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Hong et al.

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(45) **Date of Patent: Feb. 26, 2019**

(54) **LIQUID CRYSTAL COMPOSITION AND A LIQUID CRYSTAL DISPLAY INCLUDING THE SAME**

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(73) Assignee: **SAMSUNG DISPLAY CO., LTD.**, Yongin-si, Gyeonggi-do (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 39 days.

(21) Appl. No.: **15/490,392**

(22) Filed: **Apr. 18, 2017**

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(30) **Foreign Application Priority Data**

Apr. 19, 2016 (KR) 10-2016-0047577

(51) **Int. Cl.**

G02F 1/1333 (2006.01)
C09K 19/32 (2006.01)
G02F 1/1343 (2006.01)

(52) **U.S. Cl.**

CPC ***C09K 19/32*** (2013.01); ***G02F 1/134309*** (2013.01); *G02F 2001/134345* (2013.01); *G02F 2201/121* (2013.01); *G02F 2201/123* (2013.01)

(58) **Field of Classification Search**

CPC . C09K 19/32; G02F 1/1333; G02F 1/134309; G02F 2001/134345; G02F 2201/121; G02F 2201/123

USPC 252/299.62

See application file for complete search history.

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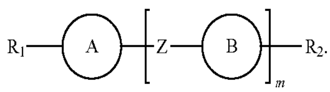
(57) **ABSTRACT**

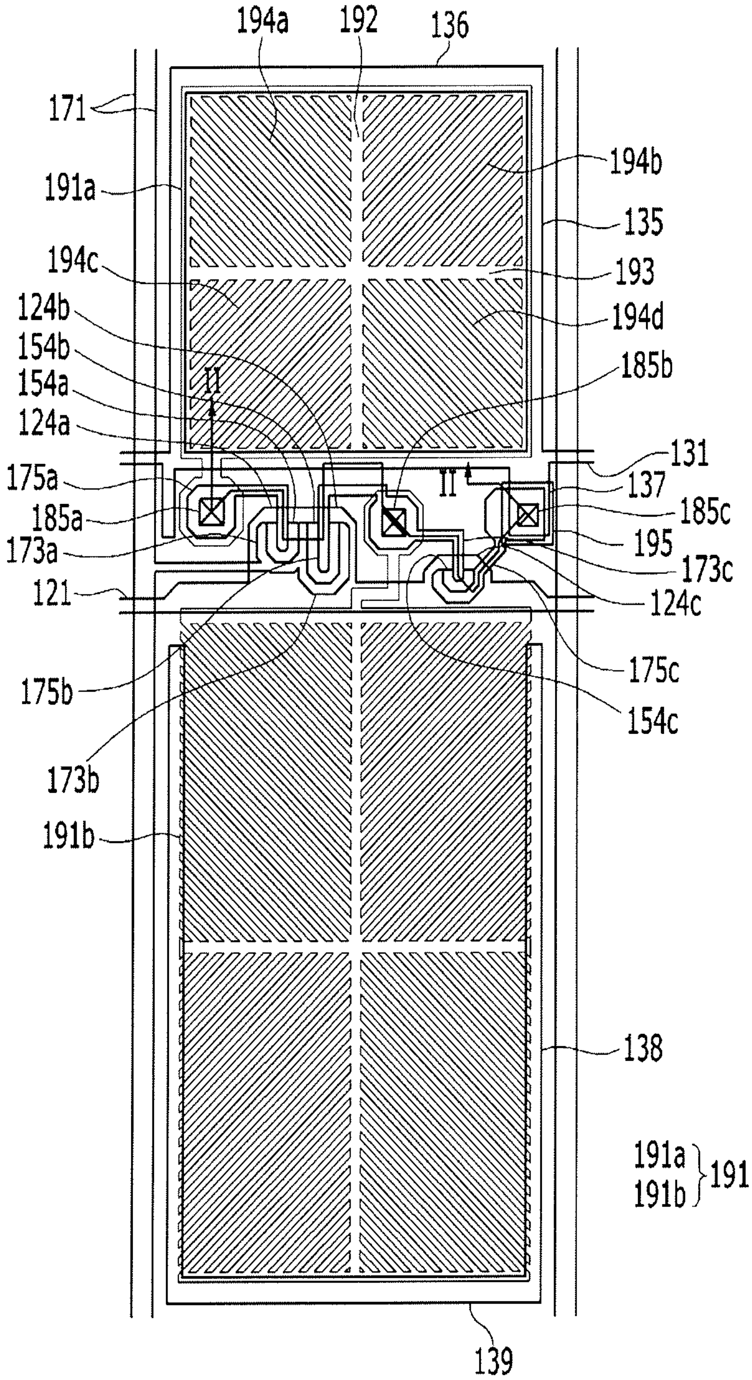
A liquid crystal composition including a liquid crystal compound represented by Formula 1:

[Formula 1]



20 Claims, 2 Drawing Sheets

FIG. 1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185a
185c
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173b
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191a
191b
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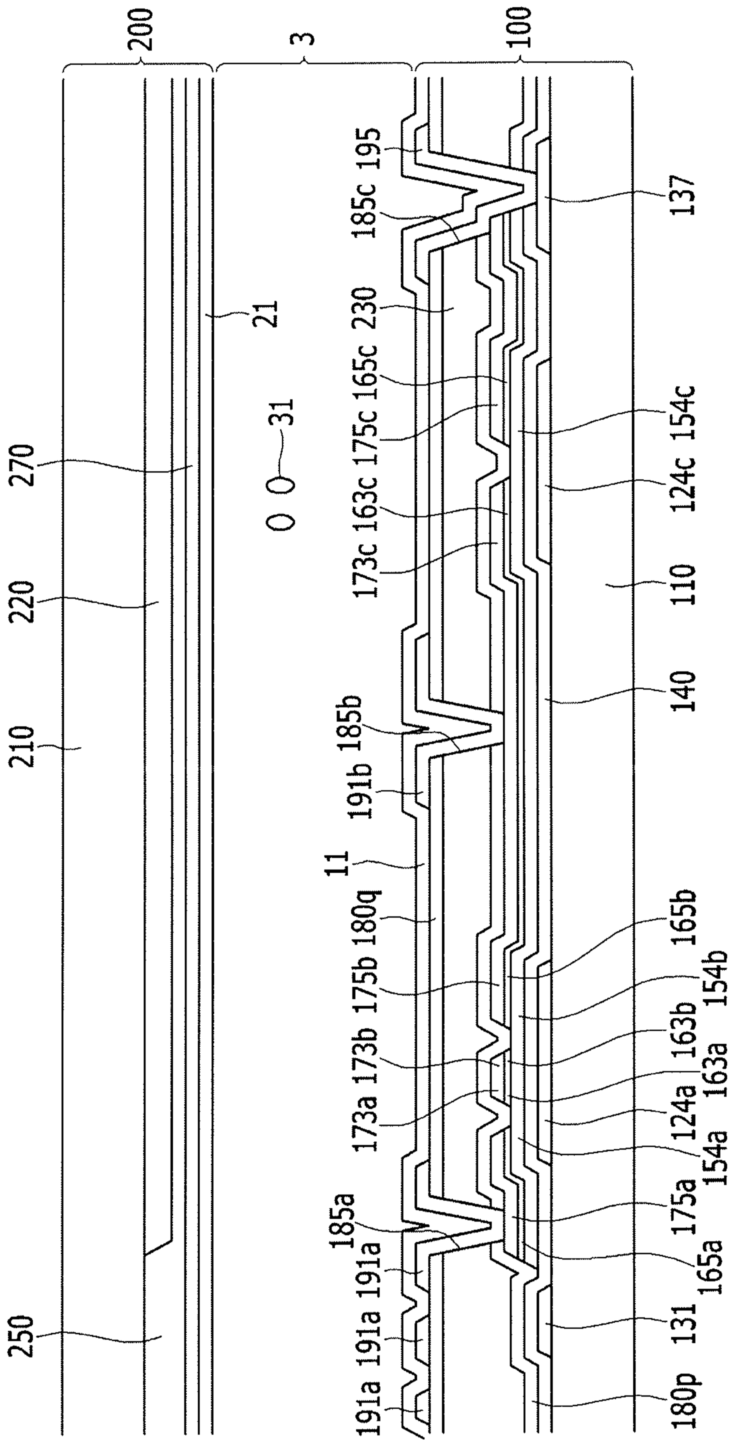
FIG. 2



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180q
175b
173b
173a
185a
191a
191a
191a
137
154c
124c
110
140
165b
154b
163b
163a
124a
154a
175a
165a
131
180p

LIQUID CRYSTAL COMPOSITION AND A LIQUID CRYSTAL DISPLAY INCLUDING THE SAME

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority under 35 U.S.C. § 119 to Korean Patent Application No. 10-2016-0047577 filed in the Korean Intellectual Property Office on Apr. 19, 2016, the disclosure of which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

Exemplary embodiments of the present invention relate to a liquid crystal composition, and more particularly to a liquid crystal display device including the same.

DISCUSSION OF RELATED ART

A liquid crystal display (LCD) is a type of display device. The liquid crystal display may determine a direction of liquid crystal molecules of a liquid crystal layer. The liquid crystal display may control a transmittance of light passing through the liquid crystal layer, for example, by applying a voltage to field generating electrodes. Thus, an electric field in the liquid crystal layer may be generated.

The liquid crystal layer may control the transmittance of light for the liquid crystal display to produce a desired image. Liquid crystal displays may have various characteristics, such as relatively low-voltage driving, a relatively high voltage holding ratio (VHR), a relatively wide viewing angle, a relatively wide operation temperature range, and a relatively high response speed.

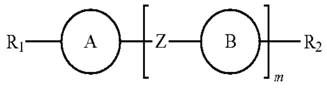
A liquid crystal display with a relatively high response speed may be produced by a relative increase in the several properties of the liquid crystal display, such as a rotational viscosity, a refractive index, or an elastic coefficient included in the liquid crystal composition.

SUMMARY

One or more exemplary embodiments of the present invention provide a liquid crystal composition which may reduce a rotational viscosity to produce a relatively high speed response characteristic, and a liquid crystal display including the same.

One or more exemplary embodiments of the present invention provide a liquid crystal composition. The liquid crystal composition includes a liquid crystal compound represented by the following Formula 1.

[Formula 1]



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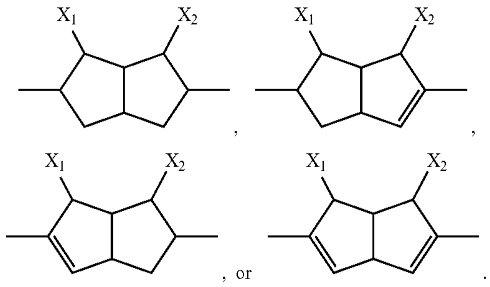
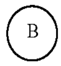


X_1 and X_2 are each independently selected fluorine, CF_3, or C_nH_{2n+1}. Z is selected from a single bond, a double bond, CF_2CF_2, OCF_2, or CF_2O. R_1 is selected from hydrogen, fluorine, CF_3, C_nH_{2+1}, or $C_nH_{2n+1}O$. R_2 is selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or OC_nH_{2n+1}.



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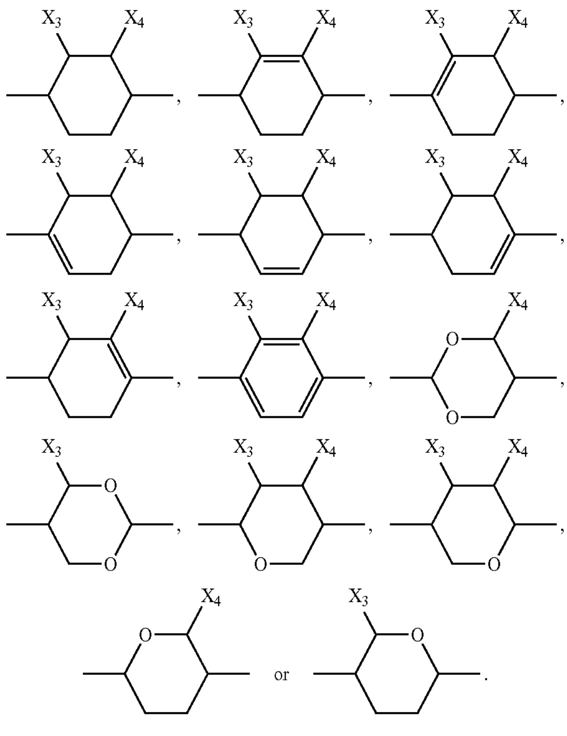
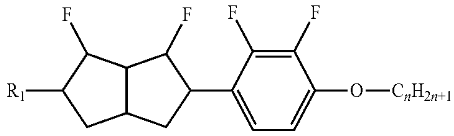


X_3 and X_4 are each independently selected from hydrogen, fluorine, CF_3, or C_nH_{2n+1}, m is a natural number selected from 1 or 2, n is a natural number selected from 1 to 5.

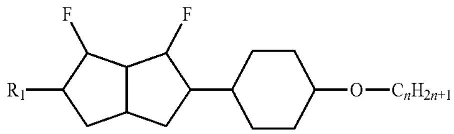
The content of the liquid crystal compound represented by Formula 1 may be in an amount ranging from about 1 wt % to about 20 wt % of the liquid crystal composition.

The liquid crystal compound represented by Formula 1 may include a liquid crystal compound represented by the following Formulae 1-1 to 1-5.

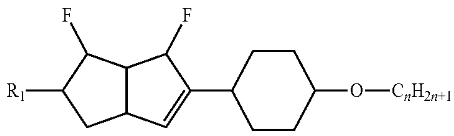
[Formula 1-1]



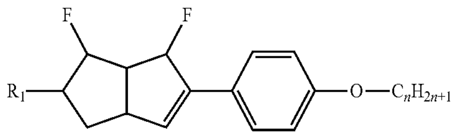
[Formula 1-2]



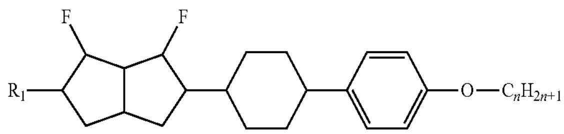
[Formula 1-3]



[Formula 1-4]



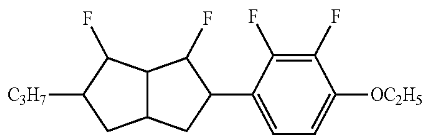
[Formula 1-5]



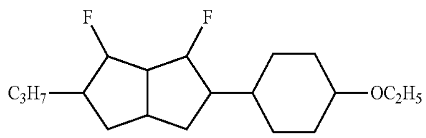
R_1 may be selected from hydrogen, fluorine, CF_3, C_nH_{2+1}, or $C_nH_{2n+1}O$, n may be a natural number selected from 1 to 5.

The liquid crystal compound represented by Formula 1 may include a liquid crystal compound represented by the following Formulae 1-6 to 1-10.

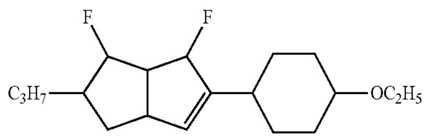
[Formula 1-6]



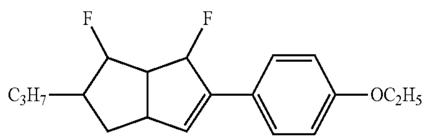
[Formula 1-7]



[Formula 1-8]



[Formula 1-9]



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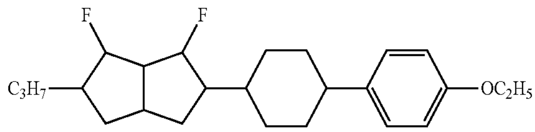
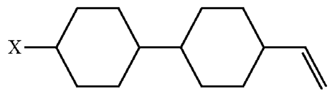
[Formula 1-10]

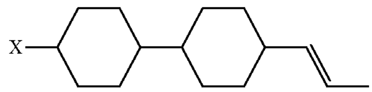


The liquid crystal composition may further include at least one liquid crystal compound selected from liquid crystal compounds represented by the following Formulae 2 to 10.

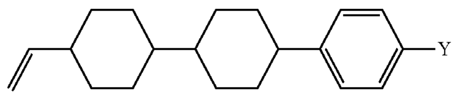
[Formula 2]



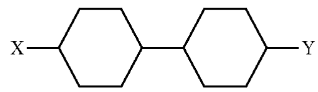
[Formula 3]



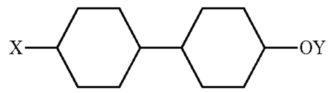
[Formula 4]



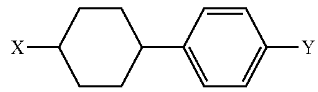
[Formula 5]



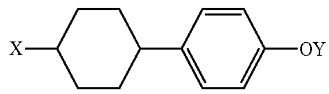
[Formula 6]



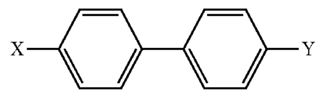
[Formula 7]



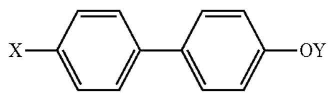
[Formula 8]



[Formula 9]



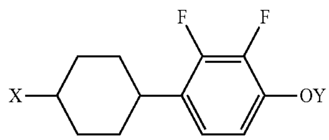
[Formula 10]



X and Y may each independently be C_nH_{2n+1}, n may be a natural number selected from 1 to 5.

The liquid crystal composition may further include at least one liquid crystal compound selected from liquid crystal compounds represented by the following Formulae 11 to 20.

[Formula 11]



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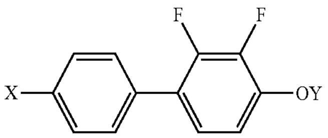
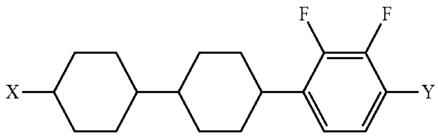
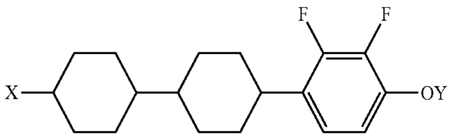
[Formula 12]



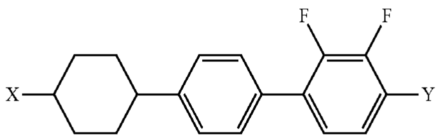
[Formula 13]



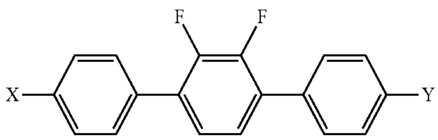
[Formula 14



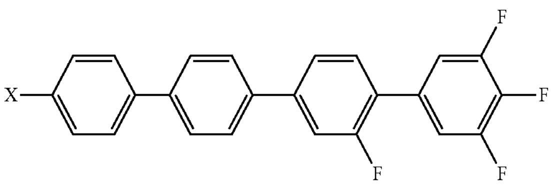
[Formula 15]



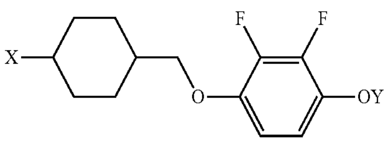
[Formula 16]



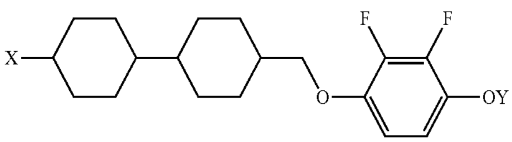
[Formula 17]



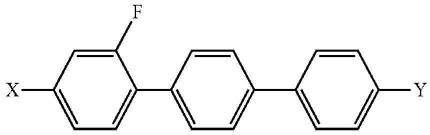
[Formula 18]



[Formula 19]



[Formula 20]



X and Y may independently be C_nH_{2n+1}, n may be a natural number selected from 1 to 5.

The liquid crystal compound represented by Formula 2 may be in an amount ranging from about 10 wt % to about 30 wt % of the liquid crystal composition. Each of the liquid crystal compounds represented by Formulae 3, 6, and 7 may be in an amount ranging from about 5 wt % to about 15 wt % of the liquid crystal composition. The liquid crystal compound represented by Formula 4 may be in an amount

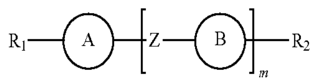
ranging from about 3 wt % to about 10 wt % of the liquid crystal composition. The liquid crystal compound represented by Formula 5 may be in an amount ranging from about 10 wt % to about 35 wt % of the liquid crystal composition. Each of the liquid crystal compounds represented by Formulae 8, 9, and 10 may be in an amount ranging from about 3 wt % to about 25 wt % of the liquid crystal composition.

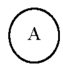
The liquid crystal compounds represented by Formulae 11, 14, and 15 may be in an amount ranging from about 5 wt % to about 25 wt % of the liquid crystal composition. Each of the liquid crystal compounds represented by Formulae 12 and 13 may be in an amount ranging from about 5 wt % to about 20 wt % of the liquid crystal composition. The liquid crystal compound represented by Formula 16 may be in an amount ranging from about 1 wt % to about 15 wt % of the liquid crystal composition. The liquid crystal compound represented by Formula 17 may be in an amount ranging from about 0.03 wt % to about 5 wt % of the liquid crystal composition. Each of the liquid crystal compounds represented by Chemical Formulae 18, 19, and 20 may be in an amount ranging from about 5 wt % to about 20 wt % of the liquid crystal composition.

A rotational viscosity of the liquid crystal composition may be less than or equal to about 100 mPa·s.

One or more exemplary embodiments of the present invention provide a liquid crystal display. The liquid crystal display includes a first substrate, a second substrate, and a liquid crystal layer. The second substrate is positioned above and overlaps the first substrate. The liquid crystal layer is disposed between the first substrate and the second substrate. The liquid crystal layer includes a liquid crystal compound represented by the following Formula 1.

[Formula 1]





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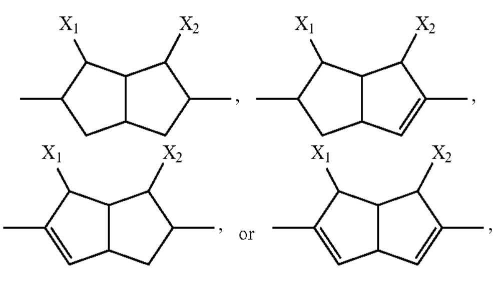
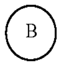


X_1 and X_2 are each independently selected from fluorine, CF_3, or C_nH_{2n+1}. Z is selected from a single bond, a double bond, CF_2CF_2, OCF_2, or CF_2O. R_1 is selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or $C_nH_{2n+1}O$. R_2 is selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or OC_nH_{2n+1}.



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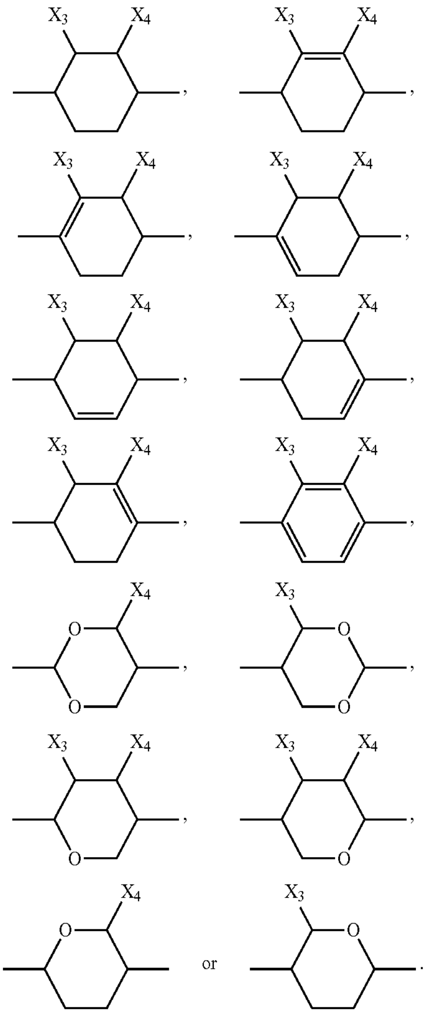
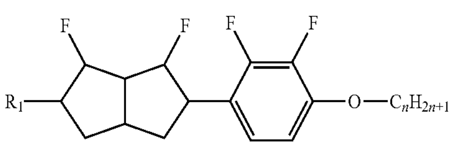


X_3 and X_4 are each independently selected from hydrogen, fluorine, CF_3, or C_nH_{2n+1}, m is a natural number selected from 1 or 2, n may be a natural number selected from 1 to 5.

The liquid crystal compound represented by Formula 1 may be in an amount ranging from about 1 wt % to about 20 wt % of the liquid crystal layer.

The liquid crystal compound represented by Formula 1 may include a liquid crystal compound represented by the following Formulae 1-1 to 1-5.

[Formula 1-1]



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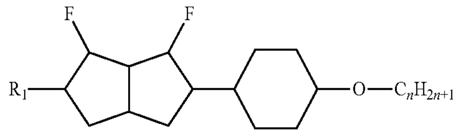
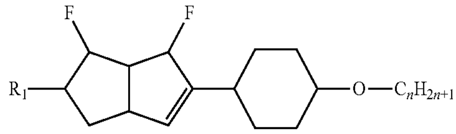
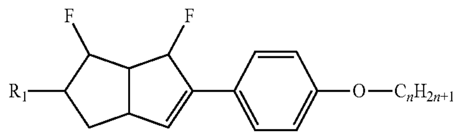
[Formula 1-2]



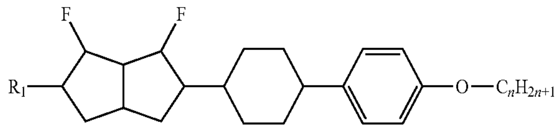
[Formula 1-3]



[Formula 1-4]



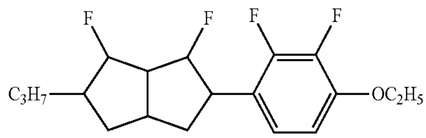
[Formula 1-5]



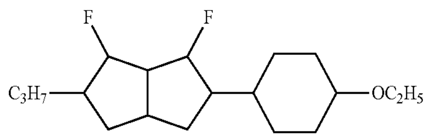
R_1 may be selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or $C_nH_{2n+1}O$, n may be a natural number selected from 1 to 5.

The liquid crystal compound represented by Formula 1 may include a liquid crystal compound represented by the following Formulae 1-6 to 1-10.

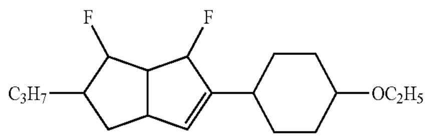
[Formula 1-6]



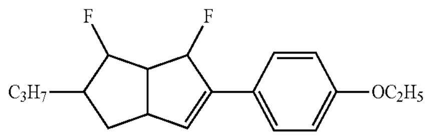
[Formula 1-7]



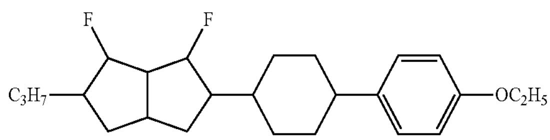
[Formula 1-8]



[Formula 1-9]

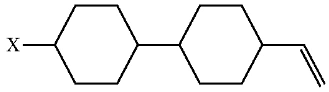


[Formula 1-10]

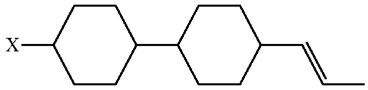


The liquid crystal layer may further include at least one liquid crystal compound selected liquid crystal compounds represented by the following Formulae 2 to 10.

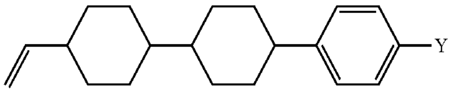
[Formula 2]



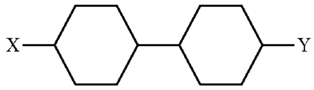
[Formula 3]



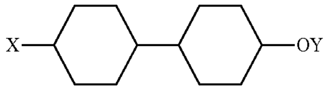
[Formula 4]



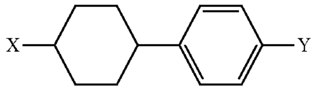
[Formula 5]



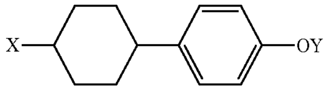
[Formula 6]



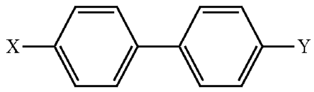
[Formula 7]



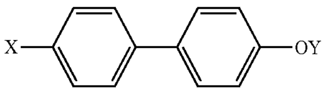
[Formula 8]



[Formula 9]



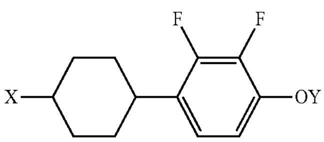
[Formula 10]



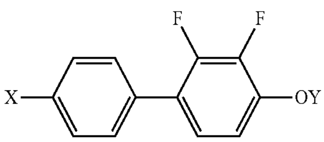
X and Y may each independently be C_nH_{2n+1}, n may be a natural number selected from 1 to 5.

The liquid crystal layer may further include at least one liquid crystal compound selected from liquid crystal compounds represented by the following Formulae 11 to 20.

[Formula 11]



[Formula 12]



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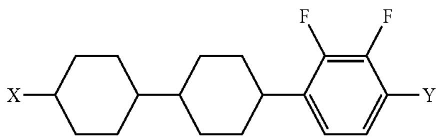
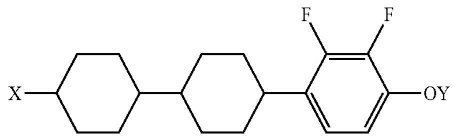
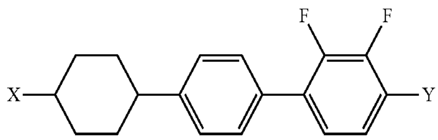
[Formula 13]



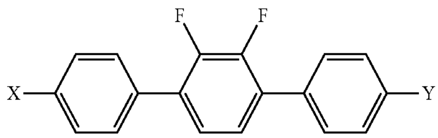
[Formula 14



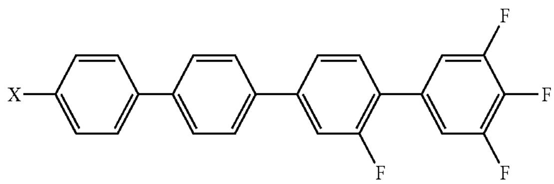
[Formula 15]



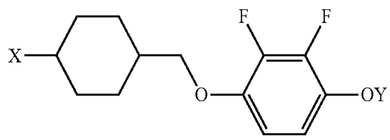
[Formula 16]



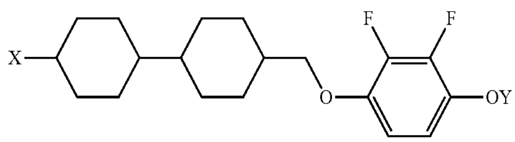
[Formula 17]



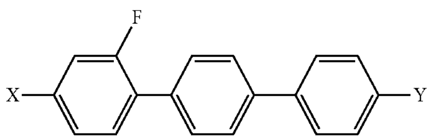
[Formula 18]



[Formula 19]



[Formula 20]



X and Y may each independently be C_nH_{2n+1}, n may be a natural number selected from 1 to 5.

The liquid crystal compound represented by Formula 2 may be in an amount ranging from about 10 wt % to about 30 wt % of the liquid crystal layer. Each of the liquid crystal compounds represented by Formulae 3, 6, and 7 may be in an amount ranging from about 5 wt % to about 15 wt % of the liquid crystal layer. The liquid crystal compound represented by Formula 4 may be in an amount ranging from about 3 wt % to about 10 wt % of the liquid crystal layer. The liquid crystal compound represented by Formula 5 may be in an amount ranging from about 10 wt % to about 35 wt % of the liquid crystal layer. Each of the liquid crystal compounds represented by Formulae 8, 9, and 10 may be in an amount ranging from about 3 wt % to about 25 wt % of the liquid crystal layer.

Each of the liquid crystal compounds represented by Formulae 11, 14, and 15 may be in an amount ranging from about 5 wt % to about 25 wt % of the liquid crystal layer. Each of the liquid crystal compounds represented by Formulae 12 and 13 may be in an amount ranging from about 5 wt % to about 20 wt % of the liquid crystal layer. The liquid crystal compound represented by Formula 16 may be in an amount ranging from about 1 wt % to about 15 wt % of the liquid crystal layer. The liquid crystal compound represented by Formula 17 may be in an amount ranging from about 0.03 wt % to about 5 wt % of the liquid crystal layer. Each of the liquid crystal compounds represented by Formulae 18, 19, and 20 may be in an amount ranging from about 5 wt % to about 20 wt % of the liquid crystal layer.

A rotational viscosity of the liquid crystal composition may be less than or equal to about 100 mPa·s.

The liquid crystal display may further include a pixel electrode and a common electrode. The pixel electrode may be disposed on the first substrate. The common electrode may be disposed on the second substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other features of the present invention will become more apparent by describing in detail exemplary embodiments thereof, with reference to the accompanying drawings, in which:

FIG. **1** is a layout view illustrating a liquid crystal display according to an exemplary embodiment of the present invention; and

FIG. **2** is a cross-sectional view illustrating a liquid crystal display of FIG. **1** taken along a line II-II according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

Exemplary embodiments of the present invention will be described below in more detail with reference to the accompanying drawings. In this regard, the exemplary embodiments may have different forms and should not be construed as being limited to the exemplary embodiments of the present invention described herein. Like reference numerals may refer to like elements throughout the specification and drawings.

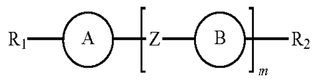
It will become understood that although the terms “first” and “second” may be used herein to describe various components, these components should not be limited by these terms.

Sizes of elements in the drawings may be exaggerated for clarity of description.

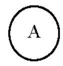
It will be understood that when a component, such as a layer, a film, a region, or a plate, is referred to as being “on” another component, the component can be directly on the other component or intervening components may be present.

A liquid crystal composition according to an exemplary embodiment of the present invention may include a liquid crystal compound represented by the following Formula 1.

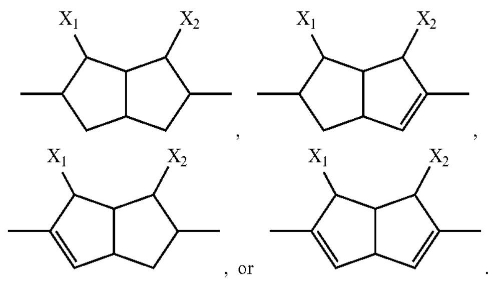
[Formula 1]



In Formula 1,



may be selected from



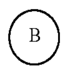
X_1 and X_2 may each independently be selected from fluorine, CF_3 or C_nH_{2n+1}, n may be a natural number selected from 1 to 5.

Z may be selected from a single bond, a double bond, CF_2CF_2, OCF_2, or CF_2O.

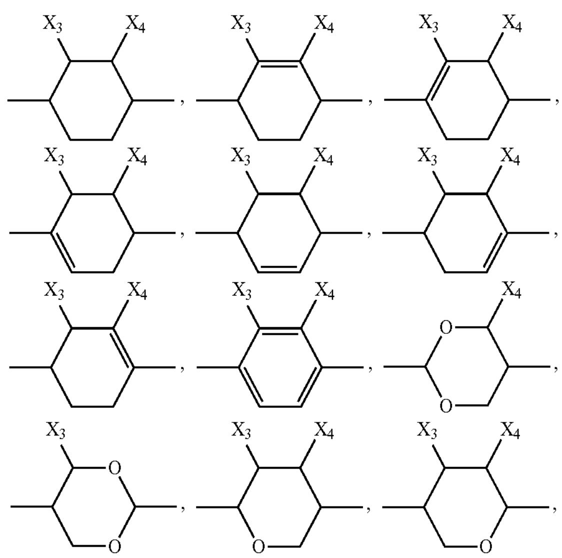
The single bond and the double bond described herein may refer to a structure in which two neighboring groups are directly bonded to each other without an intermediate group.

R_1 may be selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or $C_nH_{2n+1}O$, n may be a natural number selected from 1 to 5.

R_2 may be selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or OC_nH_{2n+1}, n may be a natural number selected from 1 to 5.



may be selected from,



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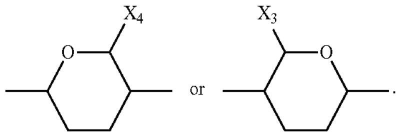


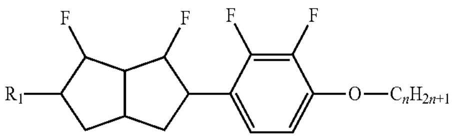
X_3 and X_4 may each independently be selected from hydrogen, fluorine, CF_3, or C_nH_{2n+1}, n may be a natural number selected from 1 to 5.

m may be a natural number selected from 1 or 2.

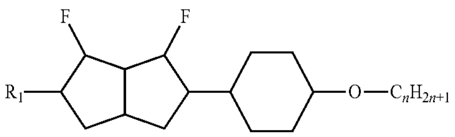
The liquid crystal compound represented by Formula 1 may be present in the range from about 1 wt % to about 20 wt % of the liquid crystal composition.

The liquid crystal compound represented by Formula 1 may include a liquid crystal compound selected from liquid crystal compounds represented by the following Formulae 1-1 to 1-5.

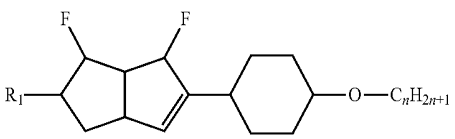
[Formula 1-1]



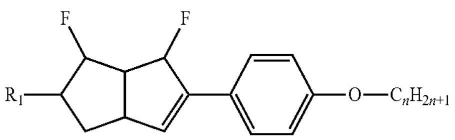
[Formula 1-2]



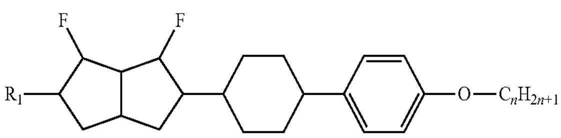
[Formula 1-3]



[Formula 1-4]



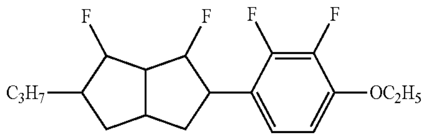
[Formula 1-5]



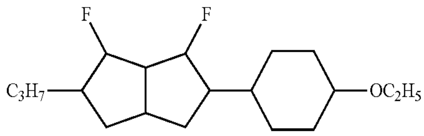
In Formulae 1-1 to 1-5, R_1 may be selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or $C_nH_{2n+1}O$, n may be a natural number selected from 1 to 5.

The liquid crystal compound represented by Formula 1 may include a liquid crystal compound selected from liquid crystal compounds represented by the following Formulae 1-6 to 1-10.

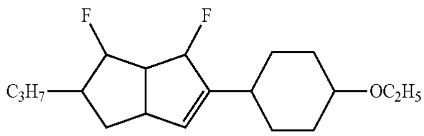
[Formula 1-6]



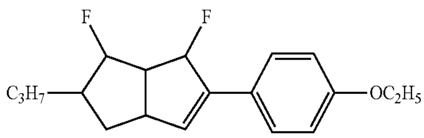
[Formula 1-7]



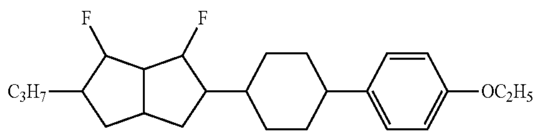
[Formula 1-8]



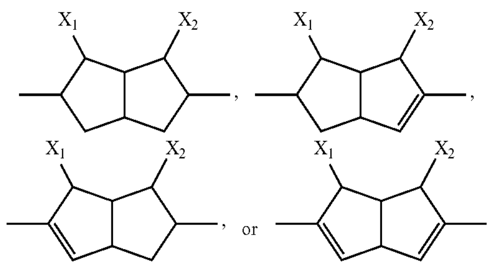
[Formula 1-9]



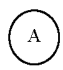
[Formula 1-10]



The liquid crystal compound represented by Formula 1 may have a structure in which at least two ring structures to three ring structures are connected to each other. Accordingly, a rotational viscosity may be relatively reduced in comparison with a liquid crystal compound having a structure in which at least three ring structures to five ring structures are connected to each other. An octane ring such as



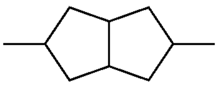
included in



of Formula 1 may be a single ring.

The rotational viscosity may relate to the response time of the liquid crystal. The rotational viscosity may increase as the length of the liquid crystal compound increases. However, since the number of ring structures of the liquid crystal compound of Formula 1 is a relatively small number, for example, two or three ring structures, the rotational viscosity may be relatively low. Due to a relatively low rotational viscosity, a relatively high response speed of the liquid crystal may be produced when the liquid crystal compound is included in a liquid crystal layer.

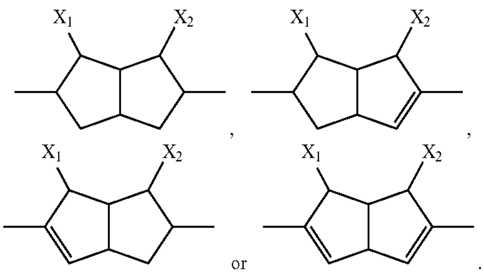
The liquid crystal compound having at least three ring structures to five ring structures included in the liquid crystal composition may have one to three ring structures in addition to the structure, for example, bicyclo[3,3,0]octane

().

The one to three additional ring structures may include phenyl. The one to three additional ring structures may be added to obtain a relatively high dielectric anisotropy ($\Delta\varepsilon$). Since a length of a molecule may become longer, a phase transition temperature (Tni) may increase, however, the rotational viscosity may also increase. The phase transition temperature (Tni) may refer to a temperature at which the liquid crystal composition including liquid crystal compounds changes from a liquid crystal state to a liquid state. The higher the Tni, the higher the liquid crystal composition property may be maintained, for example, in a relatively high temperature environment.

The liquid crystal compound of Formula 1 according to an exemplary embodiment of the present invention may reduce the rotational viscosity and obtain a relatively high dielectric anisotropy ($\Delta\varepsilon$) and phase transition temperature (Tni), for example, by substituting substituents for bicycle[3,3,0]octane or similar structures.

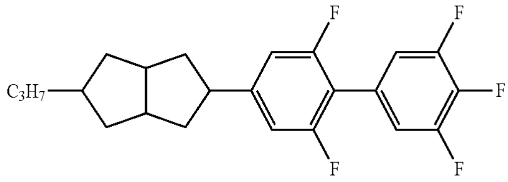
The substituents X_1 and X_2 of each of cyclopentane and cyclopentene may be substituted, such as the structures represented by



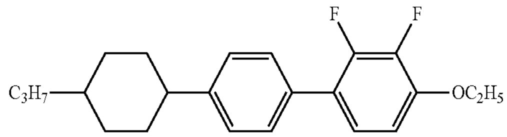
Thus, the liquid crystal compound of Formula 1 according to an exemplary embodiment of the present invention may have a relatively high dielectric anisotropy ($\Delta\varepsilon$). The term "high" may refer to that an absolute value of a permittivity is relatively large. Since the liquid crystal compound of Formula 1 according to an exemplary embodiment of the present invention may have a negative dielectric anisotropy, the liquid crystal composition including the liquid crystal compound of Formula 1 may be applicable to a liquid crystal display having a vertical electric field mode. However, the liquid crystal compound of Formula 1 may be applicable to a liquid crystal display having a coplanar electrode (CE) mode.

Exemplary rotational viscosities of the liquid crystal compounds of Comparative Examples 1 and 2 and the liquid crystal compound of Formula 1-6 are shown in Table 1 below.

[Comparative Example 1]



[Comparative Example 2]



[Formula 1-6]

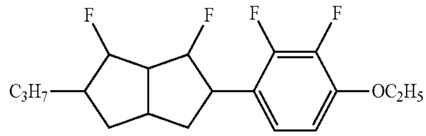


TABLE 1

	Comparative Example 1	Comparative Example 2	Formula 1-6
Rotational viscosity (mPa · s)	861.9	350	65.3

Comparing Comparative Example 1 and the liquid crystal compound of Formula 1-6, which includes the bicycle[3,3,0]octane ring, the liquid crystal compound of Comparative Example 1 does not include a substituent in bicycle[3,3,0]octane, and includes three ring structures. However, the bicycle[3,3,0]octane of the liquid crystal compound of Chemical Formula 1-6 includes a fluorine substituent, respectively, and includes two ring structures.

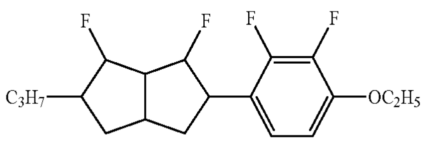
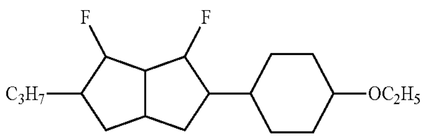
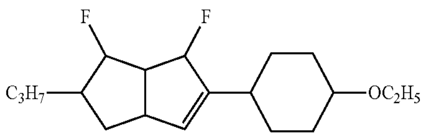
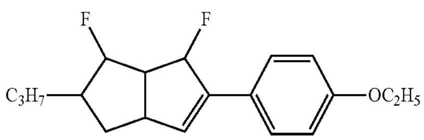
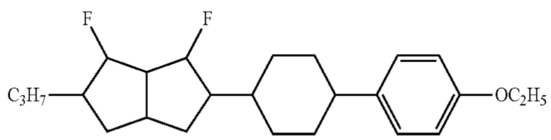
Comparing the exemplary rotational viscosities of the liquid crystal compound of Comparative Example 1 and the liquid crystal compound of Formula 1-6, the rotational viscosity of the liquid crystal compound of Comparative Example 1 may be about 861.9 mPa·s and the rotational viscosity of the liquid crystal compound of Chemical Formula 1-6 may be about 65.3 mPa·s. Thus, the liquid crystal compound of Formula 1-6 may have a rotational viscosity that is decreased by about 10 times or more as compared with a rotational viscosity of the liquid crystal compound of Comparative Example 1.

Formula 1-6 may have an end structure of —C_3H_7, —OC_2H_5. The liquid crystal compound of Comparative Example 2, which may have the same end structure as Formula 1-6, includes three ring structures. The three ring structures may include cyclohexane, benzene, or benzene having a fluorine substituent. However, the liquid crystal compound of Chemical Formula 1-6 may include two ring structures. The two ring structure may include bicycle[3,3,0]octane having a fluorine substituent, and a benzene ring having a fluorine substituent.

Comparing the exemplary rotational viscosities of the liquid crystal compound of Comparative Example 2 and the liquid crystal compound of Formula 1-6, the rotational viscosity of the liquid crystal compound of Comparative Example 2 may be about 350 mPa·s and the rotational viscosity of the liquid crystal compound of Formula 1-6 may be about 65.3 mPa·s. Thus, the liquid crystal compound of Formula 1-6 may have a rotational viscosity that is decreased by about 5 times or more as compared with a rotational viscosity of the liquid crystal compound of Comparative Example 2.

Exemplary refractive anisotropy (Δt), nisotdielectric anisotropy (Δε), ielecrotation viscosity (γ1), and phase transition temperature (Tni) for each of liquid crystal compounds of Chemical Formulae 1-6 to 1-10 are shown in below Table 2.

TABLE 2

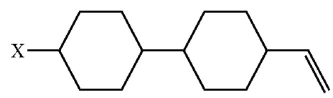
Structure	Δt	Δϵ	γ1 (mPa · s)	Tni (tur)
[Formula 1-6] 	0.044	−5.55	65.3	71
[Formula 1-7] 	0.011	−3.1	115.4	84.8
[Formula 1-8] 	0.043	−3.11	113	87.1
[Formula 1-9] 	0.084	−2.88	96.4	87.8
[Formula 1-10] 	0.051	−3.29	162.4	134.7

Referring to Table 2, the liquid crystal compounds of Formulae 1-6 to 1-10 may each have a relatively low rotational viscosity. Further, the liquid crystal compounds of Formulae 1-6 to 1-10 may maintain a similar level of the properties of refractive index anisotropy (Δt), dielectric anisotropy (Δε), and phase transition temperature (Tni) to other liquid crystal compounds.

The liquid crystal compound of Formula 1 included in the liquid crystal composition according to an exemplary embodiment of the present invention may have a relatively lower rotational viscosity than other liquid crystal compounds. Accordingly, when the liquid crystal composition including the liquid crystal compound of Formula 1 is included in the liquid crystal display, a response speed of the liquid crystal display may be increased, for example, by the relatively low rotational viscosity.

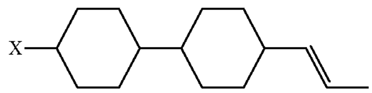
The liquid crystal composition according to an exemplary embodiment of the present invention may include at least one liquid crystal compound of the following Formulae 2 to 10.

[Formula 2]

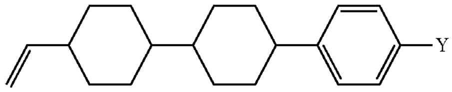


-continued

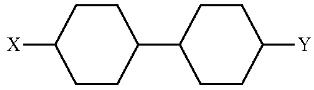
[Formula 3]



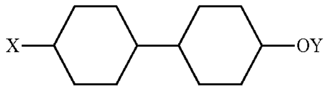
[Formula 4]



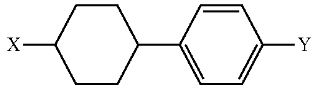
[Formula 5]



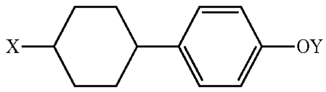
[Formula 6]



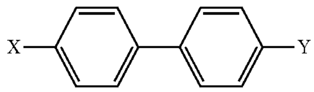
[Formula 7]



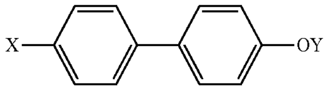
[Formula 8]



[Formula 9]



[Formula 10]

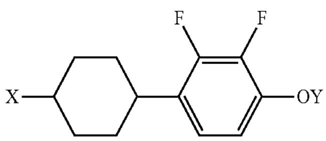


In Formulae 2 to 10, X and Y may each independently be C_nH_{2n+1}, n may be a natural number selected from 1 to 5.

The liquid crystal compound represented by Formula 2 may be present in an amount ranging from about 10 wt % to about 30 wt % of the liquid crystal composition. The liquid crystal compounds represented by Formulae 3, 6, and 7 may each be present in an amount ranging from about 5 wt % to about 15 wt % of the liquid crystal composition. The liquid crystal compound represented by Formula 4 may be present in an amount ranging from about 3 wt % to about 10 wt % of the liquid crystal composition. The liquid crystal compound represented by Formula 5 may be present in an amount ranging from about 10 wt % to about 35 wt % of the liquid crystal composition. The liquid crystal compounds represented by Chemical Formulae 8, 9, and 10 may each be present in an amount ranging from about 3 wt % to about 25 wt % of the liquid crystal composition.

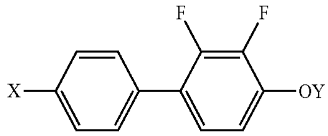
The liquid crystal composition according to an exemplary embodiment of the present invention may include at least one liquid crystal compound of the following Formulae 11 to 20.

[Formula 11]

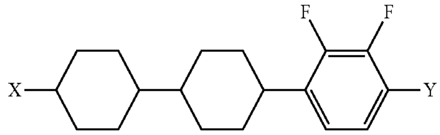


-continued

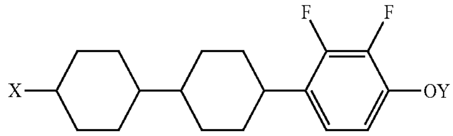
[Formula 12]



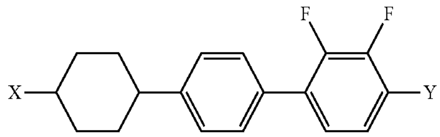
[Formula 13]



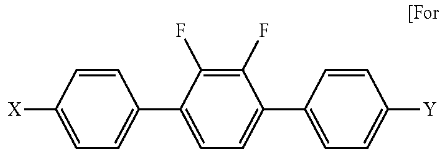
[Formula 14



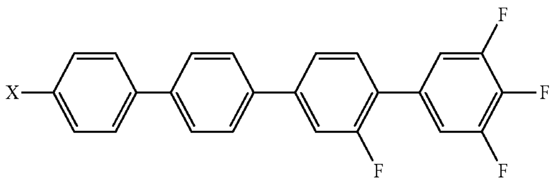
[Formula 15]



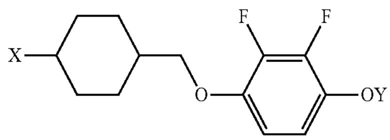
[Formula 16]



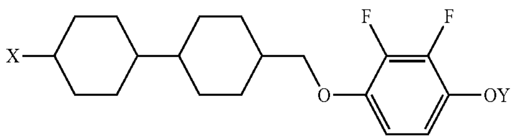
[Formula 17]



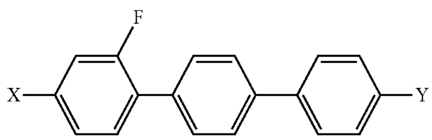
[Formula 18]



[Formula 19]



[Formula 20]



In Formulae 11 to 20, X and Y may each independently be C_nH_{2n+1}, n may be a natural number selected from 1 to 5.

The liquid crystal compounds represented by Formulae 11, 14, and 15 may each be present in an amount ranging from about 5 wt % to about 25 wt % of the liquid crystal composition. The liquid crystal compounds represented by Formulae 12 and 13 may each be present in an amount ranging from about 5 wt % to about 20 wt % of the liquid crystal composition. The liquid crystal compound represented by Formula 16 may be present in an amount ranging from about 1 wt % to about 15 wt % of the liquid crystal composition. The liquid crystal compound represented by Formula 17 may be present in an amount ranging from about 0.03 wt % to about 5 wt % of the liquid crystal composition. The liquid crystal compounds represented by Formulae 18, 19, and 20 may each be present in an amount ranging from about 5 wt % to about 20 wt % of the liquid crystal composition.

The rotational viscosity of the liquid crystal composition according to an exemplary embodiment of the present invention may be less than or equal to about 100 mPa·s.

Since the liquid crystal composition according to an exemplary embodiment of the present invention may include the liquid crystal compound represented by Formula 1, a response speed of the liquid crystal display may be relatively increased by decreasing the increase in a rotational viscosity while having a negative dielectric constant anisotropy similar to other liquid crystal compositions.

The liquid crystal composition according to an exemplary embodiment of the present invention (Embodiment 1) and the liquid crystal composition according to a comparative example of the present invention (Comparative Example 3) may be prepared as shown in Table 3 (Embodiment 1) and Table 4 (Comparative Example 3) below. Exemplary properties are illustrated below.

TABLE 3

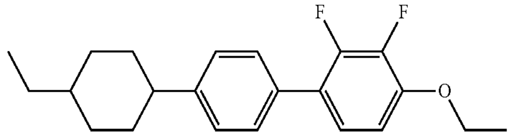
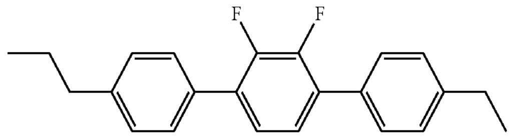
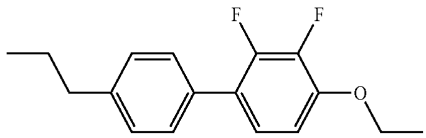
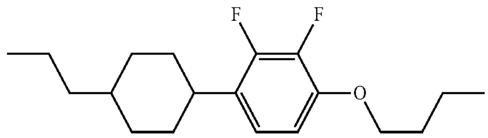
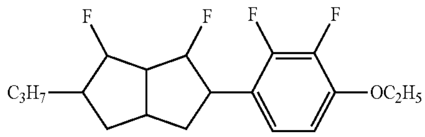
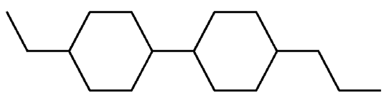
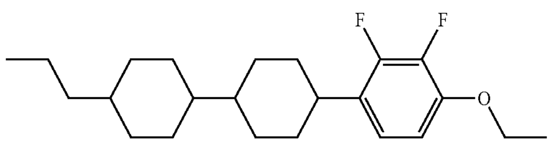
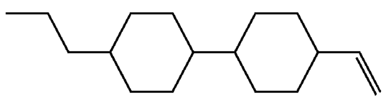
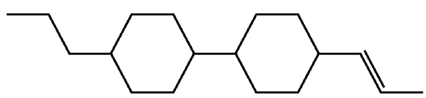
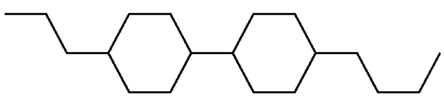
No.	Liquid Crystal Compound	wt %
1		3-25
2		3-25
3		5-20
4		5-25
5		3-25
6		5-30
7		5-25
8		10-30
9		5-15
10		5-30

TABLE 3-continued

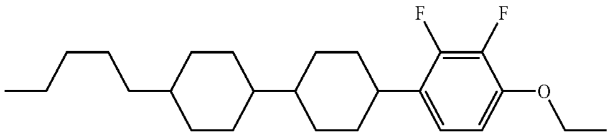
No.	Liquid Crystal Compound	wt %
11		5-25

TABLE 4

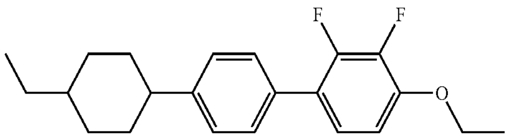
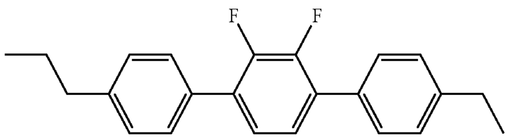
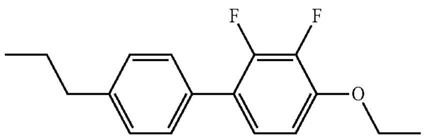
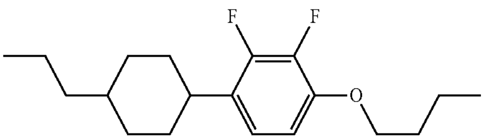
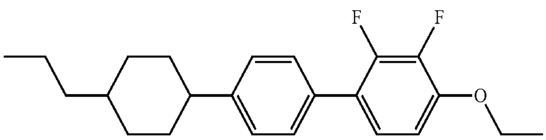
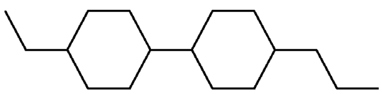
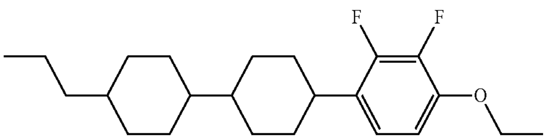
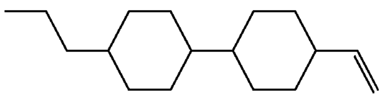
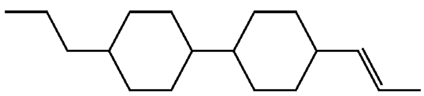
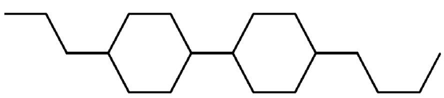
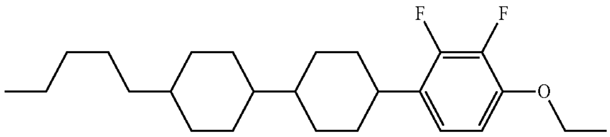
No.	Liquid Crystal Compound	wt %
1		3-25
2		3-25
3		5-20
4		5-25
5		3-25
6		5-30
7		5-25
8		10-30
9		5-15
10		5-30

TABLE 4-continued

No.	Liquid Crystal Compound	wt %
11		5-25

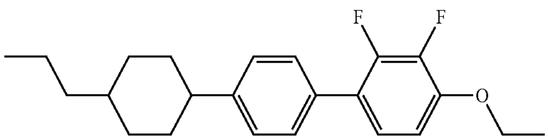
The liquid crystal composition of Embodiment 1 prepared as shown in Table 3 and the liquid crystal composition of Comparative Example 3 as shown in Table 4 may have substantially the same composition and content except for the structural formula of the fifth liquid crystal compound. The fifth liquid crystal compound of Embodiment 1 may be the liquid crystal compound of Formula 1-6. The fifth liquid crystal compound of Comparative Example 3 may include three ring structures. The fifth liquid crystal compound of Comparative Example 3 might not be included in Chemical Formula 1 as described herein.

Exemplary properties of the liquid crystal compositions of Embodiment 1 and Comparative Example 3 are shown in below Table 5. The properties are refractive anisotropy (ni), dielectric anisotropy (Δε), elerotation viscosity (γo), and phase transition temperature (Tni).

TABLE 5

	ni	Δε	γo (mPa · s)	Tni (eon)
Embodiment 1	0.105	−3.12	94	75
Comparative Example 3	0.106	−3.13	124	74

Referring to Table 5, the liquid crystal composition of Embodiment 1 including the liquid crystal compound represented by Formula 1-6 may have a relatively lower rotational viscosity than a rotational viscosity of the liquid crystal composition of Comparative Example 3, which includes a compound of a



structure. The rotational viscosity of the liquid crystal composition of Comparative Example 3 may be about 124 mPa·s. The rotational viscosity of the liquid crystal composition of Embodiment 1 may be about 94 mPa·s. Thus, the rotational viscosity of the liquid crystal composition of Embodiment 1 may be decreased by about 30% or more in relation to the rotational viscosity of the liquid crystal composition of Comparative Example 3. A decrease in the rotational viscosity may increase the response speed when the liquid crystal composition is included in the liquid crystal display.

Referring to Table 5, the other properties of the liquid crystal composition of Embodiment 1 may have a similar or same level as the properties of the liquid crystal composition of Comparative Example 3. Therefore, according to an exemplary embodiment of the present invention, the rotational viscosity may only be reduced and the other properties such as the dielectric anisotropy (Δε), the refractive anisotropy (ni), and the phase transition temperature (Tni) might not be reduced in the liquid crystal composition.

The liquid crystal display device including a liquid crystal layer according to an exemplary embodiment of the present invention will be described in more detail below.

A structure of a liquid crystal display is not limited to the examples set forth herein. For example, the liquid crystal display according to an exemplary embodiment of the present invention may be a vertical alignment (VA) mode liquid crystal display.

An arrangement of a lower panel and an upper panel included in a liquid crystal display according to an exemplary embodiment of the present invention will be described in more detail below with reference to FIGS. **1** and **2**.

FIG. **1** is a layout view illustrating a liquid crystal display according to an exemplary embodiment of the present invention. FIG. **2** is a cross-sectional view illustrating a liquid crystal display of FIG. **1** taken along a line II-II according to an exemplary embodiment of the present invention.

A lower panel **100** will be described in more detail below.

A gate conductor may be disposed on a substrate **110**. The gate conductor may include a gate line **121** and a voltage division reference voltage line **131**. The substrate **110** may be an insulating substrate. The substrate **110** may include transparent glass or plastic.

The gate line **121** may include a first gate electrode **124***a*, a second gate electrode **124***b*, a third gate electrode **124***c*, and a wide end portion. The wide end portion may connect to another layer. Alternatively, the wide end portion may connect to an external driving circuit.

The voltage division reference voltage line **131** may include first storage electrodes **135** and **136** and a reference electrode **137**. Second storage electrodes **138** and **139** may be positioned on the lower panel **100**. The second storage electrodes **138** and **139** might not be connected to the voltage division reference voltage line **131**. The second storage electrodes **138** and **139** may overlap a second sub-pixel electrode **191***b*.

A gate insulating layer **140** may be disposed on each of the gate line **121** and the voltage division reference voltage line **131**.

A semiconductor layer may be disposed on the gate insulating layer **140**. The semiconductor layer may include a first semiconductor **154***a*, a second semiconductor **154***b*, and a third semiconductor **154***c*.

A plurality of ohmic contacts **163***a*, **165***a*, **163***b*, **165***b*, **163***c*, and **165***c* may be disposed on the semiconductors layers **154***a*, **154***b*, and **154***c*.

A data line **171**, a first source electrode **173***a*, a second source electrode **173***b*, and a plurality of data conductors may be disposed on each of the ohmic contacts **163***a*, **165***a*, **163***b*, **165***b*, **163***c*, and **165***c* and the gate insulating layer **140**. The second source electrode **173***b* may be connected to the data line **171**. The data conductors may include a first drain electrode **175**a, a second drain electrode **175**b, a third source electrode **173**c, and a third drain electrode **175**c.

The data line **171** may include a relatively wide end portion. The relatively wide end portion may connect to another layer. Alternatively, the wide end portion may connect to an external driving circuit.

Each of the first to third gate electrodes **124**a, **124**b, and **124**c, the first to third source electrodes **173**a, **173**b, and **173**c, and the first to third drain electrodes **175**a, **175**b, and **175**c may respectively form thin film transistors, for example, with island semiconductors.

A first passivation layer **180**p may be disposed on each of the data conductors and exposed portions of the first to third semiconductors **154**a, **154**b, and **154**c.

A color filter **230** may be disposed on the first passivation layer **180**p. However, the color filter **230** might not be disposed in the lower display panel **100**. For example, the color filter **230** may be disposed in the upper display panel **200**.

A second passivation layer **180**p may be disposed on the color filter **230**.

A first contact hole **185**a and a second contact hole **185**b may be formed in each of the first passivation layer **180**p and the second passivation layer **180**q. The first drain electrode **175**a and the first sub-pixel electrode **191**a may be connected to each other through the first contact hole **185**a. The second drain electrode **175**b and the second sub-pixel electrode **191**b may be connected to each other through the second contact hole **185**b.

A third contact hole **185**c may be formed in each of the first passivation layer **180**p, the second passivation layer **180**q, and the gate insulating layer **140**. The third contact hole **185**c may be covered by a connecting member **195**. The connecting member **195** may electrically connect the reference electrode **137** and the third drain electrode **175**c to each other, for example, through the third contact hole **185**c.

A plurality of pixel electrodes **191** may be disposed on the second passivation layer **180**q. The first sub-pixel electrode **191**a and the second sub-pixel electrode **191**b may be spaced apart from each other. The gate line **121** may be disposed between the first sub-pixel electrode **191**a and the second sub-pixel electrode **191**b. The first sub-pixel electrode **191**a and the second sub-pixel electrode **191**b may be adjacent to each other, for example, in a column direction, with respect to the gate line **121**. The pixel electrodes **191** may include a transparent conductive material such as indium-tin oxide (ITO) or indium-zinc oxide (IZO). Alternatively, the pixel electrodes **191** may include a reflective metal such as aluminum (Al), silver (Ag), chromium (Cr), or an alloy thereof.

The first sub-pixel electrode **191**a may include a cross-shaped stem. The cross-shaped stem may have a transverse stem **193** and a longitudinal stem **192**. The transverse stem **193** and the longitudinal stem **192** may be crossed with each other. The first sub-pixel electrode **191**a may be divided into four sub-regions by the transverse stem **193** and the longitudinal stem **192**. Each of the sub-regions may include a plurality of first fine branch portions **194**a, a plurality of second fine branch portions **194**b, a plurality of third fine branch portions **194**c, and a plurality of fourth fine branch portions **194**d, respectively.

The shape of the second sub-pixel electrode **191**b may be similar to a shape of the first sub-pixel electrode **191**a.

The first sub-pixel electrode **191**a and the second sub-pixel electrode **191**b may each be electrically connected to the first drain electrode **175**a and the second drain electrode **175**b through the first contact hole **185**a and the second contact hole **185**b, respectively. The first sub-pixel electrode **191**a and the second sub-pixel electrode **191**b may each receive the data voltage from the first drain electrode **175**a and the second drain electrode **175**b, respectively. A portion of the data voltage applied to the second drain electrode **175**b may be divided by the third source electrode **173**c. Thus, a voltage applied to the first sub-pixel electrode **191**a may be greater than a voltage applied to the second sub-pixel electrode **191**b.

The first sub-pixel electrode **191**a and the second sub-pixel electrode **191**b, to which the data voltage is applied, may each generate an electrical field with a common electrode **270** of an upper display panel **200**. Thus, a direction of liquid crystal molecules of the liquid crystal layer **3** disposed between the two electrodes **191** and **270** may be determined. Luminance of light that passes through a liquid crystal layer **3** may be varied according to a direction of liquid crystal molecules **31**. A lower alignment layer **11** may be disposed on the pixel electrode **191**.

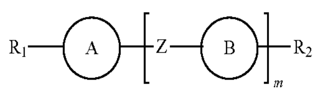
The upper panel **200** will be described in more detail below.

Referring to FIGS. **1** and **2**, a second substrate **210** may be positioned above the first substrate **110**. The second substrate **210** may overlap the first substrate **110**. A black matrix **220** may be disposed between the liquid crystal layer **3** and the second substrate **210**. The black matrix **220** may be disposed in the upper panel **200** to correspond to a region of the lower panel **100** in which the data lines **171** are disposed and a region in which thin film transistors are disposed.

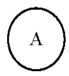
An overcoat **250** may be disposed between the liquid crystal layer **3** and the black matrix **220**. However, the overcoat layer **250** may be omitted. The common electrode **270** may be disposed between the liquid crystal layer **3** and the overcoat **250**. An upper alignment layer **21** may be disposed between the liquid crystal layer **3** and the common electrode **270**.

The liquid crystal layer **3** may be disposed between the lower panel **100** and the upper panel **200**. The liquid crystal layer **3** may include the liquid crystal composition according to an exemplary embodiment of the present invention. The liquid crystal layer **3** of the liquid crystal display according to an exemplary embodiment of the present invention may include the liquid crystal compound represented by the following Formula 1.

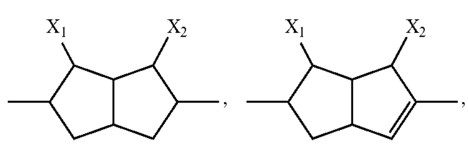
[Formula 1]



In Formula 1,



may be selected from



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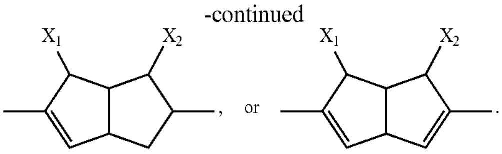
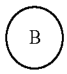


X_1 and X_2 may each independently be selected from fluorine, CF_3, or C_nH_{2n+1}, n may be a natural number selected from 1 to 5.

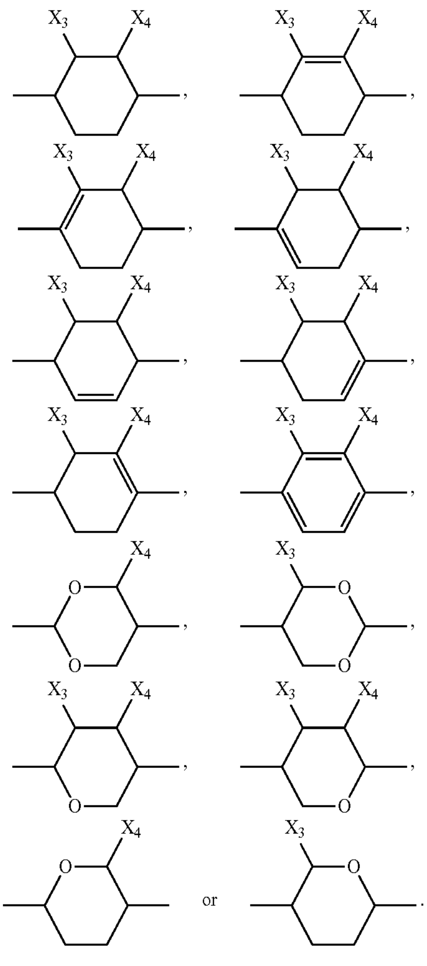
Z may be selected from a single bond, a double bond, CF_2CF_2, OCF_2, or CF_2O.

R_1 may be selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or $C_nH_{2n+1}O$, n may be a natural number selected from 1 to 5.

R_2 may be selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or OC_nH_{2n+1}, n may be a natural number selected from 1 to 5.



may be selected from



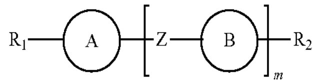
X_3 and X_4 may each independently be selected from hydrogen, fluorine, CF_3, or C_nH_{2n+1}, n may be a natural number selected from 1 to 5.

m may be a natural number selected from 1 or 2.

The liquid crystal composition including the liquid crystal layer **3** is substantially the same as described herein. Thus, description of similar constituent elements may be omitted.

In the liquid crystal display including the liquid crystal compound represented by Formula 1 as the liquid crystal layer, the rotational viscosity of the liquid crystal layer may be relatively lower than a rotational viscosity of other liquid crystal displays. Thus, the response speed of the liquid crystal display device may be relatively increased.

[Formula 1]



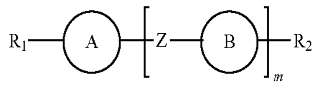
However, the liquid crystal display according to the structure of FIGS. **1** and **2** is only one example, and the liquid crystal composition according to an exemplary embodiment of the present invention may be variously applied to a vertical alignment (VA) mode liquid crystal display or a coplanar electrode (CE) mode liquid crystal display.

While exemplary embodiments of the present invention have been described herein, it is to be understood that the present invention is not limited to the disclosed exemplary embodiments, but, on the contrary, is intended to cover various modifications and equivalent arrangements included within the spirit and scope of the present invention.

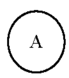
What is claimed is:

1. A liquid crystal composition, comprising a liquid crystal compound represented by Formula 1:

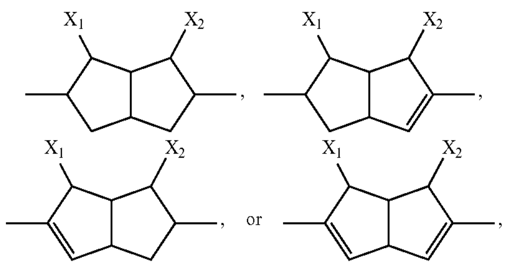
[Formula 1]



wherein



is selected from

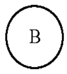


X_1 and X_2 are each independently selected from fluorine, CF_3, or C_nH_{2n+1},

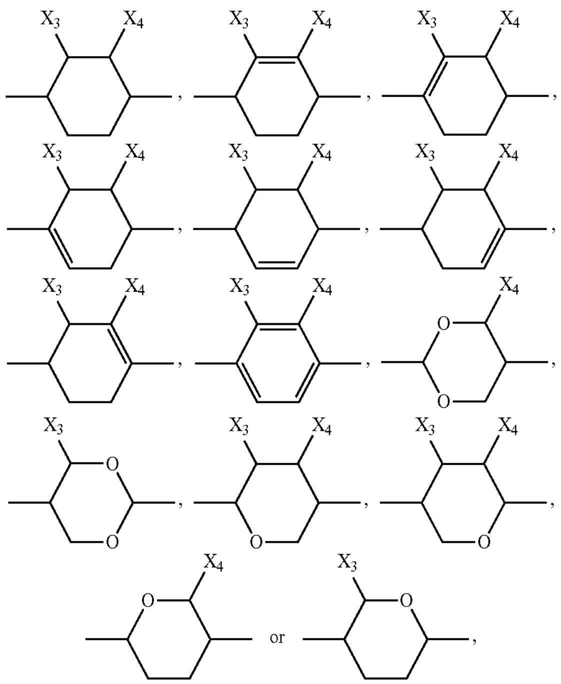
Z is selected from a single bond, a double bond, CF_2CF_2, OCF_2, or CF_2O,

R_1 is selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or $C_nH_{2n+1}O$,

R_2 is selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or OC_nH_{2n+1},



is selected from



X_3 and X_4 are each independently selected from hydrogen, fluorine, CF_3, or C_nH_{2n+1},

m is a natural number selected from 1 or 2, and

n is a natural number selected from 1 to 5.

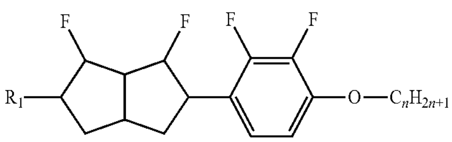
2. The liquid crystal composition of claim **1**, wherein

the liquid crystal compound represented by Formula 1 is in an amount ranging from about 1 wt % to about 20 wt % of the liquid crystal composition.

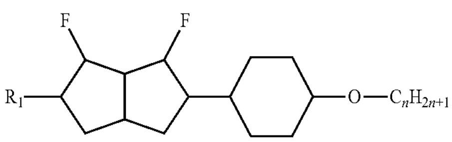
3. The liquid crystal composition of claim **1**, wherein

the liquid crystal compound represented by Formula 1 comprises a liquid crystal compound represented by the following Formulae 1-1 to 1-5:

[Formula 1-1]



[Formula 1-2]



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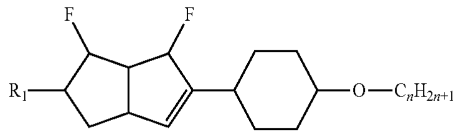
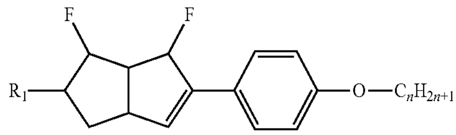
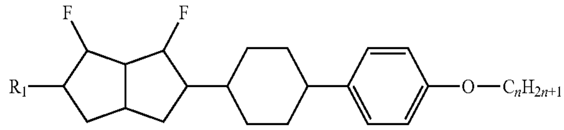
[Formula 1-3]



[Formula 1-4]



[Formula 1-5]



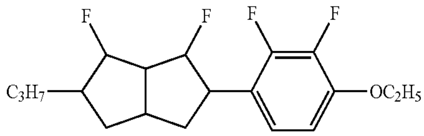
wherein R_1 is selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or $C_nH_{2n+1}O$, and

n is a natural number selected from 1 to 5.

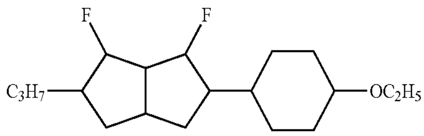
4. The liquid crystal composition of claim **1**, wherein

the liquid crystal compound represented by Formula 1 comprises a liquid crystal compound represented by the following Formulae 1-6 to 1-10:

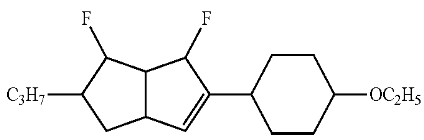
[Formula 1-6]



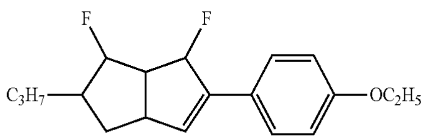
[Formula 1-7]



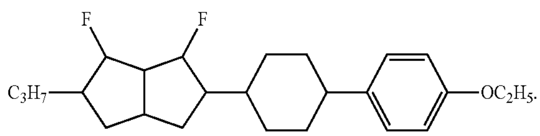
[Formula 1-8]



[Formula 1-9]



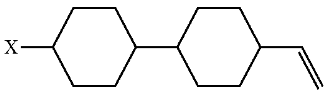
[Formula 1-10]



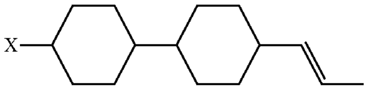
5. The liquid crystal composition of claim **1**, further comprising

at least one liquid crystal compound selected from liquid crystal compounds represented by the following Formulae 2 to 10:

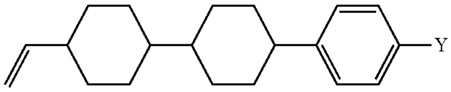
[Formula 2]



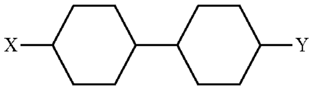
[Formula 3]



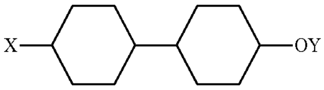
[Formula 4]



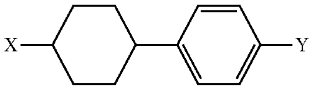
[Formula 5]



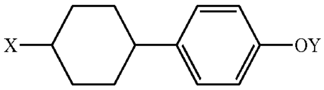
[Formula 6]



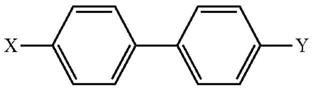
[Formula 7]



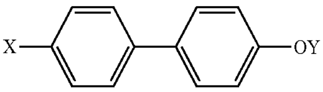
[Formula 8]



[Formula 9]



[Formula 10]

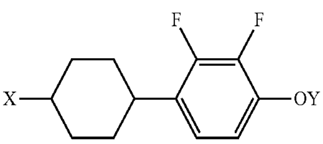


wherein X and Y are each independently C_nH_{2n+1}, and n is a natural number selected from 1 to 5.

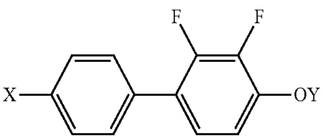
6. The liquid crystal composition of claim **1**, further comprising

at least one liquid crystal compound selected from liquid crystal compounds represented by the following Formulae 11 to 20:

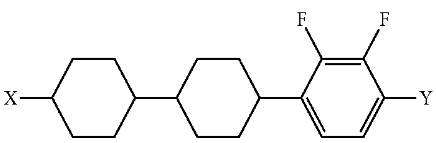
[Formula 11]



[Formula 12]



[Formula 13]



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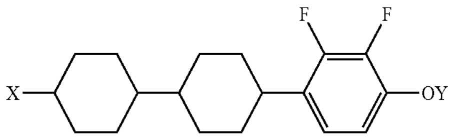
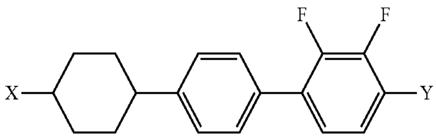
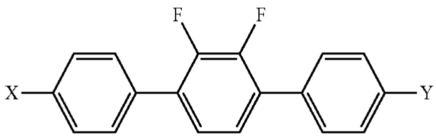
[Formula 14



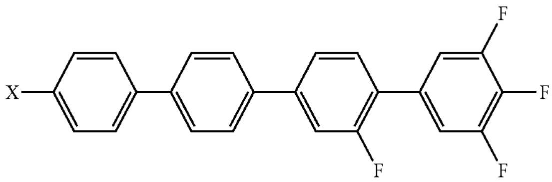
[Formula 15]



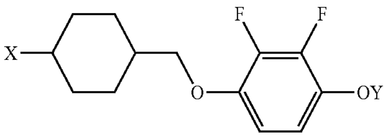
[Formula 16]



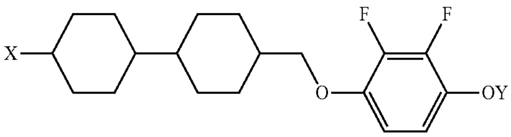
[Formula 17]



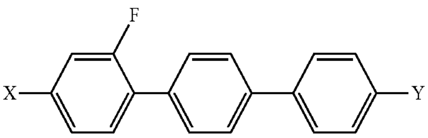
[Formula 18]



[Formula 19]



[Formula 20]



wherein X and Y are each independently C_nH_{2n+1}, and n is a natural number selected from 1 to 5.

7. The liquid crystal composition of claim **5**, wherein

the liquid crystal compound represented by Formula 2 is in an amount ranging from about 10 wt % to about 30 wt % of the liquid crystal composition,

each of the liquid crystal compounds represented by Formulae 3, 6, and 7 is in an amount ranging from about 5 wt % to about 15 wt % of the liquid crystal composition,

the liquid crystal compound represented by Formula 4 is in an amount ranging from about 3 wt % to about 10 wt % of the liquid crystal composition,

the liquid crystal compound represented by Formula 5 is in an amount ranging from about 10 wt % to about 35 wt % of the liquid crystal composition, and

each of the liquid crystal compounds represented by Formulae 8, 9, and 10 are present in an amount ranging from about 3 wt % to about 25 wt % of the liquid crystal composition.

8. The liquid crystal composition of claim 6, wherein each of the liquid crystal compounds represented by Formulae 11, 14, and 15 is in an amount ranging from about 5 wt % to about 25 wt % of the liquid crystal composition,

each of the liquid crystal compounds represented by Formulae 12 and 13 is in an amount ranging from about 5 wt % to about 20 wt % of the liquid crystal composition,

the liquid crystal compound represented by Formula 16 is in an amount ranging from about 1 wt % to about 15 wt % of the liquid crystal composition,

the liquid crystal compound represented by Formula 17 is in an amount ranging from about 0.03 wt % to about 5 wt % of the liquid crystal composition, and

each of the liquid crystal compounds represented by Formulae 18, 19, and 20 is in an amount ranging from about 5 wt % to about 20 wt % of the liquid crystal composition.

9. The liquid crystal composition of claim 1, wherein a rotational viscosity of the liquid crystal composition is less than or equal to about 100 mPa·s.

10. A liquid crystal display, comprising:

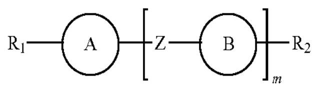
a first substrate;

a second substrate positioned above and overlapping with the first substrate; and

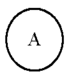
a liquid crystal layer disposed between the first substrate and the second substrate,

wherein the liquid crystal layer comprises a liquid crystal compound represented by the following Formula 1:

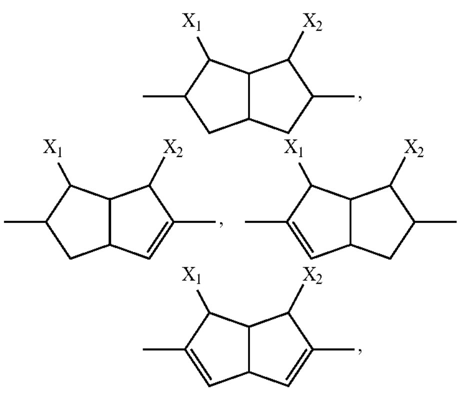
[Formula 1]



wherein,



is selected from



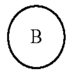
or

X_1 and X_2 are each independently selected from fluorine, CF_3, or C_nH_{2n+1},

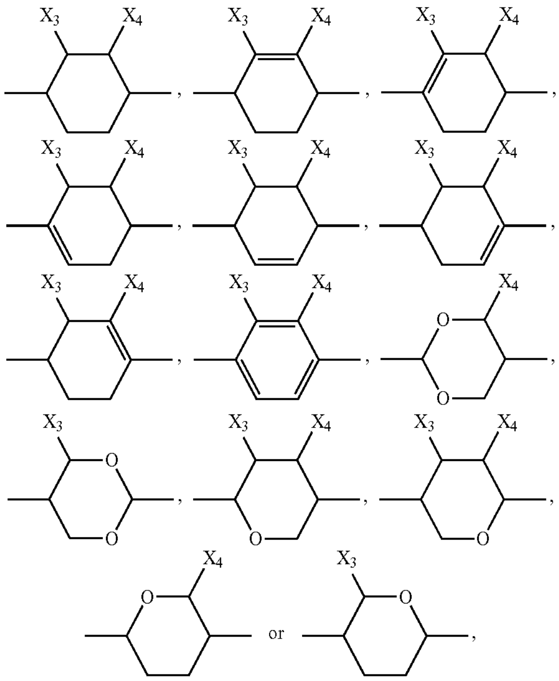
Z is selected from a single bond, a double bond, CF_2CF_2, OCF_2, or CF_2O,

R_1 is selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or $C_nH_{2n+1}O$,

R_2 is selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or OC_nH_{2n+1},



is selected from



X_3 and X_4 are each independently selected from hydrogen, fluorine, CF_3, or C_nH_{2n+1},

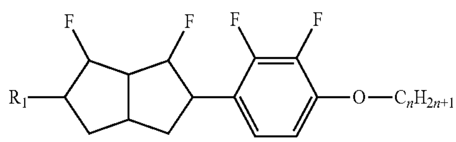
m is a natural number selected from 1 or 2, and

n is a natural number selected from 1 to 5.

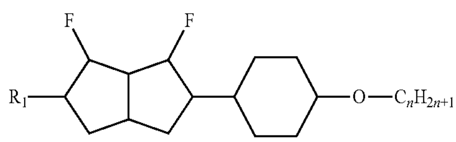
11. The liquid crystal display of claim 10, wherein the liquid crystal compound represented by Formula 1 is in an amount ranging from about 1 wt % to about 20 wt % of the liquid crystal layer.

12. The liquid crystal display of claim 10, wherein the liquid crystal compound represented by Formula 1 comprises a liquid crystal compound represented by the following Formulae 1-1 to 1-5:

[Formula 1-1]



[Formula 1-2]



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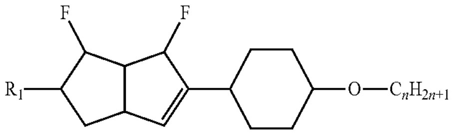
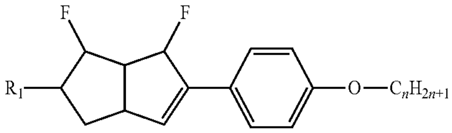
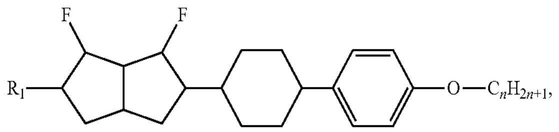
[Formula 1-3]



[Formula 1-4]



[Formula 1-5]



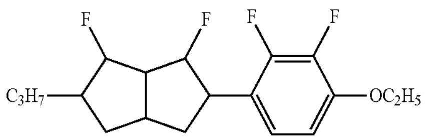
wherein R_1 is selected from hydrogen, fluorine, CF_3, C_nH_{2n+1}, or $C_nH_{2n+1}O$, and

n is a natural number selected from 1 to 5.

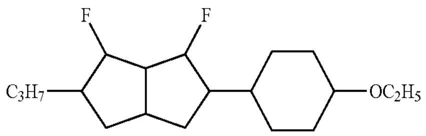
13. The liquid crystal display of claim **10**, wherein

the liquid crystal compound represented by Formula 1 comprises a liquid crystal compound represented by the following Chemical Formulae 1-6 to 1-10:

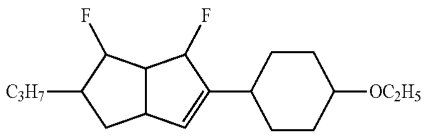
[Formula 1-6]



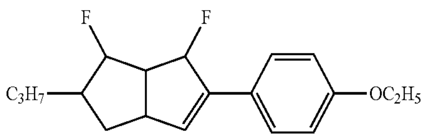
[Formula 1-7]



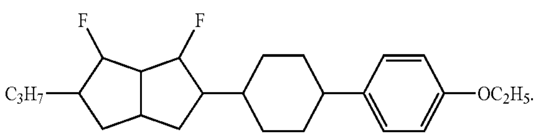
[Formula 1-8]



[Formula 1-9]



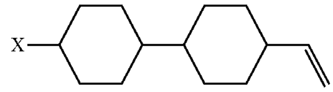
[Formula 1-10]



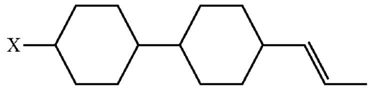
14. The liquid crystal display of claim **10**, wherein

the liquid crystal layer further comprises at least one liquid crystal compound selected from liquid crystal compounds represented by the following Formulae 2 to 10:

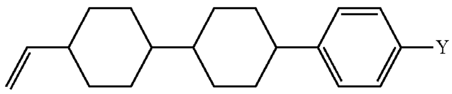
[Formula 2]



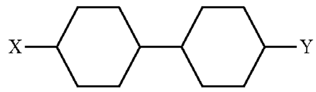
[Formula 3]



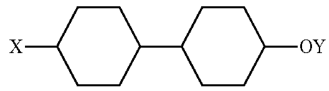
[Formula 4]



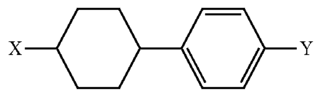
[Formula 5]



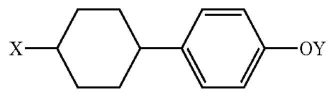
[Formula 6]



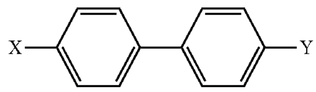
[Formula 7]



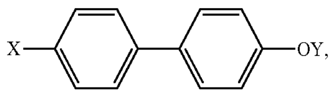
[Formula 8]



[Formula 9]



[Formula 10]

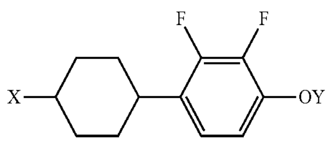


wherein X and Y are each independently C_nH_{2n+1}, and n is a natural number selected from 1 to 5.

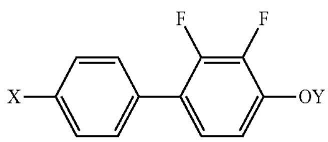
15. The liquid crystal display of claim **10**, wherein

the liquid crystal layer further comprises at least one liquid crystal compound selected from liquid crystal compounds represented by the following Formulae 11 to 20:

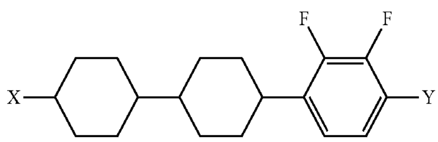
[Formula 11]



[Formula 12]

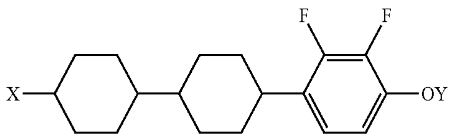


[Formula 13]

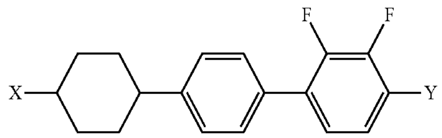


-continued

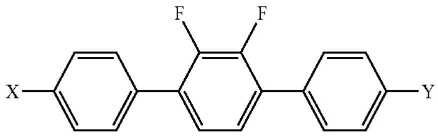
[Formula 14



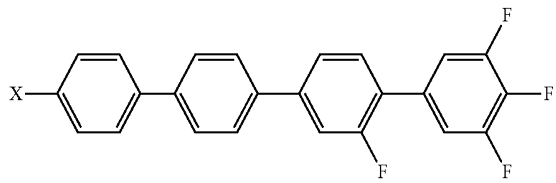
[Formula 15]



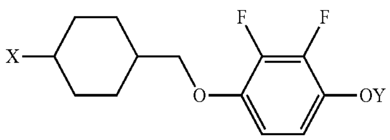
[Formula 16]



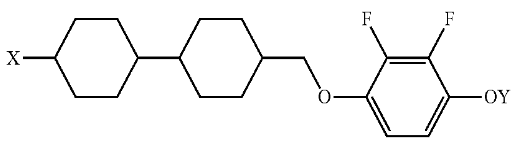
[Formula 17]



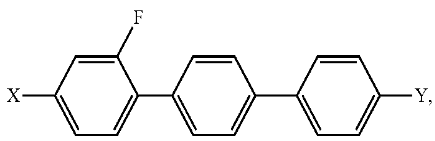
[Formula 18]



[Formula 19]



[Formula 20]



wherein X and Y are each independently CH_nH_{2n+1} and n is a natural number selecte from 1 to 5.

16. The liquid crystal display of claim **14**, wherein

the liquid crystal compound represented by Formula 2 is in an amount ranging from about 10 wt % to about 30 wt % of the liquid crystal layer,

each of the liquid crystal compounds represented by Formulae 3, 6, and 7 is in an amount ranging from about 5 wt % to about 15 wt % of the liquid crystal layer,

the liquid crystal compound represented by Chemical Formula 4 is 3 wt % to 10 wt % of the entire liquid crystal layer,

the liquid crystal compound represented by Formula 5 is in an amount ranging from about 10 wt % to about 35 wt % of the liquid crystal layer, and

each of the liquid crystal compounds represented by Formulae 8, 9, and 10 is in an amount ranging from about 3 wt % to about 25 wt % of the liquid crystal layer.

17. The liquid crystal display of claim **15**, wherein

each of the liquid crystal compounds represented by Formulae 11, 14, and 15 is in an amount ranging from about 5 wt % to about 25 wt % of the liquid crystal layer,

each of the liquid crystal compounds represented by Formulae 12 and 13 is in an amount ranging from about 5 wt % to about 20 wt % of the liquid crystal layer,

the liquid crystal compound represented by Formula 16 is in an amount ranging from about 1 wt % to about 15 wt % of the liquid crystal layer,

the liquid crystal compound represented by Formula 17 is in an amount ranging from about 0.03 wt % to about 5 wt % of the liquid crystal layer, and

each of the liquid crystal compounds represented by Formulae 18, 19, and 20 is in an amount ranging from about 5 wt % to about 20 wt % of the liquid crystal layer.

18. The liquid crystal display of claim **10**, wherein

a rotational viscosity of the liquid crystal composition is less than or equal to about 100 mPa·s.

19. The liquid crystal display of claim **10**, further comprising:

a pixel electrode disposed on the first substrate; and

a common electrode disposed on the second substrate.

20. The liquid crystal display of claim **19**, wherein the pixel electrode includes a first sub-pixel electrode and a second sub-pixel electrode.

* * * * *

专利名称(译)	液晶组合物和包含其的液晶显示器		
公开(公告)号	US10214690	公开(公告)日	2019-02-26
申请号	US15/490392	申请日	2017-04-18
[标]申请(专利权)人(译)	三星显示有限公司		
申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
当前申请(专利权)人(译)	三星DISPLAY CO.，LTD.		
[标]发明人	HONG SUNG HWAN KOH EUN KYUNG KIM MYUNG EUN TAKESHITA FUSAYUKI BAE JI HONG		
发明人	HONG, SUNG-HWAN KOH, EUN KYUNG KIM, MYUNG-EUN TAKESHITA, FUSAYUKI BAE, JI HONG		
IPC分类号	G02F1/1333 C09K19/32 G02F1/1343		
CPC分类号	C09K19/32 G02F1/134309 G02F2201/123 G02F2201/121 G02F2001/134345 C09K2019/3422 G02F1/0045		
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其他公开文献	US20170298274A1		
外部链接	Espacenet		

摘要(译)

包含由式1表示的液晶化合物的液晶组合物：

[Formula 1]