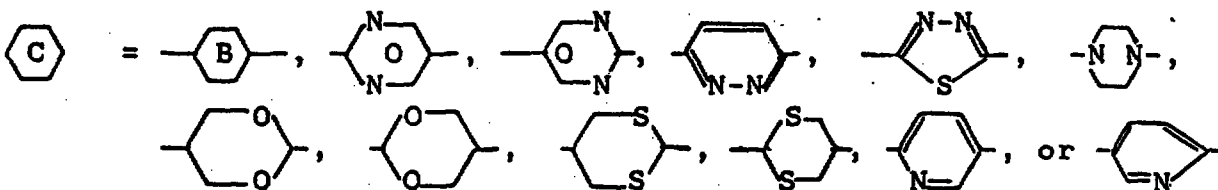
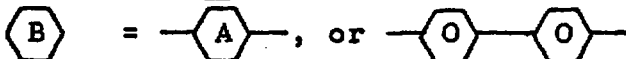
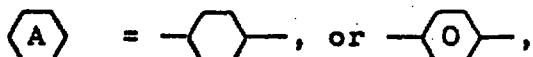
Accordingly the present invention provides the following:
ferro-electric crystalline-liquid derivatives of branched acyclic α -chlorocarboxylic acids of the general Formula:



wherein $n = 0$ or 1 ; $m = 0$ or 1 ; $o = 0$ or 1 ; $p = 0$ or 1

$\text{X} = -\text{COO}, -\text{OOC}, \text{ or } -\text{CH}_2-\text{CH}_2-$,

$\text{Y} = \text{X}, -\text{CH}_2-, -\text{N}=\text{N}-, \text{ or } -\text{N}=\text{N}(\text{o})-$,

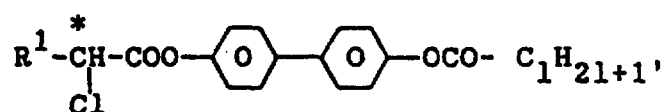
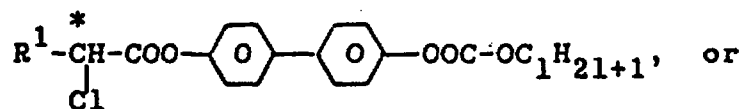
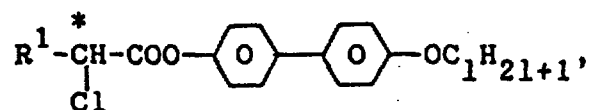


$R^1 = (\text{CH}_3)_2\text{CH}-, (\text{CH}_3)_2\text{CH}-\text{CH}_2-, \text{ or } \text{C}_2\text{H}_5-\text{CH}(\text{CH}_3)-$

$R^2 = \text{C}_{12}\text{H}_{25}, -\text{O}-\text{C}_{12}\text{H}_{25}, -\text{S}-\text{C}_{12}\text{H}_{25}, -\text{CO}-\text{C}_{12}\text{H}_{25},$
 $-\text{OOC}-\text{C}_{12}\text{H}_{25}, -\text{COO}-\text{C}_{12}\text{H}_{25}, \text{ or } -\text{NH}-\text{C}_{12}\text{H}_{25}, \text{ and}$

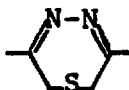
$l = 1 \text{ to } 12,$

with the exclusion of the substances of the class:



and wherein if any of the rings A, B or C if present is  and o is 0 then X is not -COO, OOC-, or a single bond; and if

R^1 is $(\text{CH}_3)_2\text{CH}-$ or $(\text{CH}_3)_2\text{-CH-CH}_2$ and the ring C is either a

single bond or a ring other than  then Y when present is is not X.

The compounds of the above mentioned general formula I may be used in mixtures with one another also with other crystalline-liquid or non-crystalline-liquid substances.

- The ferro-electric crystalline-liquid derivatives of branched acrylic α -chlorocarboxylic acids in accordance with the invention are obtained by reaction of chiral α -chlorocarboxylic acids or chlorocarboxylic acid chlorides or bromides, produced from natural amino acids by reaction with nitric and hydrochloric acid, with corresponding hydroxy compounds directly or in the presence of strongly dehydrating substances preferably carbodiimides such as dicyclohexyl carbodiimide, 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide-methiodide or 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide-metho-p-toluene sulphonate.

The α -chlorocarboxylic acids chlorides or bromides are esterified with the corresponding hydroxy compounds according to the method of Schotten-Baumann or according to the variant of Einhorn.

- The derivatives obtained from the natural amino acids L-Valin, L-Leucin and L-Isoleucin by reaction with nitric and hydrochloric acid are preferredly suitable as α -chlorocarboxylic acids. However the chloro-carboxylic acids obtainable from the optically active opposites D-Valin, D-Leucin and D-Isoleucin are also usable.

These compounds can be produced according to known instructions, see

E. FISCHER, H. SCHEIBLER: Ber.Dtsch.Chem. Ges. 41, 889 (1908); P. KARRER, M. RENHARD: J. Biol. Chem. 28, 497 (1946); P. KARRER, H. RESCHOFSKY, W KAASE; Helv. Chim. Acta 30, 271 (1947).

The hydroxy compounds are fragments of crystalline-liquid substances which do not themselves have to be crystalline-liquid and can be produced according to known instructions (see quotations in D. Demus and H. Haschke "Liquid Crystals in Tables II", Leipzig 1984).

In the process the chirality of the α -chlorocarboxylic acid grouping is maintained, and surprisingly the yield in the execution of the process by reaction of the α -chlorocarboxylic acids with the hydroxy compounds in the presence of strongly dehydrating media is about twice as high (40 - 60%) as in the reaction into α -chlorocarboxylic acid chlorides and subsequent esterification.

The substances are colourless, chemically and thermally very stable and due to the Cl-substituent directly at the chiral centre they possess a high dipole moment and thus a high spontaneous polarisation.

The invention is to be explained in greater detail below by examples for the production of crystalline liquid derivatives, some, but not all, of which embody the present invention.

Example 1

(S) -(+)-1-(4-n-alkyloxy-benzoyloxy)-4-(2-chloro-3-methyl-butiryloxy)-biphenyls

A. (S)-(+)-2-chloro-3-methyl butane acid

10g. (0.085 mol) of L-(+)-Valin, 1g. of urea, 30ml. of
5 conc. HCl and 15ml. of conc. HNO₃ are shaken for about
30 - 60 minutes in a flask, until the N₂ generation is
terminated. Then the reaction batch is heated for 45
minutes at 70 to 80°C. in the water bath (complete
dissolution with foaming, precipitation of a yellow oil).
10 After cooling, extraction with ether is effected, the
ether extract is washed several times with cold water,
dried over CaCl₂, the solvent is withdrawn on the rotary
evaporator and the residue fractionally distilled
in vacuo.

15 Yield: 3.2g. (28% of theory)

B.P.: 125 - 126°C./4.25 kPa

B. (S) -(+)-2-chloro-3-methyl butyryl chloride

20g. (0.147 mol) of (S)-(+)-2-chloro-3-methyl butane
acid and 13g. of PCl₃ are shaken in a flask for 12 h.
20 and then heated for 1 hour over the water bath. The
reaction mixture is distilled under normal pressure.

Yield: 5.4g. (27% of theory)

B.P. : 144 - 146°C.

25 if as halogen carrier 5 times the quantity of SOCl₂ are
used and the batch is heated over the water bath for 2
hours at 50 - 60°C., one gains 12.2g. of:

(S)-(+)-2-chloro-3-methylbutyryl chloride (60% of theory).

C. (S)-(+)-1-(4-n-alkyloxy-benzoyloxy)-4-(2-chloro-3-methyl-butiryloxy)-biphenyls

0.77g. (0.005 mol) of (S)-(+)-2-chloro-3-methyl-butiryyl chloride are added to the solution of 0.005 mol of 1-(4-n-alkyloxy-benzoyloxy)-4-hydroxy biphenyl, 0.6ml. of triethylamine and 50 ml. of absolute toluene. The material is left to stand for one day at room temperature and then heated for one hour at 80°C. over the water bath. After the occurring precipitate is filtered off, the solvent is distilled off and the residue is recrystallised several times out of ethanol/water. The yield amounts to 50 to 60% of theory. The crystalline-liquid melting behaviour is stated in the Tables.

15 Example 2

(S)-(+)-1-(4-n-alkyloxy-benzoyloxy)-4-(4-(2-chloro-3-methyl butiryloxy)benzoyloxy)-benzene

A. (S)-(+)-4-(2-chloro-3-methyl-butiryloxy)-benzoic acid 8.9g. (0.065 mol) of 4-hydroxybenzoic acid are dissolved in 20 ml. of abs. pyridine and 10g. (0.065 mol) of (S)-(+)-2-chloro-3-methyl butiryyl chloride added by drops with stirring at 0 to 5°C. After the batch has stood for 4 hours at room temperature the batch is poured on to ice/conc. HCl (200g./30ml.), the precipitate is drawn off, washed repeatedly with dilute HCl and water. The residue is recrystallised out of methanol/water.

Yield: 11.7g. (70% of theory)

F.p. : 150 - 151°C.

B. (S)-(+)-1-(4-n-alkyloxy-benzoyloxy)-4-(4-(2-chloro-3-methyl-butyryloxy)-benzoyloxy)-benzene

5 (S)-(+)-4-(2-chloro-3-methyl-butyryloxy)-benzoyl chloride produced by reaction of 0.8g. (0.003 mol/(S)-(+)-4-(2-chloro-3-methyl-butyryloxy)-benzoic acid and 3 ml. of SOCl_2 as crude product are added by drops to 0.003 mol of 1-(4-n-alkyloxy-benzoyloxy)-4-hydroxy benzenes,
10 dissolved in 30ml. of toluene and 0.6ml. (0.004 mol) of triethylamine. The material is left to stand for one day at room temperature and then heated briefly to 80°C. (water bath temperature). Next the precipitate is filtered off, the mother liquid is concentrated and the
15 remaining residue is recrystallised several times out of ethanol/water.

The yield amounts to 55 to 60% of theory.

Example 3

(S)-(+)-1-(4-n-alkyloxy-benzoyloxy)-4-(4-(2-chloro-3-methyl-
20 pentanoyloxy)-benzoyloxy)-benzene

A. (S)-2-chloro-3-methyl pentane acid

60 ml. of conc. HCl and 30 ml. of conc. HNO_3 are added at room temperature to 20 g. (0.150 mol) of
L-(+)-Isoleucin and 2 g. of urea, and then heated over
25 the water bath for one hour at 80°C. and thereafter for one hour at 50°C. (complete solution of the acid with vigorous foaming). After cooling, extraction is

effected several times with ether, the ether extract is washed with water, dried over CaCl_2 , the solvent is distilled off with the rotary evaporator and the residue is fractionally distilled in vacuo.

5 Yield : 6.7 g. (29% of theory)

B.P. : 136 - 138°C./3.47 kPa

Example 4

A. (S)-2-chloro-4-methyl-pentane acid

10 g. (0.076 mol) of L-(+)-Leucin are put together with
10 24 ml. of conc. HCl and 10 ml. of conc. HNO_3 with
addition of 2 g. of urea and then heated over the water
bath for one hour at 80°C. and thereafter for one hour
at 50°C. (complete dissolution of the acid with vigorous
foaming. After cooling extraction is effected several
15 times with ether, the ether extract is washed with water,
dried over CaCl_2 , the solvent is distilled off with the
rotary evaporator and the residue is fractionally
distilled in vacuo.

Yield : 4.1 g. (36% of theory)

20 B.P. : 136-137°C., 3.99 kPa

B. Esterification in the presence of dicyclohexyl
carbodiimide (DDC)

1.5 g. (0.01 mol) of (S)-2-chloro-3-methyl pentane acid,
2.06 g. (0.01 mol) of DCC, 0.12 g. (0.001 mol) of
25 4-dimethylaminopyridine (DMAP) and 0.01 of corresponding
1-(4-n-alkyloxy-benzoyloxy)-4-hydroxy-benzene are added
with agitation to 50 ml. of ether. The material is

10
left to stand for 2 - 3 days at room temperature, then the mother liquor is washed repeatedly with water, dried over Na_2SO_4 , the solvent is distilled off with the rotary evaporator and the residue is recrystallised several
5 times out of methanol.

Yield : 40 - 50% of theory.

C. Esterification in the presence of water-soluble carbodiimides

0.69 g. (0.0025 mol) in 30 ml. abs. CH_2Cl_2 are added by
10 drops with agitation and ice cooling in a flask to the solution of 0.3 g. (0.0021 mol) of (S)-2-chloro-3-methyl pentane acid, 0.003 mol of 1-(4-n-alkyloxy-benzoyloxy)-4-hydroxybenzene and 0.01 g. of DMAP in 50 ml. of abs
15 CH_2Cl_2 . After standing for 2 to 3 days at room temperature the reaction batch is washed several times with water, dried over Na_2SO_4 . The solvent is removed with the rotary evaporator and the residue is repeatedly recrystallised out of ethanol or n-hexane/acetic ester.

Yield : 50 -60% of theory.

20 The following Tables 1 to 8 show the conversion temperatures of substances according to the invention.

The significances are:

K = crystalline-solid condition

S_C = ferro-electric smectic C-phase

25 S_A , S_B , S_G = smectic A,B,G phase

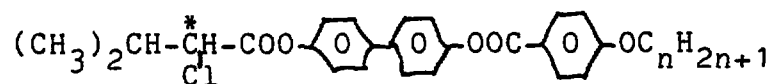
CH = cholesterinic phase

N = nematic phase

Is = isotropic-liquid phase

The temperatures are stated in °C.

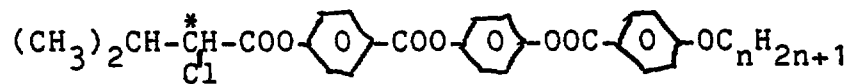
Table 1



n	K	S_C^*	CH	Is

5	.	76	120	198
6	.	86	132	195
7	.	91	140	185
8	.	87	154	188
10	.	82	155	172
12	.	81	159 _A	166171

Table 2



n	K	S_C^*	CH	Is

6	.	84	85	208
7	.	95	100	191
8	.	94	109	188
9	.	95	-	191

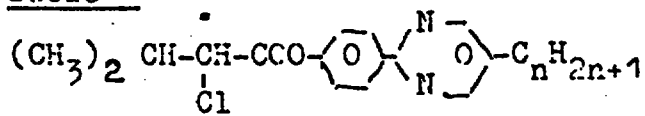
Table 3 $(CH_3)_2CH-CH(Cl)-COO-\langle O \rangle-X-\langle B \rangle-Y-\langle C \rangle-R^2$

X	Y	$\langle B \rangle$	$\langle C \rangle$	R ²	K	S _B	S _C	S _A	CH	Is
-COO-	-		-	-	•	49 -	•	58 -	•	•
-COO-	-OCC-			OC ₈ H ₁₇ OC ₅ H ₁₁	•	180 -	•	202 -	•	•
-COO-	-			C ₆ H ₁₃	•	85 -	-	-	•	•
-	-OCC-			C ₅ H ₁₁	•	100 •	156 -	•	•	•
-	-OCC-			C ₆ H ₁₃	•	95 •	151.5 -	•	•	•
-	-OCC-			C ₇ H ₁₅	•	•	•	-	•	•
-	-OCC-			C ₁₂ H ₂₅	•	80 •	149 -	•	173 -	•
-	-OCC-			C ₆ H ₁₃	•	88 •	93 -	•	•	•
-	OCC			C ₆ H ₁₃	•	88 •	93 •	-	140 •	•
-	OCC			O-C ₃ H ₇	•	113 -	-	155 -	•	•
-	CCC			O-C ₄ H ₉	•	106 -	-	126 -	•	•
-	CCC			O-C ₉ H ₁₉	•	82 -	-	152 -	•	•

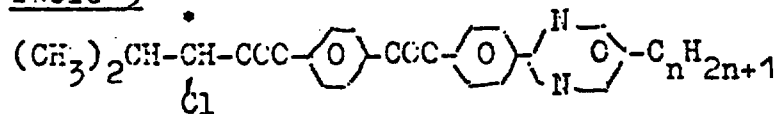
1) Blue phase at 72 - 74° C.

2) Decomposition

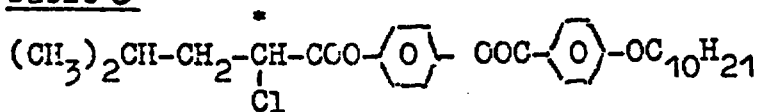
3) S_G phase, not S_B

Table 4

n	K	is
7	.	60 .
5	9	. 45 .

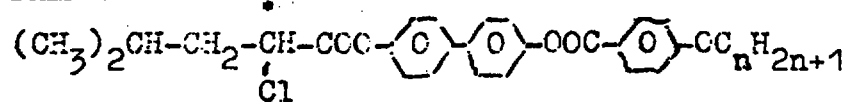
Table 5

n	K	S	CH	is
7	.	70 .	96 .	202 .
10	9	. 62 .	69 .	157 .

Table 6

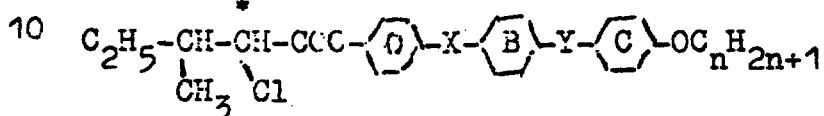
K	S _C [*]	S _A	is
.	44 (. 34) .	58 .	

Table 7



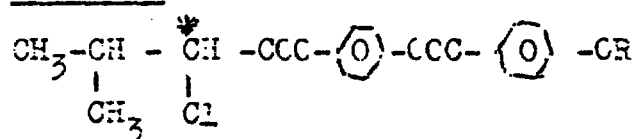
n	K	S _C	S _A	CH	Is
5	5	99	116	158	.
6	.	86	122	142	156
7	.	81	132	145	160
8	.	80-82	137	154	160

Table 8



x	B	Y	C	n	K	S _A	CH	Is
-OOC-		-	-	8	70	(. 48	.	63)
-		-OOC-		8	94	.	174	187
-		-OOC-		10	76	.	141	166
-		-OOC-		12	90	.	159	190
OOC		-	-	6	64	(. 42	.	45)
OOC		-	-	7	62	(. 33	.	38)
OOC		-	-	9	60	.	80	-

Table 9



	R	K	S _C *	S _A	CH	Bl.Fh.	I
5	C ₅ H ₁₁	. 92-93			(. 64)	-	.
	C ₆ H ₁₃	. 87-88			(. 58)	-	.
	C ₇ H ₁₅	. 74-75	. (53.5)		. 56	. (58)	.
	C ₈ H ₁₇	. 49	. 58		. 72	. 74	.
	C ₉ H ₁₉	. 65	. (46.5)		. 67	. 70	.
10	C ₁₀ H ₂₁	. 66	. (45).	68	. 70	. 72	.
	C ₁₂ H ₂₅	62-63	. (42).	69	-	-	.

In the following Table 10 substances are named with their conversion points, which are joined together into various mixtures, of which then the conversion temperatures were ascertained.

TABLE 10

Substance No.	Chemical structure	Conversion points			T./°C.			Blue phase	Is
		K	S _C [*]	S _A	CH	SA	CH		
1		•	90	•	153	-	•	188	-
2		•	66 (•)	45)	•	68	•	70	•
3		•	38-39	•	44	•	60	•	62.5
4		•	40	•	51	•	65	-	-
5		•	28.5	•	55.5	•	62	•	68
6		•	55	•	66	-	-	•	89.5
7		•	62.5	•	73.5	-	-	•	90.5

Produced mixtures :

Mixture 1

The mixture consists of

- 5 No. 1 (S)(+)-1-[4-n-octyl-oxybenzoyloxy]-4'-[2-chloro-3-methylbutyryloxy]-biphenyl 25% mol
- No. 2 (S)(+)-4-n-decyloxybenzoic acid-4'-[2-chloro-3-methylbutyryloxy]-phenyl ester 75% mol

Mixture 2

10 The mixture consists of

- No. 1 (S)(+)-1-[4-n-octyloxybenzoyloxy]-4'-[2-chloro-3-methylbutyryloxy]-biphenal 16.1% mol
- No..2 (S)(+)-4-n-decyloxybenzoic acid-4-[2-chloro-3-methylbutyryloxy]-phenyl ester 48.2% mol
- 15 No. 3 (S)-4-n-octyloxybenzoic acid-4-[2-methylbutyloxy]-phenyl ester 35.7% mol

Mixture 3

The mixture consists of

- No. 1 (S)(+)-1-[4-n-octyloxybenzoyloxy]-4'-[2-chloro-3-methylbutyryloxy]-biphenyl 23.75% mol
- 20 No. 2 (S)(+)-4-n-decyloxybenzoic acid-4-[2-chloro-3-methylbutyryloxy]-phenyl ester 71.25% mol
- No. 5 5-n-octyl-2-[4-n-octyloxy-phenyl]-pyrimidine 5.00% mol

25 Mixture 4

The mixture consists of

- No. 1 (S)(+)-1-[4-n-octyloxybenzoyloxy]-4'-[2-chloro-3-methylbutyryloxy]-biphenyl 13.5% mol

No. 2 (S)(+)-4-n-decyloxybenzoic acid-4'-[2-chloro-
-3-methylbutyryloxy]-phenyl ester 25.3% mol

No. 4 (S)-4-n-decyloxybenzoic acid-4-[2-methylbutyloxy]
-phenyl ester 61.2% mol

5 Mixture 5

The mixture consists of

No. 1 1(S)(+)-1-[4-n-octyloxybenzoyloxy]-4'-[2-chloro-
3-methylbutyryloxy]-biphenyl 11.5% mol

No. 2 (S)(+)-4-n-decyloxy-benzoic acid-4-[2-chloro-
3-methylbutyryloxy]-phenyl ester 21.5% mol

No. 4 (S)-4-n-decyloxy-benzoic acid-4-[2-methyl-
butyloxy]-phenyl ester 52.0% mol

No. 5 5-n-octyl-2-[4-n-octyloxy-phenyl]-pyrimidine
15.0% mol

15 Mixture 6

The mixture consists of

No. 1 (S)(+)-1-[4-n-octyl-oxybenzoyloxy]-4'-
[2-chloro-3-methylbutyryloxy]-biphenyl 5% mol

No. 3 (S)-4-n-octyloxy benzoic acid-4-[2-methyl
butyloxy]-phenyl ester 56% mol

No. 6 4-n-octyloxy-benzoic acid-4-n-hexyloxy phenyl ester
22.8% mol

No. 7 4-n-octyloxy-benzoic acid-4-n-octyloxy phenyl ester
16.2% mol

25 Mixture 7

The mixture consists of

No. 2 (S)(+)-4-n-decyloxybenzoic acid-4-[2-chloro-

	3-methylbutyryloxy]-phenyl ester	10% mol
No. 3	(S)-4-n-octyloxybenzoic acid-4-[2-methyl butyloxy]-phenyl ester	53% mol
No. 6	4-n-octyloxybenzoic acid-4-n-hexyloxy phenyl ester	21.6% mol
No. 7	4-n-octyloxybenzoic acid-4-n-octyloxy phenyl ester	15.3% mol

Mixture 8

The mixture consists of

10	No. 1 (S)(+)-1-[4-n-octyloxybenzoloxy]-4'- [2-chloro-3-methyloxybutyryloxy]-biphenyl	9.5% mol
	No. 2 (S)(+)-4-n-decyloxybenzoic acid-4-[2-chloro -3-methylbutyryloxy]-phenyl ester	17.67% mol
15	No. 4 (S)-4-n-decyloxybenzoic acid -4-[2-methyl- butyloxy] -phenyl ester	42.79% mol
	No. 6 4-n-octyloxybenzoic acid-4-n-hexyloxy phenyl ester	17.5% mol
	No. 7 4-n-octyloxybenzoic acid-4-n-octyloxy phenyl ester	12.54% mol

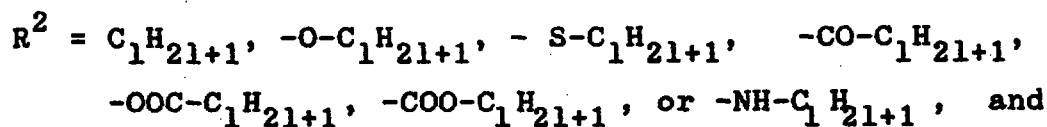
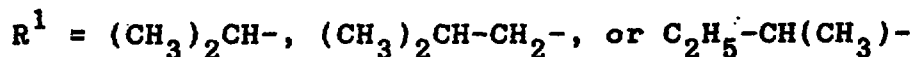
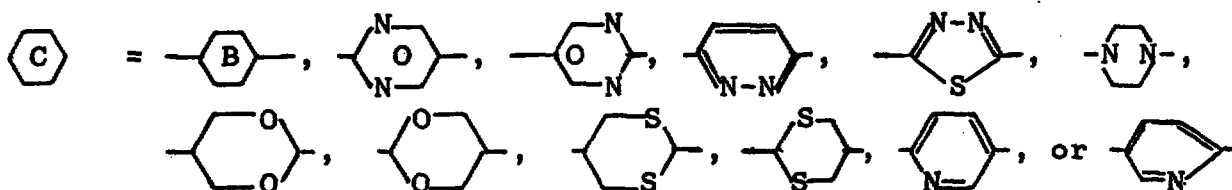
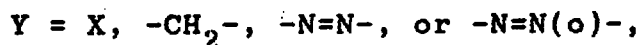
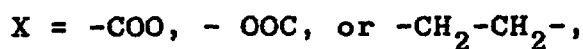
Conversion temperatures of the mixtures

Mixture Conversion points

	K	S _C	S _A	CH	Blue phase	Is
1	. 23	. 63	. 86.5	. 92	. 100	.
2	. 18	. 45	. 75	. 89	- -	.
3	. 24	. 58	. 85.5	. 90.5	. 96.5	.
4	. 21	. 52	. 77	. 82	- -	.
5	. 15	. 39	. 70	. 76	- -	.
6	. 17.5	. 55	. 66	. 79.5	- -	.
7	. 17	. 48	. 68	. 74	- -	.
8	. 28	. 54	. 76	. 81.5	- -	.

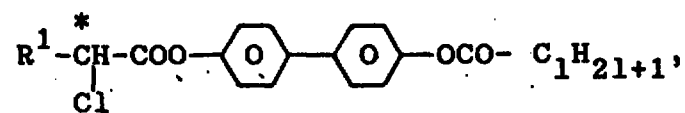
All mixtures possess ferro-electric phases which are stable at room temperature or somewhat higher temperatures.

1. Ferro-electric crystalline-liquid derivatives of branched acyclic α -chlorocarboxylic acids of the general Formula:



1 = 1 to 12,

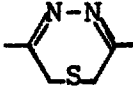
with the exclusion of the substances of the class:





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and wherein if any of the rings A, B or C if present is  and o is O then X is not -COO, OOC-, or a single bond; and if R^1 is $(CH_3)_2CH-$ or $(CH_3)_2CH-CH_2$ and the ring C is either a

single bond or a ring other than  then Y when present is is not X.

2. Process for the production of the compounds according to Claim 1, characterised in that α -chlorocarboxylic acids or α -chlorocarboxylic acid chlorides or bromides are reacted with corresponding hydroxy compounds directly or in the presence of strongly dehydrating substances.

3. Process according to Claim 2, characterised in that the derivatives obtained from the natural amino acids L-Valin, L-Leucin and L-Isoleucin by reaction with nitric and hydrochloric acid are used as α -chlorocarboxylic acids or α -chlorocarboxylic acid chlorides or bromides.

4. Process according to Claim 2, characterised in that the α -chlorocarboxylic acids or chlorides or bromides obtained from the optically active opposites D-Valin, D-Leucin and D-Isoleucin are used.

5. Process according to Claims 2 to 4, characterised in that the α -chlorocarboxylic acids are reacted with the corresponding hydroxy compounds in the presence of strongly dehydrating substances, preferably carbodiimides such as dicyclohexyl carbodiimide, 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide-methiodide or 1-(3-dimethylaminopropyl)-3-ethyl-carbodiimide-methio-p-toluene sulphonate.



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6. Process according to Claims 2 to 5, characterised in that the α -chlorocarboxylic acids, chlorides or bromides are esterified with the corresponding hydroxy compounds according to the method of Schotten-Baumann or according to the variant of Einhorn.

7. The use as a component in a liquid crystal composition of the compounds according to the general Formula according to Claim 1, characterised in that the compounds are used in mixtures with one another, generally with other crystalline-liquid or non-crystalline-liquid substances.

8. Ferro-electric crystalline-liquid derivatives of branched acyclic α -chlorocarboxylic acids as claimed in Claim 1, substantially as described in any one of the examples.

9. Process for the production of the compounds according to Claim 1, as claimed in Claim 2, substantially as described in any one of the examples.
