

Liquid Crystal Compound

The present invention relates to liquid crystal compounds, particularly ferroelectric liquid crystal compounds or compounds for use in the preparation of liquid crystal mixtures having ferroelectric properties.

5 The use of ferroelectric liquid crystal phases in the preparation of ferroelectric liquid crystal devices is known. See, for example, Clark and Largerwall, *Appl. Phys. Lett.* 1980, 36, 899. Ferroelectric liquid crystal devices (FLCDs) have been found to overcome the limitations associated with devices based on nematic liquid crystal (LC) compounds and mixtures. These limitations include a limited range of viewing angles
10 and relatively slow switching times.

Ferroelectric liquid crystal (FLC) phases comprise chiral smectic liquid crystal compounds. In smectic phases, the LC molecules are arranged in layers. The director can be either orthogonal to the layer (e.g. smectic-A or S_A) or tilted (smectic-C or S_C). For ferroelectricity to occur, at least one component comprising the liquid crystal phase
15 has to be chiral. The chiral S_C -phase is denoted by S_C^* . A FLC-mixture usually comprises one or more non-chiral components and one or more chiral dopants. The non-chiral component is generally not required for the preparation of FLCs. However, the preparation of FLC mixtures containing a non-chiral component means that there is a large design flexibility available in respect to the manufacture of LCDs.

20 The spontaneous polarization associated with ferroelectric liquid crystal phases and the strong interaction of such liquid crystal phases with applied electric fields means that these materials are able to provide a very fast electro-optic response, Meyer et al. *J. Physique Lett.* 1975, 36, L-69- L-71. In addition, in contrast to nematic LCs, ferroelectric liquid crystals are able to exhibit a linear electro-optic response in the field.
25 This means that ferroelectrics can be switched on and off with equal speed by reversing the sign of the applied voltage: in contrast to nematic LCDs, both transitions are driven by the electric field.

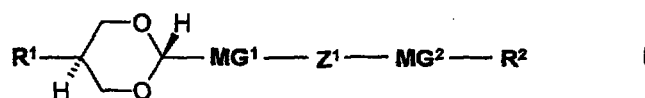
The use of pyrimidinyl compounds in liquid crystal applications is well known. US 4,774,020 discloses liquid crystal materials, which include a pyrimidinyl dioxane
30 derivative. These compounds have been used in nematic liquid crystal applications.

Examples of known pyrimidinyl compounds that have found application in ferroelectric liquid crystal applications can be found in WO 96/30344. These include halogen substituted pyrimidinyl dioxane derivatives.

The properties of the LC material used in the manufacture of ferroelectric liquid crystal (FLC) displays exerts a strong influence over the functioning of the display. Apart from the requirement that the FLC exhibit a ferroelectric phase over the entire operating temperature range, there are quite a number of additional requirements that have to be met by the FLC material. These include a low viscosity, large electro-optic effect and chemical and photochemical stability to name but a few.

There is, therefore, a need for further liquid crystalline compounds that are able to meet, at least in part, the above mentioned requirements and which can be used in the preparation of ferroelectric liquid crystal phases. The present invention addresses that need.

A first aspect of the invention provides a compound of formula (I)

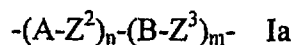


in which

R^1 represents a chiral or non-chiral, branched or straight chain C_{1-20} alkyl or C_{1-20} alkenyl, which may be optionally substituted by one or more halogen atoms and in which one or more non-adjacent $\text{-CH}_2\text{-}$ groups may be optionally replaced by -CH=CH- , -O- , -CO- , -COO- , -OOC- , -O-OC-O- or -S- ;

R^2 represents a chiral or non-chiral, branched or straight chain C_{1-20} alkoxy, C_{1-20} alkenyloxy, C_{1-20} alkylcarbonyloxy (alkyl-COO-) or C_{1-20} alkenylcarbonyloxy (alkenyl-COO-), which may be optionally substituted by one or more halogen atoms and in which one or more non-adjacent $\text{-CH}_2\text{-}$ groups may be optionally replaced by -CH=CH- , -O- , -CO- , -COO- , -OOC- , -O-OC-O- or -S- .

MG¹ represents a group of formula Ia



5 in which A and B are each independently a 1,4-phenylene or 1,4-cyclohexylene group, which may each be optionally substituted by halogen, cyano or nitro or a group of formula R¹ and in which one or two non-adjacent -CH- or -CH₂- groups may be optionally replaced by nitrogen or oxygen respectively;

10

Z¹, Z², Z³ independently represent a single bond, -COO- or -OOC-, -CH₂CH₂-, -CH=CH-, -C≡C-, -OCH₂- or -CH₂O-;

m and n are each independently 0 or 1; and

15

MG² represents a 1,4 phenylene group which may be optionally substituted by halogen, cyano or nitro or a group of formula R¹ and in which one or two non-adjacent -CH- groups is replaced by nitrogen.

20 The dioxane-pyridine and -pyrimidine derivatives of the present invention may be included in ferroelectric LC mixtures. This allows a skilled person to selectively optimize certain mixture parameters. The parameters that can be optimized include:

1. A wide S_C-phase. This is important not only because the addition of the new
25 components increases the useful phase range, but because it also allows the replacement of existing S_C-components (which are e.g. not stable) without reducing the S_C-range.
2. A large tilt angle. This is important in applications such as DHF-LCDs because it facilitates the preparation of devices having a high brightness.
- 30 3. The suppression of the S_A-phase. This is important in applications such as APD-LCDs which require an N-S_C* transition without an intervening S_A-phase.

4. A low birefringence Δn . The dioxane-phenyl-pyrimidine compounds of the present invention have lower birefringence than other common wide temperature range S_C -components. Lower birefringence is desired for most FLC-LCDs because it enables devices to be prepared having larger cell gaps d , which significantly reduces production difficulties and costs.

It will therefore be appreciated that the use of these compounds either alone or in combination with other liquid crystal components leads to the preparation of LCDs having superior performance characteristics.

- 10 The group R^1 is preferably a branched or straight chain C_{5-16} alkyl group.

The group R^2 is preferably a branched or straight chain C_{5-16} alkoxy or C_{5-16} alkenyloxy group.

The groups R^1 and R^2 may, independently of each other, be chiral.

- 15 The group MG^1 is preferably a 1,4-phenylene group, which is optionally substituted by halogen, cyano, nitro, an alkyl or alkoxy group.

Z^1 , Z^2 and Z^3 are each preferably a single bond.

The term "alkyl" should be understood to include groups such as methyl, ethyl, propyl, butyl, pentyl, hexyl, heptyl, octyl, nonyl, decyl, undecyl and dodecyl.

- 20 The term "alkenyl" should be understood to include groups such as E or Z alkenyl as well as alkenyl groups with a terminal double bond. Examples of such groups include allyl, 2-butenyl, 2-pentenyl, 2-hexenyl, 2-heptenyl, 2-octenyl, 2-nonenyl, 2-decenyl, 3-butenyl, 3-pentenyl, 3-hexenyl, 3-heptenyl, 3-octenyl, 3-nonenyl, 3-decenyl, 4-pentenyl, 4-hexenyl, 4-heptenyl, 4-octenyl, 4-nonenyl, 4-decenyl, 5-hexenyl, 6-heptenyl, 7-octenyl, 25 8-nonenyl, 9-decenyl, 10-undecyl, 11-dodecenyl and the like.

The term "alkoxy" should be understood to include groups such as methoxy, ethoxy, n-propoxy, isopropoxy, butoxy, pentyloxy, hexyloxy, heptyloxy, octyloxy, nonyloxy, decyloxy, undecyloxy and dodecyloxy.

- 30 The term "alkenyloxy" should be understood to include groups such as 2E-alkenyloxy, 3Z-alkenyloxy, 4E-alkenyloxy and alkenyloxys with a terminal double bond. The terms "2E-alkenyloxy", "3Z-alkenyloxy" and "4E-alkenyloxy" embrace straight chain alkenyloxy groups with 3 or more, 4 or more and 5 or more carbon atoms respectively in

which the double bond is present in the 2, 3 and 4 positions respectively, with E and Z denoting the configuration of the double bond. Such groups include 2E-butenyloxy, 2E-pentenylloxy, 2E-hexenylloxy, 2E-heptenylloxy, 2E-octenylloxy, 2E-nonenylloxy, 2E-decenylloxy, 3-butenylloxy, 3Z-pentenylloxy, 3Z-hexenylloxy, 3Z-heptenylloxy, 3Z-octenylloxy, 3Z-nonenylloxy, 3Z-decenylloxy, 4-pentenylloxy, 4E-hexenylloxy, 4E-heptenylloxy, 4E-octenylloxy, 4E-nonenylloxy, 4E-decenylloxy, 5-hexenylloxy, 6-heptenylloxy, 7-octenylloxy, 8-nonenylloxy, 9-decenylloxy, 10-undecylloxy, 11-dodecenylloxy and the like.

The term "alkylcarbonyloxy" should be understood to include groups such as methylcarbonyloxy, ethylcarbonyloxy, propylcarbonyloxy, butylcarbonyloxy, pentylcarbonyloxy, hexylcarbonyloxy, octylcarbonyloxy, nonylcarbonyloxy, decylcarbonyloxy, undecylcarbonyloxy and dodecylcarbonyloxy.

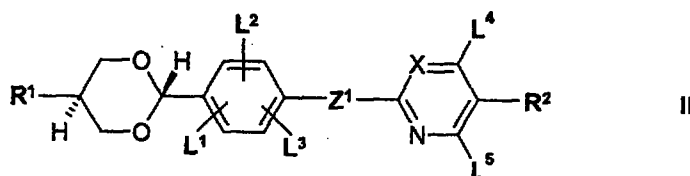
The term "alkenylcarbonyloxy" should be understood to include groups such as 1E-alkenylcarbonyloxy, 2Z-alkenylcarbonyloxy, 3E-alkenylcarbonyloxy, 4Z-alkenylcarbonyloxy and alkenylcarbonyloxys with a terminal double bond. The terms "1E-alkenylcarbonyloxy", "2Z-alkenylcarbonyloxy", "3E-alkenylcarbonyloxy" and "4Z-alkenylcarbonyloxy" embrace straight chain alkenyl groups with 3 or more, 4 or more and 5 or more carbon atoms respectively in which the double bond is present in the 2, 3 and 4 positions respectively, with E and Z denoting the configuration of the double bond. Such groups include allylcarbonyloxy, 2Z-butenylcarbonyloxy, 2Z-pentenylcarbonyloxy, 2Z-hexenylcarbonyloxy, 2Z-heptenylcarbonyloxy, 2Z-octenylcarbonyloxy, 2Z-nonenylcarbonyloxy, 2Z-decenylcarbonyloxy, 3-butenylcarbonyloxy, 3E-pentenylcarbonyloxy, 3E-hexenylcarbonyloxy, 3E-heptenylcarbonyloxy, 3E-octenylcarbonyloxy, 3E-nonenylcarbonyloxy, 3E-decenylcarbonyloxy, 4-pentenylcarbonyloxy, 4Z-hexenylcarbonyloxy, 4Z-heptenylcarbonyloxy, 4Z-octenylcarbonyloxy, 4Z-nonenylcarbonyloxy, 4Z-decenylcarbonyloxy, 5-hexenylcarbonyloxy, 6-heptenylcarbonyloxy, 7-octenylcarbonyloxy, 8-nonenylcarbonyloxy, 9-decenylcarbonyloxy, 10-undecylcarbonyloxy, 11-dodecenylcarbonyloxy and the like.

The term "branched" in relation to the groups R^1 and R^2 should be understood to mean that any of the foregoing alkyl, alkenyl, alkoxy, alkenyloxy, carboxyalkyl or carbonylalkenyl groups may be further substituted with an alkyl or alkenyl group as hereinbefore defined in which one or more hydrogen atoms of the substituted groups may

be replaced by a halogen and wherein one or more non-adjacent $-\text{CH}_2-$ groups may be replaced by $-\text{CH}=\text{CH}-$, $-\text{O}-$, $-\text{CO}-$, $-\text{COO}-$, $-\text{OOC}-$, $-\text{O-OC-O-}$ or $-\text{S}-$.

The term halogen is understood to include groups such as fluorine, chlorine, bromine and iodine.

- 5 In a preferred embodiment of the first aspect of the invention there is provided a compound of formula (II)



in which

R^1 , R^2 and Z^1 are as defined above for the compound of formula (I);

10

L^1 to L^5 represent, independently, hydrogen, halogen, cyano, nitro or a branched or straight chain C_{1-20} alkyl or C_{1-20} alkenyl, which may be optionally substituted by one or more halogen atoms and in which one or more non-adjacent $-\text{CH}_2-$ groups may be optionally replaced by $-\text{CH}=\text{CH}-$, $-\text{O}-$, $-\text{CO}-$, $-\text{COO}-$, $-\text{OOC}-$, $-\text{O-OC-O-}$ or $-\text{S}-$; and

15

X represents $-\text{CH}-$ or nitrogen.

20

The particular preferences for R^1 , R^2 and Z^1 are the same as those defined above for the compound of formula (I).

It is preferred that each of L^1 to L^5 represents hydrogen.

It is preferred that X represents nitrogen

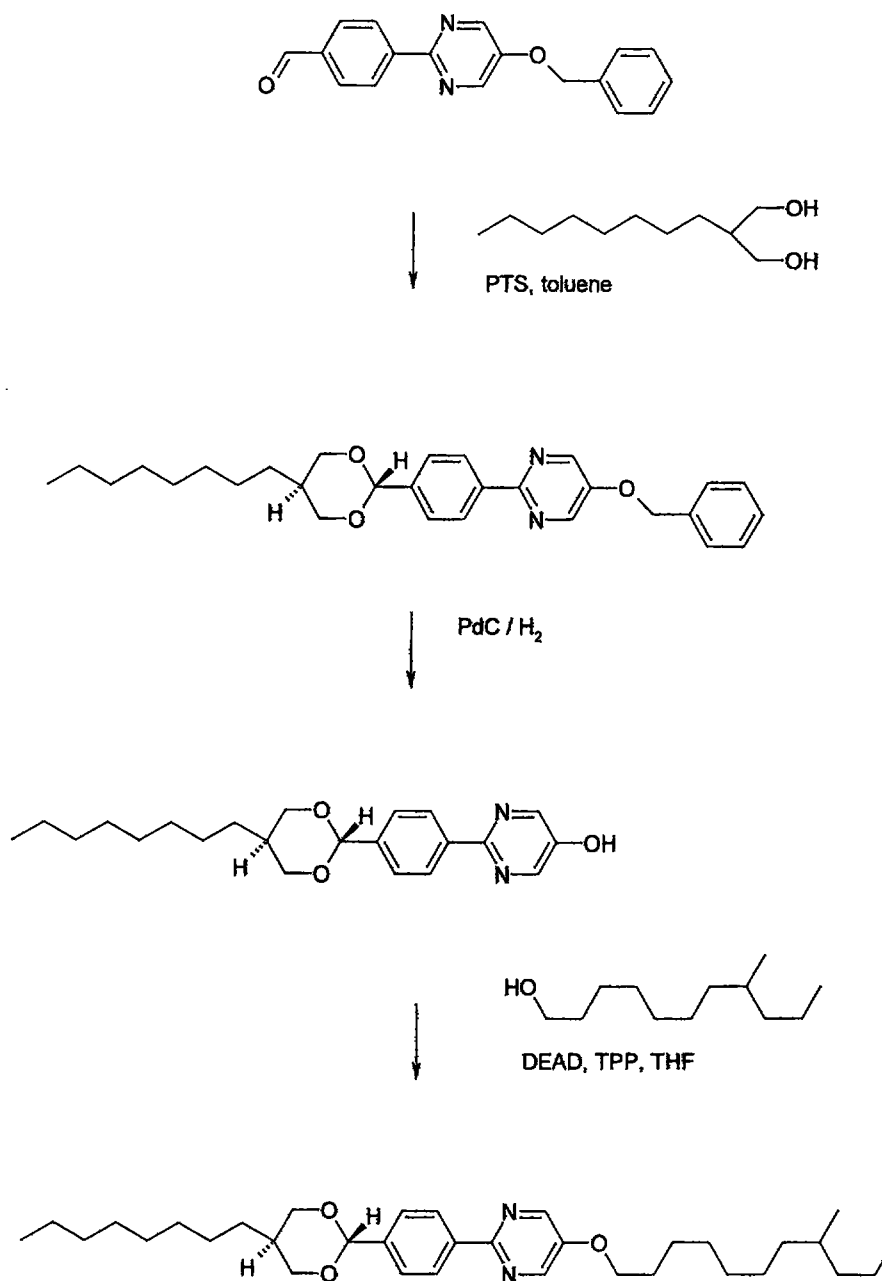
25

The compounds of the invention may be readily synthesized using known methods such as those indicated in schemes 1 and 2. A second aspect of the invention provides a method for the preparation of the compounds of the invention which comprises the steps of reacting an ether of 4-(5-hydroxy-2-pyrimidyl)benzaldehyde with a 2-alkylpropane-1,3-diol to form a dioxane ring.

It should be appreciated that it is not necessary to protect the ether oxygen of the starting material of Scheme 1 with a benzyl group. An alternative preparative method

would require the reaction of a long chain alkyl derivative with a diol to form a dioxane ring, thereby removing the necessity to deprotect the hydroxy group by catalytic hydrogenation.

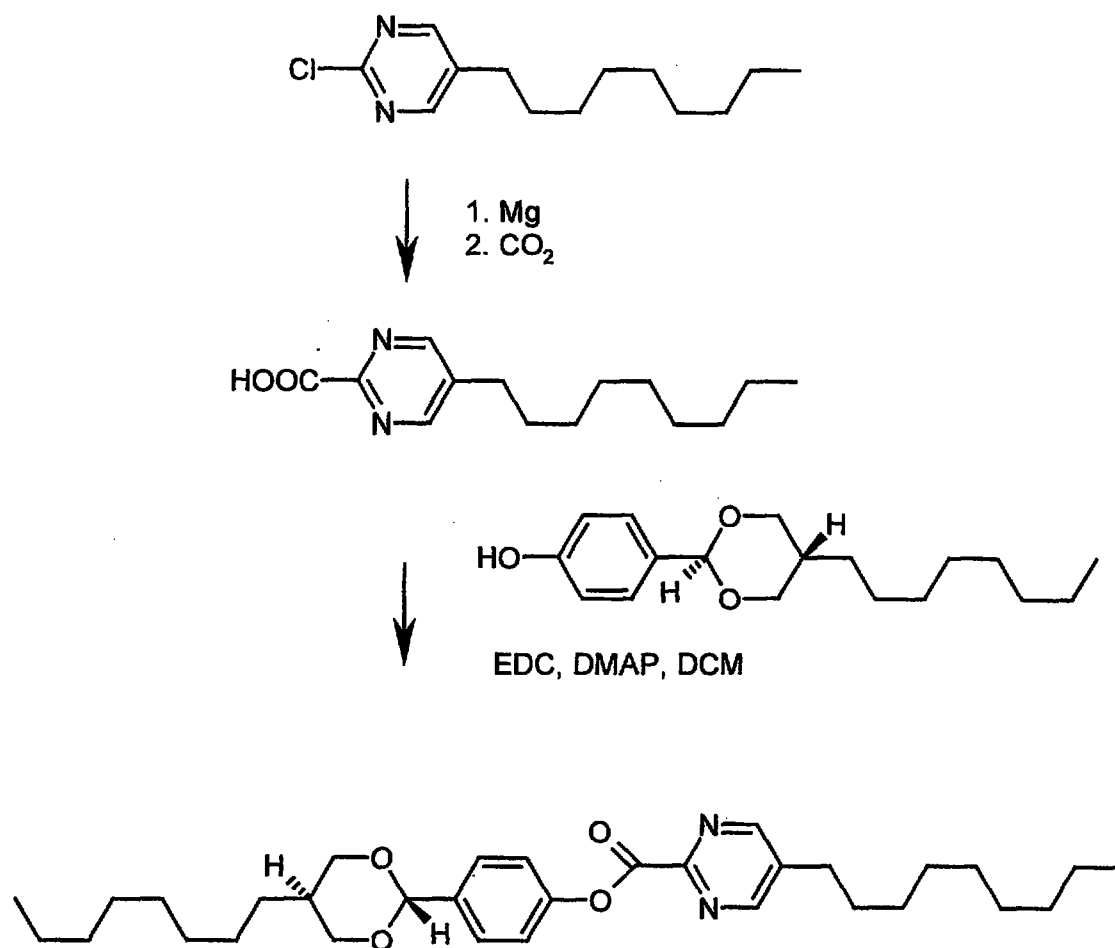
- 5 In an alternative embodiment of the second aspect of the invention, there is provided a method for the preparation of the compounds of formula (I) and (II) which comprises reacting a pyrimidine-2-carboxylic acid with a 2-hydroxy derivative of a 1,3-dioxane. This is exemplified in Scheme 2.



Scheme 1

in which:

THF tetrahydrofuran
 DEAD diethyl azodicarboxylate
 TPP triphenylphosphine
 5 PTS para-toluenesulfonic acid



Scheme 2

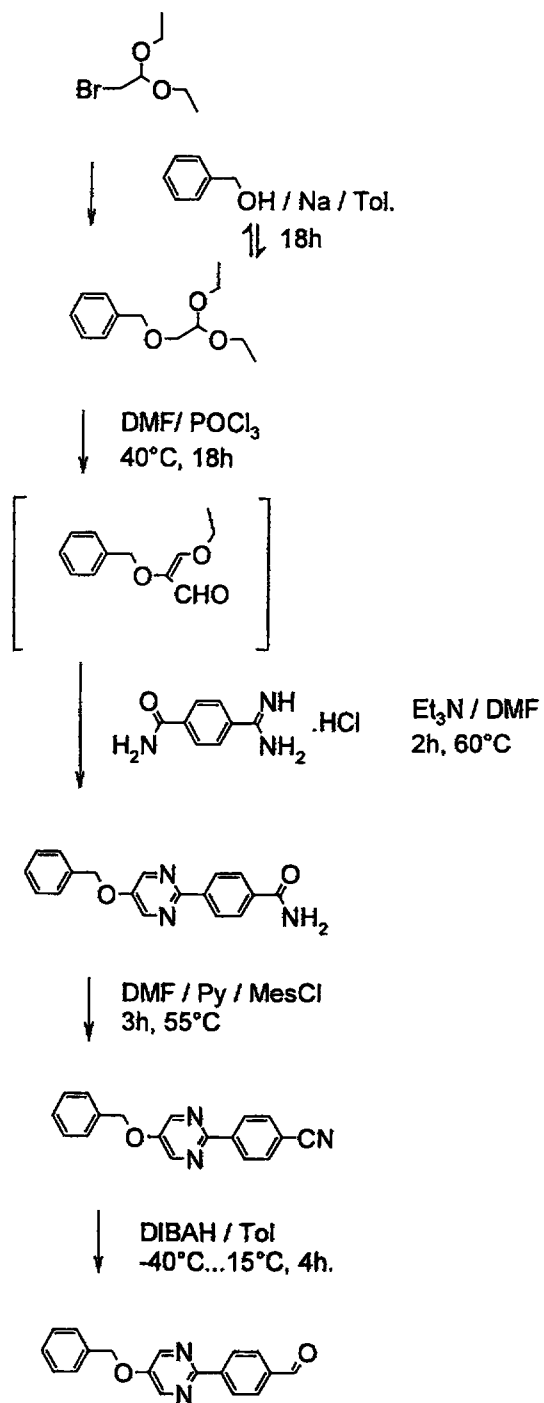
in which:

EDC is *N*-(3-dimethylaminopropyl)-*N'*-ethylcarbodiimide hydrochloride

DMAP is 4-dimethylaminopyridine

DCM is dichloromethane

The starting material used in Scheme 1 may be prepared using the procedure set out in Scheme 3.



Scheme 3

5 in which:

DMF is dimethylformamide

POCl3 is phosphorous oxychloride

Et₃N is triethylamine

Py is pyridine

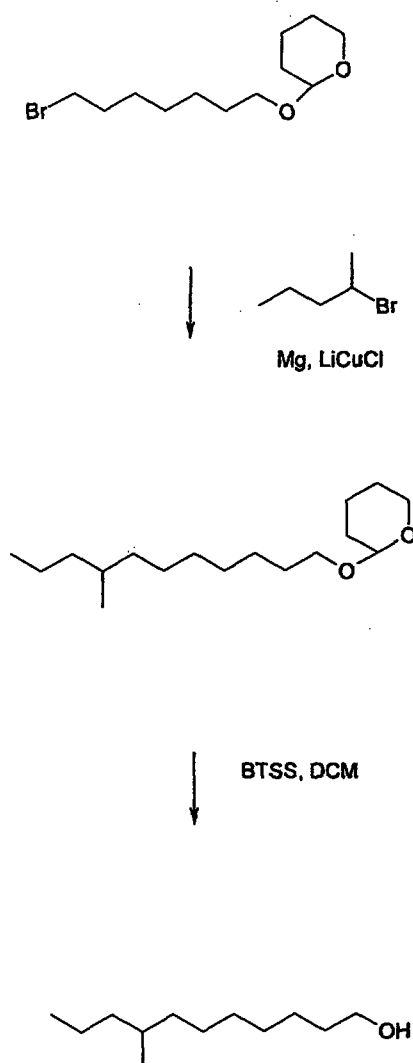
MesCl is mesyl chloride

DIBAH is diisobutylaluminum hydride; and

5 Tol is toluene

The branched alkyl-spacer used in the final step of Scheme 1 was synthesized by Fouquet Schlosser coupling (*Angew. Chem.* 1974, 86(1), 50 - 51) as shown in Scheme 4.

10



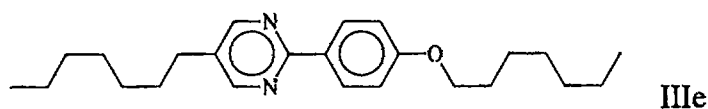
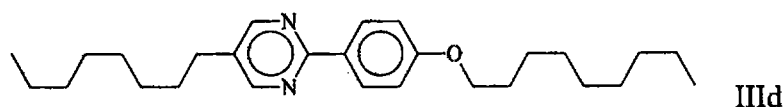
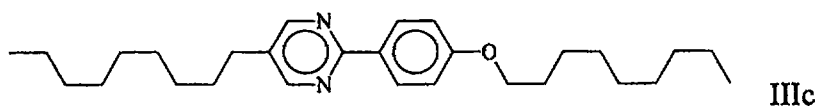
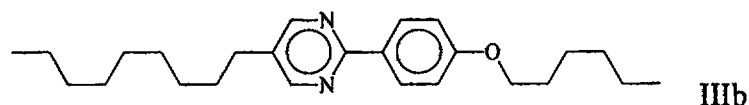
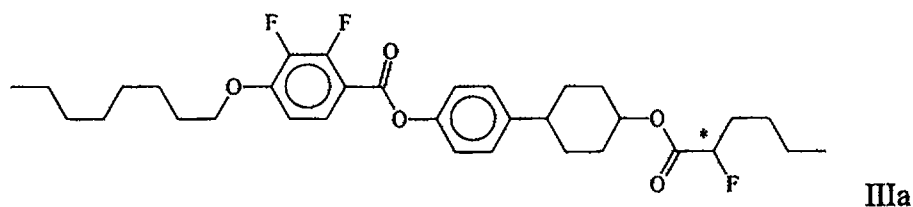
Scheme 4

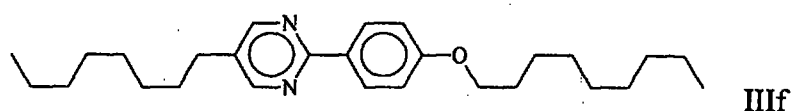
in which:

BTSS bis(trimethylsilyl) sulfate

DCM dichloromethane

The compounds of the invention may be used alone or as a component of a ferroelectric liquid crystal mixture. A third aspect of the invention therefore provides a ferroelectric liquid crystal mixture comprising a compound of formula (I), the liquid crystal mixture comprising at least two components. The additional component or components of the liquid crystal mixture may comprise one or more compounds of formula (I) or, alternatively, may include other suitable known mesogenic or non-mesogenic compounds. The additional liquid crystal components must be miscible with the compounds of formula (I). Examples of known mesogenic materials suitable for use with the compounds of the present invention are listed below. Further examples of additional components that may be used in the mixtures of the present invention can be found in US 4,898,455, US 4,929,278, US 5,082,589, US 5,238,602, US 5,100,577 and US 5,242,619.





5 Ferroelectric liquid crystal mixtures may be readily prepared by admixing the compounds of formula (I) with one or more additional mesogenic or non-mesogenic components. A fourth aspect of the invention therefore provides a method of preparing a ferroelectric liquid crystal mixture comprising admixing a compound of formula (I) with a further mesogenic or non-mesogenic compound. The one or more additional components may include further compounds of formula (I) or other suitable mesogenic or
10 non-mesogenic components such as those referred to above.

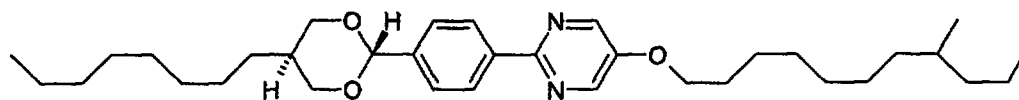
The compounds of the invention may be used in the preparation of ferroelectric liquid crystal devices. As indicated above, such devices have been found to exhibit superior optical and electro-optical properties. A fifth aspect of the invention therefore provides the use of a compound of formula (I) in the preparation of a ferroelectric liquid
15 crystal device. The compounds of formula (I) may be used alone but are most preferably used in the form of a liquid crystal mixture as defined above.

The invention also includes an optic or electro-optic device comprising a compound of formula (I) in addition to an optic or electro-optic device comprising a liquid crystal mixture as defined above.

20 The invention will now be described with reference to the following examples. Variations on these examples falling within the scope of the invention will be apparent to a person skilled in the art.

Example 1

25 Preparation of (RS)-5-(8-Methylundecyloxy)-2-[4-(trans-5-octyl[1,3]dioxan-2-yl)-phenyl]pyrimidine



0.44 g (1.20 mmol) 5-hydroxy-2-[4-(trans-5-octyl[1,3]dioxan-2-yl)-phenyl]pyrimidine and 0.25 g (1.32 mmol) (RS)-8-methyl undecan-1-ol were dissolved in 30 ml tetrahydrofuran (THF). 0.35 g (1.32 mmol) triphenylphosphine and 0.23 g (1.32 mmol) diethyl azodicarboxylate (DEAD) was added and the solution was stirred
5 over night at room temperature. The reaction mixture was then poured into 150 ml water and the product was extracted three times with 50 ml ethyl acetate. The combined organic layers were washed twice with water, dried over magnesium sulfate, filtered and the solvent was evaporated. The crude product was purified by column chromatography on silica gel using cyclohexane/ethyl acetate 7:3 as eluant.
10 Recrystallization from ethanol yields 0.52 g (RS)-5-(8-methylundecyloxy)-2-[4-(trans-5-octyl-1,3-dioxan-2-yl)phenyl]pyrimidine; melting point (C - S_C) 98.8 °C, phase transition (S_C - N) 135.3 °C, clearing point (N - I) 145.6 °C.

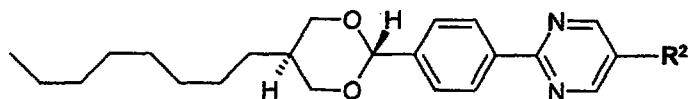
5-hydroxy-2-[4-(trans-5-octyl-[1,3]-dioxan-2-yl)phenyl]pyrimidine used as
15 starting material was prepared by the following method:

- (a) 10.35 g (55 mmol) 2-hydroxymethyldecan-1-ol and 14.45 g (55 mmol) 2-(4-formylphenyl)-5-benzyloxypyrimidine were suspended in 470 ml toluene. Then 0.5 g p-toluenesulfonic acid was added and the reaction
20 water was removed by azeotropic distillation. After cooling slightly the solution was washed three times with 120 ml warm water. The organic layer was evaporated on a rotary evaporator. Then diethyl ether was added and the solution was allowed to crystallize in a cool place. The crystals were filtered and washed with diethyl ether to give 22.0 g
25 (87 %) 5-(benzyloxy)-2-[4-(trans-5-octyl-1,3-dioxan-2-yl)phenyl]-pyrimidine as white crystals.
- (b) 22.0 g (47.7 g) 5-(benzyloxy)-2-[4-(trans-5-octyl-1,3-dioxan-2-yl)phenyl]-pyrimidine was suspended in a mixture containing 500 ml dioxane and 500 ml ethanol. After addition of 2.2 ml triethylamine the mixture was
30 hydrogenated at room temperature for 90 minutes using 2.2 g 10 % Pd/C as hydrogenating catalyst. As soon as the hydrogen uptake was complete, the

reaction mixture was filtered through dicalcite. Then the solvent was removed. Crystallization of the residue from ethanol gave 9.7 g (66 %) 5-hydroxy-2-[4-(trans-5-octyl[1,3]dioxan-2-yl)phenyl]pyrimidine as white crystals.

5

The following compounds can be prepared in a similar fashion:



10

R ²	C-S _x [°C]	C-S _c [°C]	S _x /S _c - N [°C]	N - I [°C]
		123.6	129.0	167.3
		114.3	134.6	161.0
		112.6	139.9	159.0
		105.9	144.1	157.6
		91.8	113.6	134.2
	55.5		123.9	169.2
		112.2	137.0	161.6
		103.5	140.8	155.6
		97.4	127.0	145.4

		89.0	125.1	139.8
		93.8	134.9	142.6
		88.9	136.0	145.6
		86.7	134.2	141.0

In which ---- represents bonding of neighbouring atoms by a single bond

Example 2

Preparation of Ferroelectric Liquid Crystalline Mixtures

- 5 A ferroelectric liquid crystal mixture, SC0-1014, having the composition shown in table I was prepared. The properties of this mixture were compared with a (15/85) mixture of compound (Ia) in SC0-1014. The properties of the two mixtures were compared and the results are shown in table II.

- 10 Table I: The composition of the test mixture SC0-1014.

Weight-%	Structure
16.6	
23.8	
23.4	
11.8	

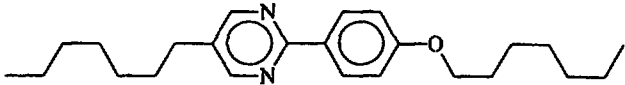
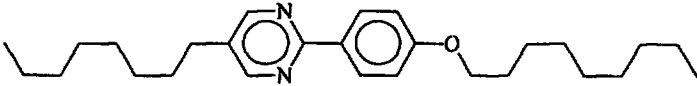
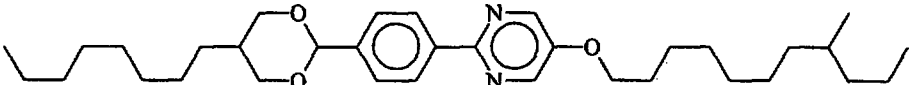
12.1	
12.3	

Table Ia: Compound Ia.

(Ia)	
------	--

5 Table II

	N [C]	S _A [C]	S _C * [C]	2θ [°]
SC0-1014	75.6	67.7	60.6	52.2
15% (Ia) in SC0-1014	81.1	-	66.2	65.9

N, S_A and S_C* are the upper temperature limits of the corresponding LC-phases.

A missing phase is denoted by "-".

- 10 2θ is the observed switching angle at 25°C, measured in test cells with 10V_{pp}/μm square wave field applied.

The test cells have ITO electrodes, low-tilt, parallel-brushed polyimide orientation layers and a cell gap of 10μm.

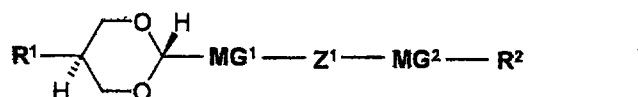
- 15 The data in table II clearly confirms the excellent influence of dioxane-phenyl-pyrimidine compound (Ia) on the mixture parameters of the test mixture. In particular:

- The upper limit of the S_C*-phase is increased by 5.6 °C;
- The clearing point is increased by 5.5 °C; and
- 20 • The switching angle is increased by 13.7°.

Claims



1. A compound of formula (I)

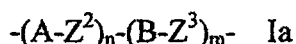


in which

R^1 represents a chiral or non-chiral, branched or straight chain C_{1-20} alkyl or C_{1-20} alkenyl, which may be optionally substituted by one or more halogen atoms and in which one or more non-adjacent $-\text{CH}_2-$ groups may be optionally replaced by $-\text{CH}=\text{CH}-$, $-\text{O}-$, $-\text{CO}-$, $-\text{COO}-$, $-\text{OOC}-$, $-\text{O-OC-O-}$ or $-\text{S}-$;

R^2 represents a chiral or non-chiral, branched or straight chain C_{1-20} alkoxy, C_{1-20} alkenyloxy, C_{1-20} alkylcarbonyloxy (alkyl- $\text{COO}-$) or C_{1-20} alkenylcarbonyloxy (alkenyl- $\text{COO}-$), which may be optionally substituted by one or more halogen atoms and in which one or more non-adjacent $-\text{CH}_2-$ groups may be optionally replaced by $-\text{CH}=\text{CH}-$, $-\text{O}-$, $-\text{CO}-$, $-\text{COO}-$, $-\text{OOC}-$, $-\text{O-OC-O-}$ or $-\text{S}-$

MG^1 represents a group of formula Ia



in which A and B are each independently a 1,4-phenylene or 1,4-cyclohexylene group, which may each be optionally substituted by halogen, cyano or nitro or a group of formula R^1 and in which one or two non-adjacent $-\text{CH}-$ or $-\text{CH}_2-$ groups may be optionally replaced by nitrogen or oxygen respectively;

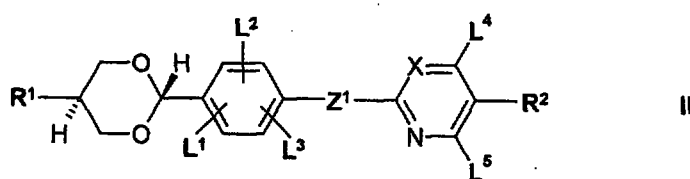
$\text{Z}^1, \text{Z}^2, \text{Z}^3$ independently represent a single bond, $-\text{COO}-$ or $-\text{OOC}-$, $-\text{CH}_2\text{CH}_2-$, $-\text{CH}=\text{CH}-$, $-\text{C}\equiv\text{C}-$, $-\text{OCH}_2-$ or $-\text{CH}_2\text{O}-$;



m and n are each independently 0 or 1; and

MG² represents a 1,4 phenylene group which may be optionally substituted by halogen, cyano or nitro or a group of formula R¹ and in which one or two non-adjacent -CH- groups is replaced by nitrogen.

2. A compound of formula (II)



in which

R¹ represents a chiral or non-chiral, branched or straight chain C₁₋₂₀ alkyl or C₁₋₂₀ alkenyl, which may be optionally substituted by one or more halogen atoms and in which one or more non-adjacent -CH₂- groups may be optionally replaced by -CH=CH-, -O-, -CO-, -COO-, -OOC-, -O-OC-O- or -S-;

R² represents a chiral or non-chiral, branched or straight chain C₁₋₂₀ alkoxy, C₁₋₂₀ alkenyloxy, C₁₋₂₀ alkylcarbonyloxy (alkyl-COO-) or C₁₋₂₀ alkenylcarbonyloxy (alkenyl-COO-), which may be optionally substituted by one or more halogen atoms and in which one or more non-adjacent -CH₂- groups may be optionally replaced by -CH=CH-, -O-, -CO-, -COO-, -OOC-, -O-OC-O- or -S-

Z₁ represent a single bond, -COO- or -OOC-, -CH₂CH₂-, -CH=CH-, -C≡C-, -OCH₂- or -CH₂O-;

L¹ to L⁵ represents hydrogen, halogen, cyano, nitro or a branched or straight chain C₁₋₂₀ alkyl or C₁₋₂₀ alkenyl, which may be optionally substituted by one or more halogen atoms and in which one or more non-adjacent -CH₂- groups



may be optionally replaced by -CH=CH-, -O-, -CO-, -COO-, -OOC-,
-O-OC-O- or -S-; and

X represents -CH- or nitrogen.

- 5
3. A compound according to Claim 1 or 2, in which R¹ is a branched or straight chain C₅₋₁₆ alkyl group.
4. A compound according to any one of claims 1 to 3, in which R¹ is an octyl group.
5. A compound according to any one of the preceding claims, in which the group R² is
- 10 selected from a branched or straight chain C₅₋₁₆ alkoxy or C₅₋₁₆ alkenyloxy group.
6. A compound according to Claim 5, in which R² is selected from the group comprising 2E-octenyloxy, 2E-nonyloxy, 2E-decenyloxy, 2E-undecenyloxy, 2E-dodecenyloxy, octyloxy, decyloxy, dodecyloxy, 7-methyldecyloxy, 7-methylundecyloxy, 8-methyldodecyloxy, 9-methyldodecyloxy and 9-methyltridecyloxy.
- 15 7. A compound according to any one of the preceding claims, in which the groups R¹ and R² are, independently of each other, chiral.
8. A compound according to any one of the preceding claims in which Z¹ is a single bond.
9. A compound according to any one of the preceding claims in which L¹, L², L³, L⁴
- 20 and L⁵ are hydrogen.
10. A method of preparation of a compound of formula (I) or (II) comprising reacting an ether of a 4-(5-hydroxy-2-pyrimidyl)benzaldehyde with a 2-alkyl-1,3-propanediol.
11. A ferroelectric liquid crystal mixture comprising at least two components, characterized in that one of the components is a compound of formula (I) or (II) as
- 25 defined in any one of claims 1 to 9.
12. Use of a compound of formula (I) or (II) according to any one of claims 1 to 9, or a liquid crystal mixture according to Claim 11 in the preparation of an optic or an electro-optic device.
13. An optic or electro-optic device comprising a compound of formula (I) or (II) as
- 30 defined in any one of claims 1 to 9 or a liquid crystal mixture as defined in Claim 11.