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(54) **PHOTO-ALIGNMENT MATERIAL AND LIQUID CRYSTAL DISPLAY DEVICE AND ITS MANUFACTURING METHOD USING THE SAME**

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(57) **ABSTRACT**

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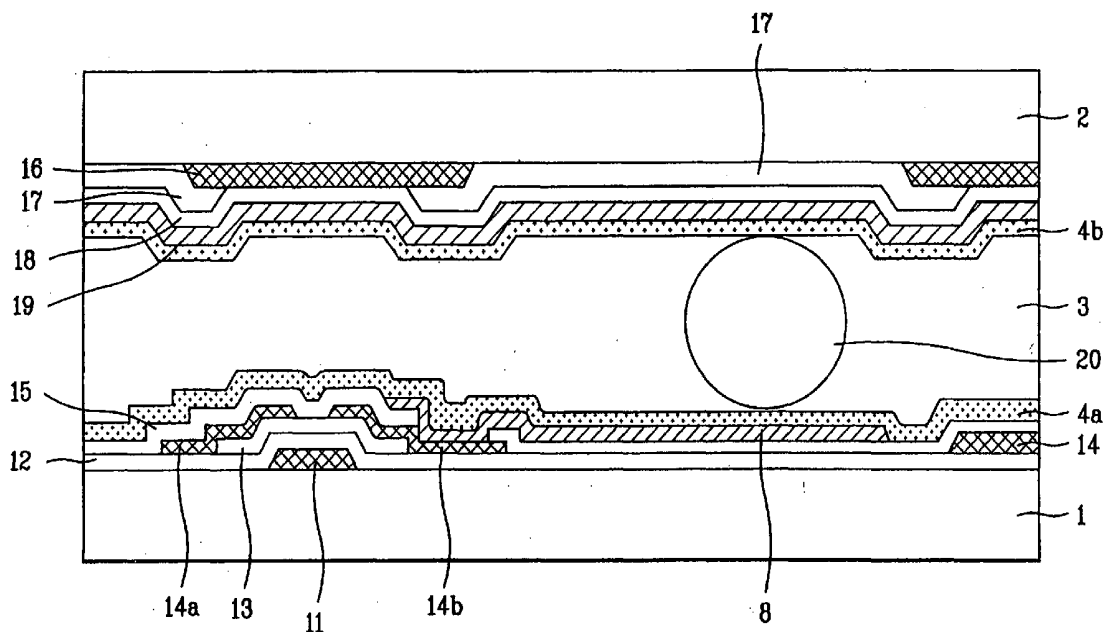
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A photo-alignment material, a liquid crystal display device using the photo-alignment material, and a manufacturing method. The photo-alignment material is a polymer having a photo-reactive ethenyl group on a main chain. When used as a photo-alignment layer, the photo-alignment material enables improved alignment stability against external shocks, light, and heat. The liquid crystal display device includes a first substrate, a second substrate, a liquid crystal layer formed between the first and second substrates, and a photo-alignment layer formed at least on the first substrate, with the photo-alignment layer formed from a photo-alignment material having an ethenyl group at a main chain.





**PHOTO-ALIGNMENT MATERIAL AND LIQUID CRYSTAL DISPLAY DEVICE AND ITS MANUFACTURING METHOD USING THE SAME**

**BACKGROUND OF THE INVENTION**

**[0001]** 1. Field of the Invention

**[0002]** The present invention relates to alignment layers for liquid crystal display devices (hereinafter abbreviated LCD). More particularly, it relates to a photo-alignment material having a photo-reactive functional group of ethenyl at a main-chain, and to the use of that material in liquid crystal displays.

**[0003]** 2. Background of the Related Art

**[0004]** Flat panel LCD devices have become widely used as displays for mobile terminals, notebook computers, office equipment, video equipment, and the like. This is because flat panel LCD devices have advantages of small-size, lightweight, and low power consumption.

**[0005]** In general, an LCD includes a pair of substrates that are separated by a predetermined interval, and an interposed liquid crystal.

**[0006]** An LCD has numerous functional requirements, including light transmission characteristics, operational response time, viewing angle, and contrast. Many of those requirements are impacted by the alignment characteristics of the liquid crystal molecules in the LCD. Indeed, uniformly aligned liquid crystal molecules are important to the electro-optical characteristics of LCDs.

**[0007]** The alignment characteristics of LCDs are results of an alignment layer. Generally, a rubbing technique has been used to form that layer. In that technique, a special cloth is rubbed over a substrate to form the alignment layer. While the rubbing technique is a simple process, it has problems. For example, various process variables related to rubbing are difficult to accurately control. Furthermore, dust adsorption, unwanted scratches generated by the rubbing, and damage to thin film transistors caused by static electricity can also result from the rubbing. Such problems reduce the manufacturing yield and the performance of LCDs.

**[0008]** Because of the forgoing problems, significant effort has been expended in developing alignment techniques that do not use mechanical rubbing. In particular, photo-alignment methods could solve the static electricity and dust problems, as well as improve the viewing angle.

**[0009]** Photo-alignment methods include photo-decomposition, photo-polymerization, and photo-isomerization. In these methods, optical anisotropy is brought about in a polymer layer by inducing a photo-reaction after most of the molecules facing a polarizing direction in the disorderly-aligned polymer molecules have absorbed light.

**[0010]** In the photo-decomposition method, liquid crystals are arranged by inducing optical anisotropy using a photo-decomposition reaction that selectively breaks partial bonds of the molecules in a specific direction by the application of linearly-polarized ultraviolet rays to a polymer layer consisting of a photo-alignment material. The material typically used for this method is polyimide. Although polyimide requires the application of ultraviolet rays for a relatively

long time to induce liquid crystal alignment, a polyimide alignment layer formed by photo-decomposition has a relatively-high thermal stability as compared to other photo-alignment layers fabricated by other methods.

**[0011]** In the photo-polymerization method, liquid crystals are arranged by polymerizing the molecules in a specific direction by applying linearly-polarized rays to a polymer layer where polymerization is to occur.

**[0012]** In the photo-isomerization method, cis/trans isomers are formed by a polarized light. Thus, liquid crystals are aligned by the direction generated from the transformation of the produced isomers. Although the alignment direction is reversibly controlled by applying light of a specific wave length, it is difficult to give a pre-tilt angle to a liquid crystal as well as to maintain the stability of the liquid crystal.

**[0013]** The chemical structure of photo-alignment materials is mainly divided into two categories: a main chain, and side chains including photo-sensitive groups such as an alkyl group, an ethenyl group and the like. The main chain makes liquid crystal molecules arrange to face a predetermined direction, while the side chains form a pre-tilt angle.

**[0014]** Photo-reactions take place at side chains having photosensitive groups when light is irradiated onto them. Thus, liquid crystal alignment depends on the side chains. Therefore, liquid crystal alignment of the photo-alignment material is controlled by the side chains, which include hydrocarbon branches such as alkyl, ethenyl and the like.

**[0015]** Unfortunately, related art photo-alignment materials, and LCDs using the same, have problems. As noted, the photo-alignment of a photo-alignment layer according to the related art is controlled by the side chains. As the side chains are flexible and fragile, that alignment tends to be easily broken by thermal, physical, electrical, and photo shocks. Furthermore, the alignment tends to be hard to restore. Additionally, the photo-alignment layer used in the photo-decomposition method has such poor photo-sensitivity that relatively high light intensity is required to break the predetermined bonds of the side chain or main chain. Finally, in general, with related art photo-alignment layers the actual liquid crystal alignment is relatively poor.

**SUMMARY OF THE INVENTION**

**[0016]** Accordingly, the present invention is directed to a photo-alignment material, to a liquid crystal display device that incorporates that photo-alignment material, and to a method of manufacturing a liquid crystal display device that incorporates that photo-alignment material, wherein that photo-alignment material substantially obviates one or more of the problems due to limitations and disadvantages of the related art.

**[0017]** Additional features and advantages of the invention will be set forth in the description that follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the structure particularly pointed out in the written description and claims hereof as well as the appended drawings.

**[0018]** To achieve these and other advantages, and in accord with the principles of the present invention as

embodied and broadly described, a photo-alignment material according to the present invention includes at least a photo-reactive ethenyl functional group at a polymer main chain.

[0019] In another aspect, a liquid crystal display device in accord with the principles of the present invention includes a first substrate, a second substrate, a liquid crystal layer between the first and second substrates, and a photo-alignment layer on the first and/or the second substrate. That photo-alignment layer includes an ethenyl group on a main chain of the photo-alignment material.

[0020] In another aspect, a method of fabricating a liquid crystal display device according to the principles of the present invention includes preparing a first substrate and a second substrate, forming a photo-alignment layer having an ethenyl group at a main chain on at least the first substrate; and forming a liquid crystal layer between the first and second substrates.

[0021] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The accompanying FIG. 1, which is included to provide a further understanding of the invention and which is incorporated in and constitutes a part of this specification, illustrates an embodiment of the invention and together with the description serves to explain the principles of the invention. Specifically

[0023] FIG. 1 shows a cross-sectional view of a general liquid crystal display device.

#### DETAILED DESCRIPTION OF AN ILLUSTRATED EMBODIMENTS

[0024] Reference will be made in detail to an illustrated preferred embodiment of the present invention, the example of which is illustrated in the accompanying drawing. In the illustrated embodiment a liquid crystal display device includes a first substrate, a second substrate, a liquid crystal layer formed between the first and second substrates, and a photo-alignment layer formed at least on the first substrate, wherein the photo-alignment layer is formed from a photo-alignment material having an ethenyl group in a main chain. The alignment stability with respect to thermal, physical, electrical, and photo shocks is increased by that photo-alignment layer. More specifically, a photo-alignment material according to the present invention consists of polymers denoted by the following Chemical Formula 1.

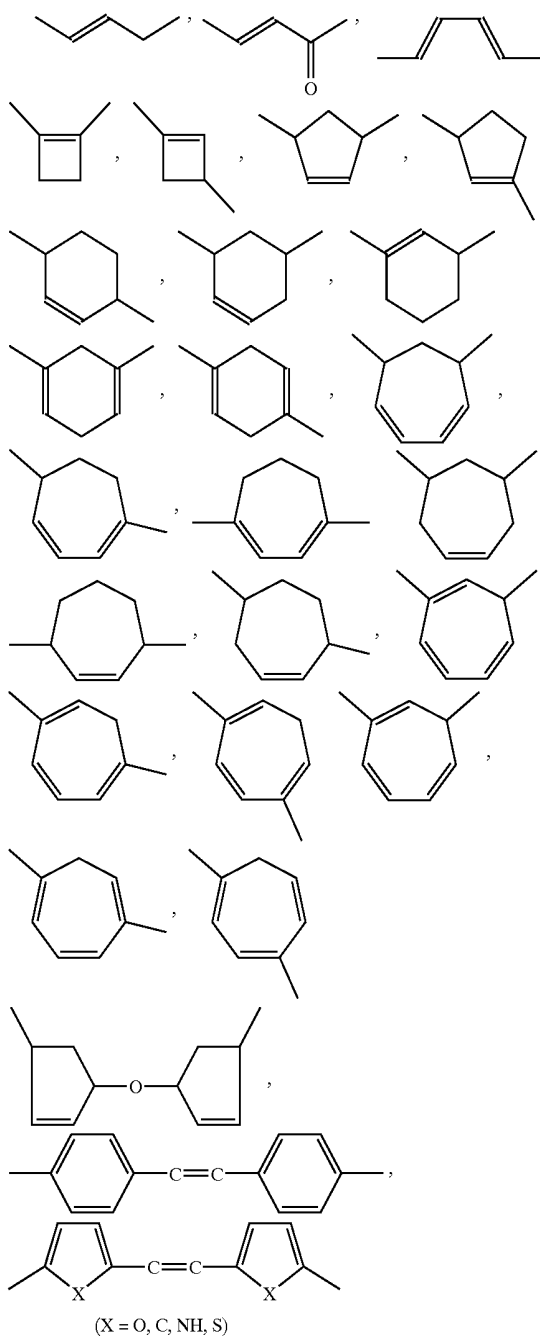


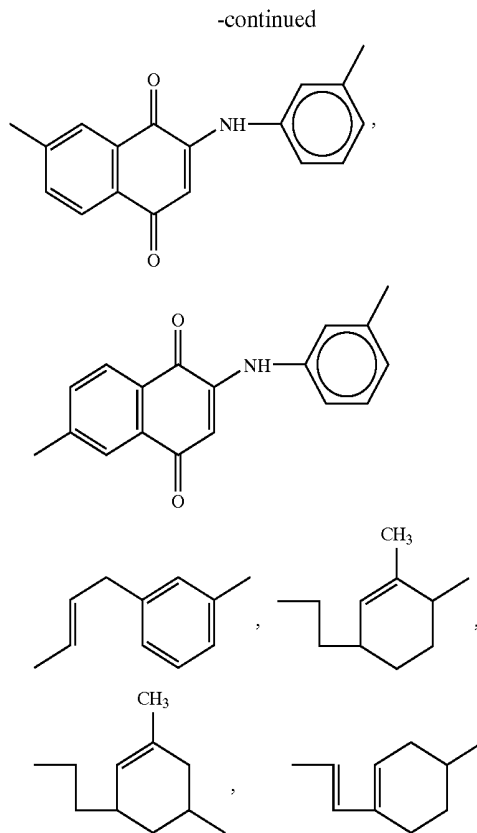
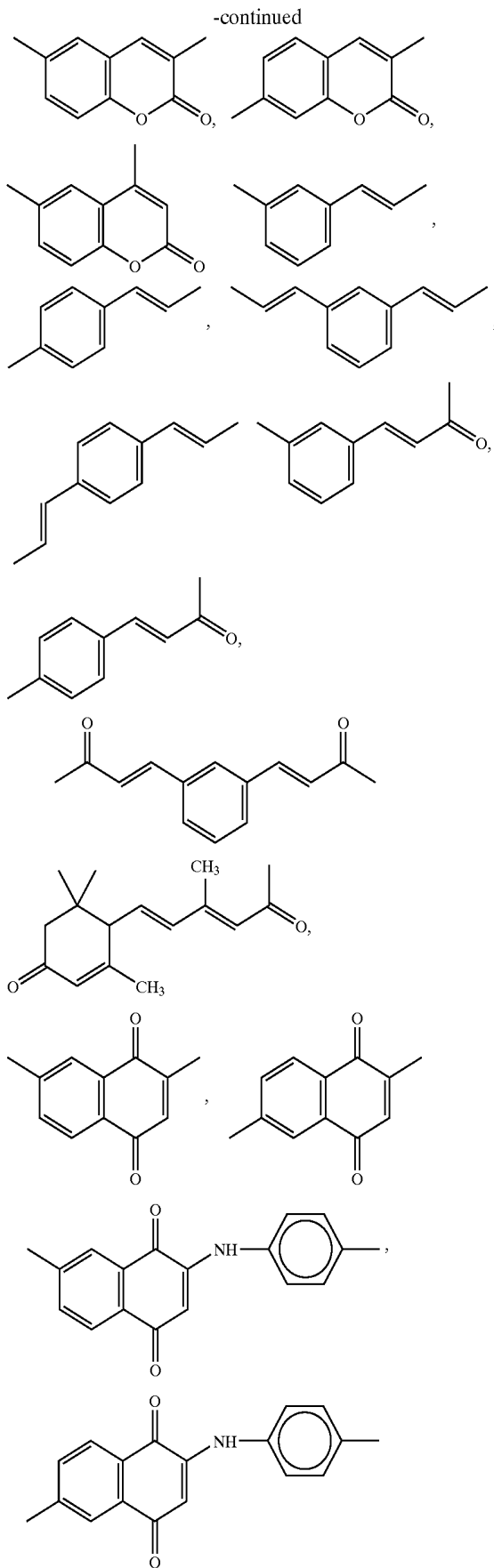
[0025] Components 'A', 'B', and 'C' are monomers constituting the polymer and are selectively coupled to produce a homopolymer, a copolymer, or a block-copolymer. The arrangement order of components 'A', 'B', and 'C' is not limited by the above Chemical Formula 1. Furthermore,

subscripts 'a', 'b', and 'c' denote component ratios between the respective monomers, where  $0 < a \leq 1$ ,  $0 \leq b < 1$ , and  $0 \leq c < 1$ .

[0026] Component 'A' is a monomer including a photo-reactive ethenyl group. That component is selected from groups designated in the following Chemical Formula 2, substituted-structure groups of Chemical Formula 2 with a halogen, a cyano, a nitro, an amino group and the like, and other substituted-structure groups with an alkyl, a haloalkyl, or a cyanoalkyl group having 1 to 10 carbons, or an aryl, an alkylaryl, a haloaryl, a haloalkyl aryl, a nitroaryl, or a cyanoaryl group having 3 to 8 carbons.

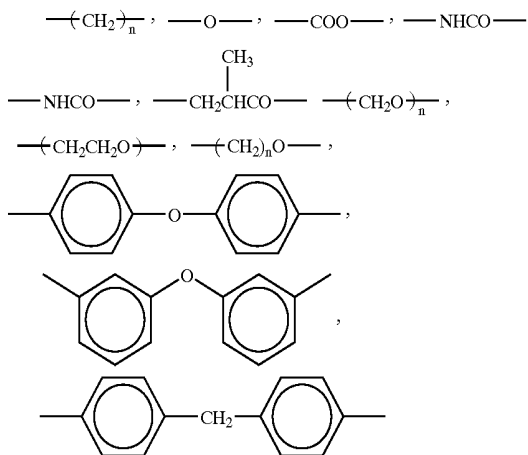
\{Chemical Formula 2\}

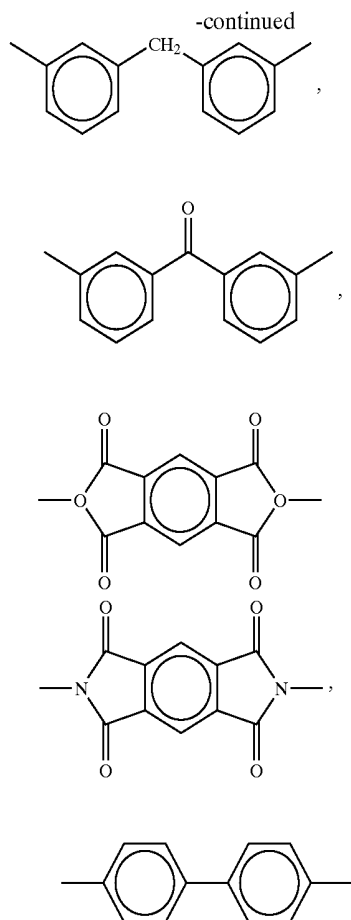




[0027] Components 'B' and 'C' are selected independently from the following groups shown in Chemical Formula 3, substituted-structure groups of Chemical Formula 3 with a halogen, a cyano, a nitro, an amino group and the like, and other substituted-structure groups with carbonated groups of which carbon number n lies between 1 and 10 such as an alkyl, a haloalkyl, and a cyanoalkyl or other carbonated groups of which carbon number lies between 3 and 8 such as an alkaryl, a haloaryl, a nitroaryl, a cyanoaryl and the like.

{Chemical Formula 3}





[0028] Components 'B' and 'C', which are non-photosensitive components connected to component 'A' regardless of a photo-reactive ethenyl group of the present invention, increase the reaction of the photo-sensitive ethenyl groups, secures a marginal space for the reaction, or increases the reciprocal reaction with liquid crystals.

[0029] Therefore, a photo-alignment material according to the principles of the present invention is formed by connecting other main chains to a main chain including a photo-reactive ethenyl group.

[0030] The photo-alignment material described above provides a photo-alignment layer in which photo-reactivity and alignment stability are improved.

[0031] A liquid crystal display device using the photo-alignment material according to the present invention is explained with reference to FIG. 1, which shows a cross-sectional view of a liquid crystal display device. Referring to FIG. 1, a liquid crystal display device according to the principles of the present invention includes a first substrate 1, a second substrate 2, a liquid crystal layer 3 formed between the first and second substrates, and a spacer 20 that maintains a uniform interval between the substrates 1 and 2.

[0032] The first substrate 1 is a substrate for thin film transistor (hereinafter abbreviated TFT) switching devices that selectively turn data signals on/off in accordance with

gate voltages. To that end, on the first substrate 1 are a gate line having a gate electrode 11 for a thin film transistor and a gate insulating layer 12 over the substrate and the gate electrode 11. The gate insulating layer is beneficially a silicon nitride layer (SiNx). A semiconductor layer 13 is on the gate insulating layer 12 and over the gate electrode 11. A data line 14 crosses the gate line. A source electrode 14a and a drain electrode 14b are on the semiconductor layer 13. A first passivation layer 15 is formed over the substrate as shown in FIG. 1, including over the source electrode 14a and the drain electrode 14b. The first passivation layer 15 is beneficially of silicon nitride (SiNx) or BCB (Benzocyclo Butene). A pixel electrode 8 that connects to the drain electrode 14b is formed on the first passivation layer 15. The pixel electrode 8 is beneficially of ITO (indium tin oxide). Furthermore, a first alignment layer 4a extends over the surface, including the pixel electrode 8, as shown in FIG. 1.

[0033] The second substrate 2 supports a color filter layer for expressing colors. On the second substrate 2 are black matrices 16 that prevents light leakage, a color filter layer 17 (RGB) between neighboring black matrices 16, and a second passivation layer 18 over the entire surface as shown in FIG. 1. The second passivation layer 18 protects the color filter layer 17. A common electrode 19 is then formed on the second passivation layer 18. The common electrode 19 is beneficially comprised of ITO (indium-tin-oxide). A second alignment layer 4b is then formed over the entire surface as shown in FIG. 1.

[0034] At least one of the first and second alignment layers 4a and 4b is formed from a photo-alignment material that is in accord with the principles of the present invention. If the other alignment layer is not formed from a photo-alignment layer material, it can be formed by rubbing.

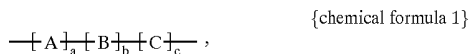
[0035] To form a photo-alignment layer using a photo-alignment material as described above (having an ethenyl group in the main chain), the photo-alignment material is uniformly coated on a substrate. That photo-alignment layer material is then thermally treated and dried in an oven. Subsequently, a structure that assists anisotropy of the liquid crystals is attained by irradiating polarized UV rays onto the exposed surface of the photo-alignment layer. The UV rays may be irradiated vertically and slantwise using unpolarized light, non-polarized light, linearly polarized light, partially polarized light or the like, depending on the alignment structure to be implemented.

[0036] A photo-alignment layer according to the present invention enables improvement of the optical and thermal stability of the liquid crystal alignment, pre-tilt stability against electric stress, and improved shock-resistance. Moreover, the principles of the present invention enable improved display quality and an improved LCD display manufacturing method.

[0037] The foregoing embodiments are merely exemplary and are not to be construed as limiting the present invention. The present inventions can be readily applied to other types of apparatuses. The description of the present invention is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art.

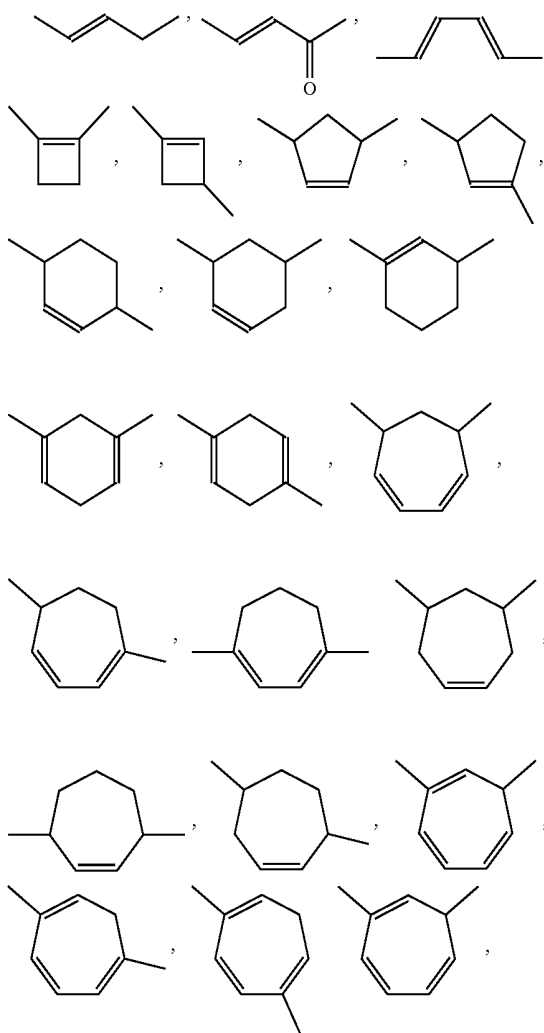
What is claimed is:

1. A photo-alignment material having a photo-reactive ethenyl group on a polymer main chain, wherein the polymer is in accord with chemical formula 1:

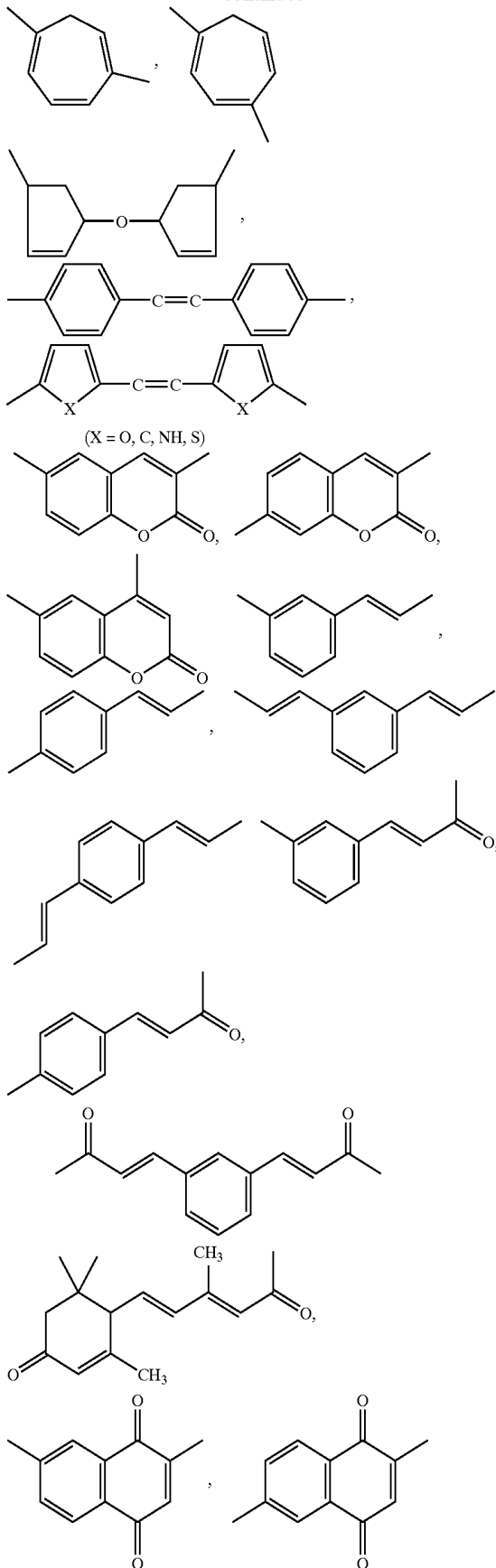


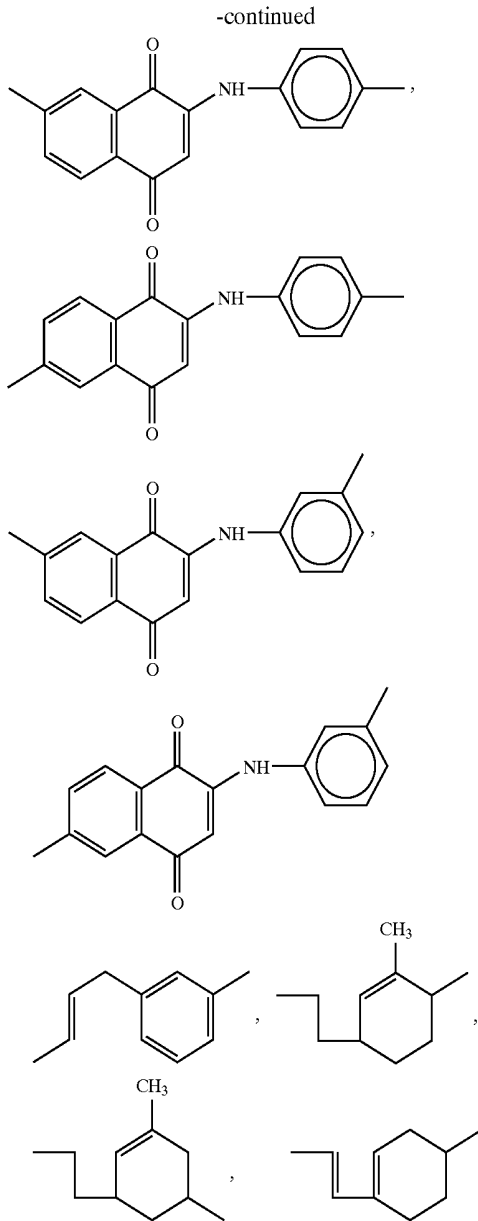
wherein subscripts a, b, and c denote a component ratio of respective monomers, wherein  $0 < a \leq 1$ ,  $0 \leq b < 1$ , and  $0 \leq c < 1$ , and wherein component A is a monomer including a photo-reactive ethenyl group selected from groups designated in chemical formula 2, substituted-structure groups of chemical formula 2 having a halogen, a cyano, a nitro, an amino group, and other substituted-structure groups with an alkyl, a haloalkyl, a cyanoalkyl group having 1 to 10 carbons, or an aryl, an alkyl, an aryl, a haloaryl, a haloalkyl aryl, a nitroaryl, and a cyanoaryl group having 3 to 8 carbons;

{Chemical Formula 2}



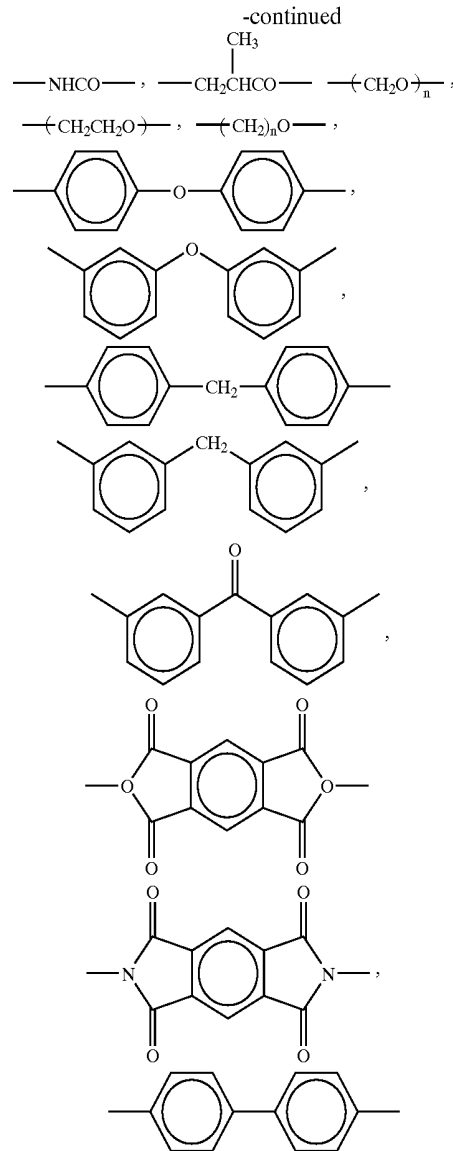
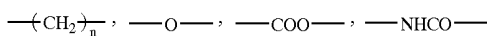
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2. The photo-alignment material of claim 1, wherein components B and C are selected independently from groups shown in chemical formula 3, substituted-structure groups of chemical formula 3 with a halogen, a cyano, a nitro, an amino group, other substituted-structure groups with carbonated groups of which carbon number n lies between 1 and 10 such as an alkyl, a haloalkyl, and a cyanoalkyl, and other carbonated groups of which carbon number lies between 3 and 8 such as an alkylaryl, a haloaryl, a haloalkylaryl, a nitroaryl, and a cyanoaryl;

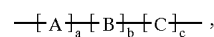
{Chemical Formula 3}



3. A liquid crystal display device comprising:  
 a first substrate;  
 a second substrate;  
 a liquid crystal layer between the first and second substrates; and  
 a photo-alignment layer on the first substrate, wherein the photo-alignment layer includes an ethenyl group on a main chain.

4. The device of claim 3, wherein the photo-alignment layer is formed of material having a photo-reactive ethenyl group on a polymer main chain, wherein the polymer is according to following chemical formula 1:

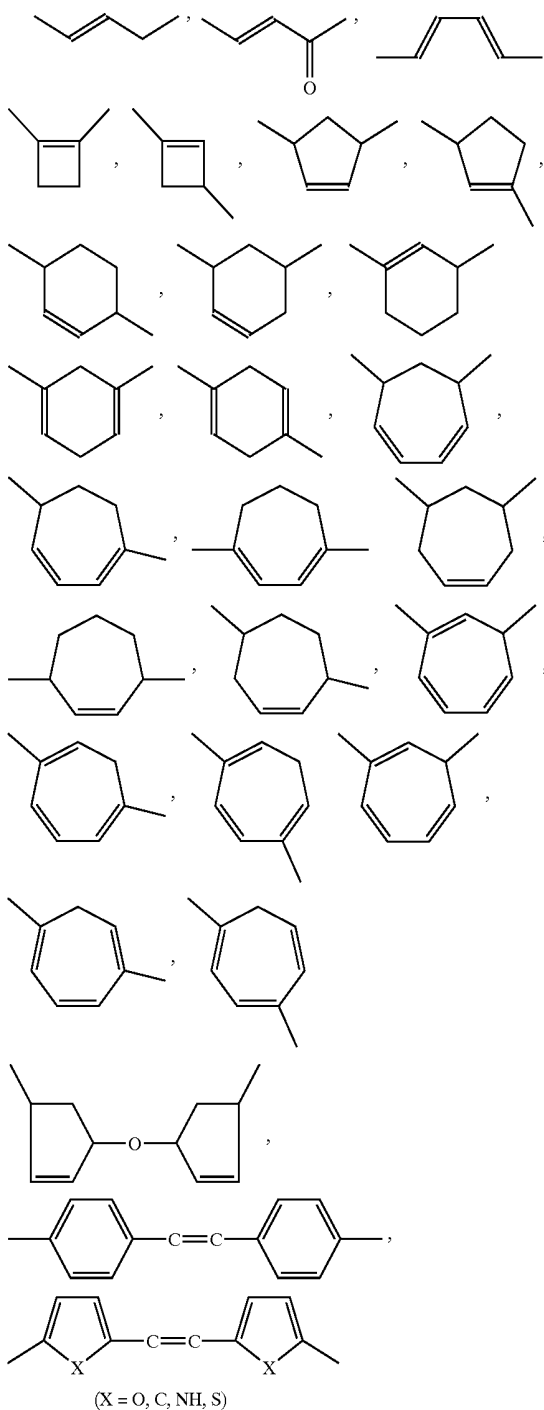
{chemical formula 1}



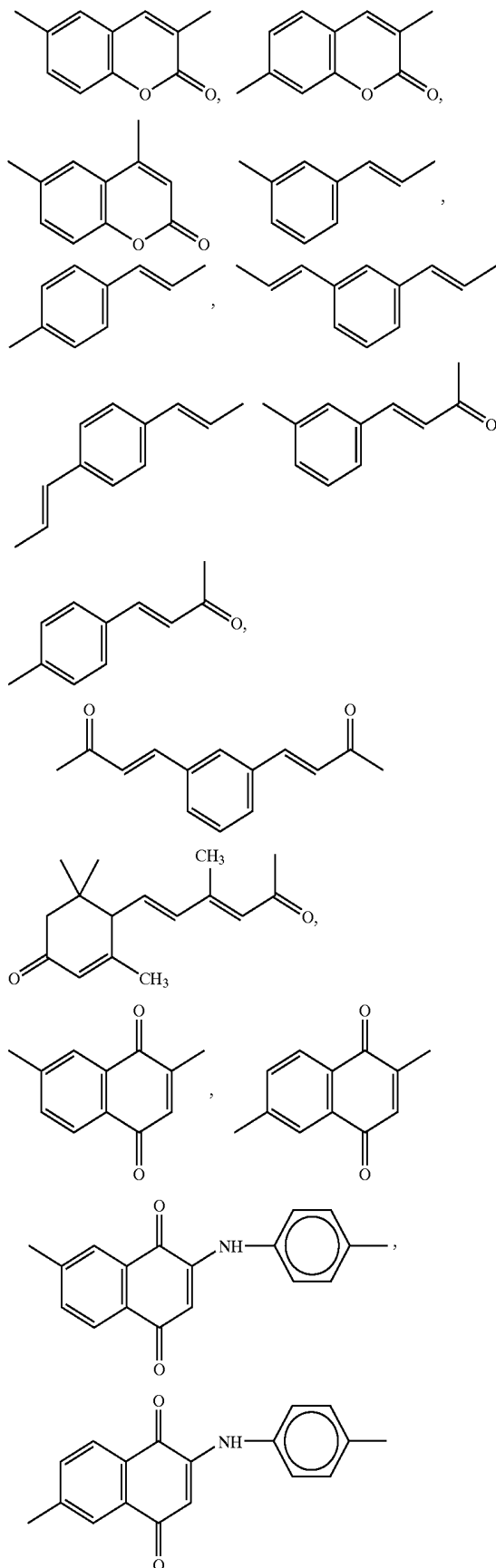
wherein subscripts a, b, and c denote a component ratio of respective monomers, wherein  $0 < a \leq 1$ ,  $0 \leq b < 1$ , and

$0 \leq c < 1$ , and wherein component A is a monomer including the photo-reactive ethenyl group, selected from groups designated in chemical formula 2, substituted-structure groups of the chemical formula 2 with a halogen, a cyano, a nitro, an amino group, and other substituted-structure groups with an alkyl, a haloalkyl, a cyanoalkyl group having 1 to 10 carbons, or an aryl, an alkyl, an aryl, a haloaryl, a haloalkyl aryl, a nitroaryl, a cyanoaryl group having 3 to 8 carbons;

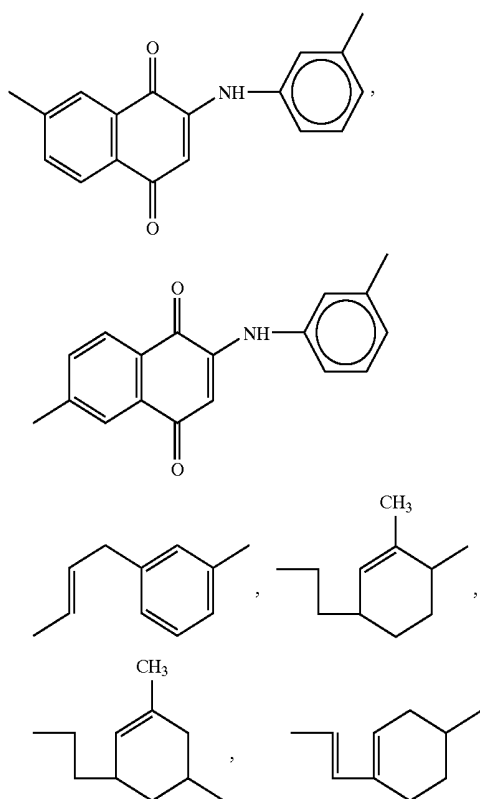
{Chemical Formula 2}



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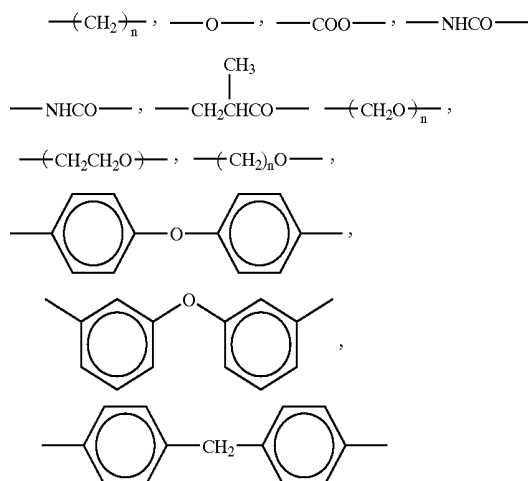


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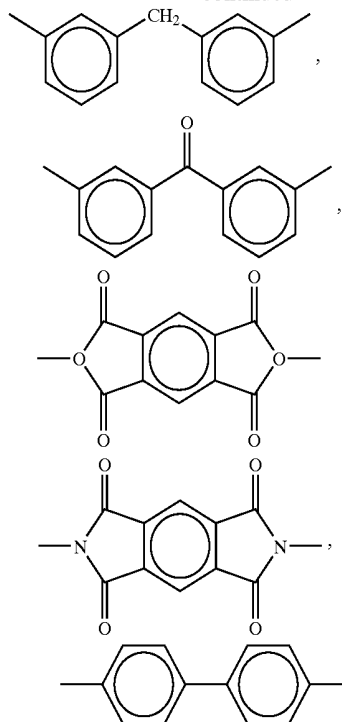


5. The device of claim 4, wherein components B and C are selected from groups shown in chemical formula 3, substituted-structure groups of the chemical formula 3 with a halogen, a cyano, a nitro, an amino group, other substituted-structure groups with carbonated groups of which carbon number n lies between 1 and 10 such as an alkyl, haloalkyl, and cyanoalkyl, and other carbonated groups of which carbon number lies between 3 and 8 such as an alkylaryl, a haloaryl, a haloalkylaryl, a nitroaryl, and a cyanoaryl;

{Chemical Formula 3}



-continued



6. The device of claim 3, further comprising at least one thin film transistor including a gate electrode, a semiconductor layer, a source electrode, and a drain electrode.

7. The device of claim 3, wherein the photo-alignment layer is formed by light-irradiation.

8. The device of claim 7, wherein the light-irradiation is irradiated at least once.

9. The device of claim 7, wherein the light is selected from a group consisting of unpolarized light, non-polarized light, linearly polarized light and partially polarized light.

10. A liquid crystal display device comprising:

a first substrate;

a second substrate;

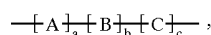
a liquid crystal layer between the first and second substrates;

a photo-alignment layer on the first substrate, the photo-alignment layer having an ethenyl group at a main chain; and

a rubbing alignment layer on the second substrate.

11. The device of claim 10, wherein the photo-alignment layer is formed of material having at least a photo-reactive ethenyl group at a polymer main chain, wherein the polymer is denoted by the following chemical formula 1:

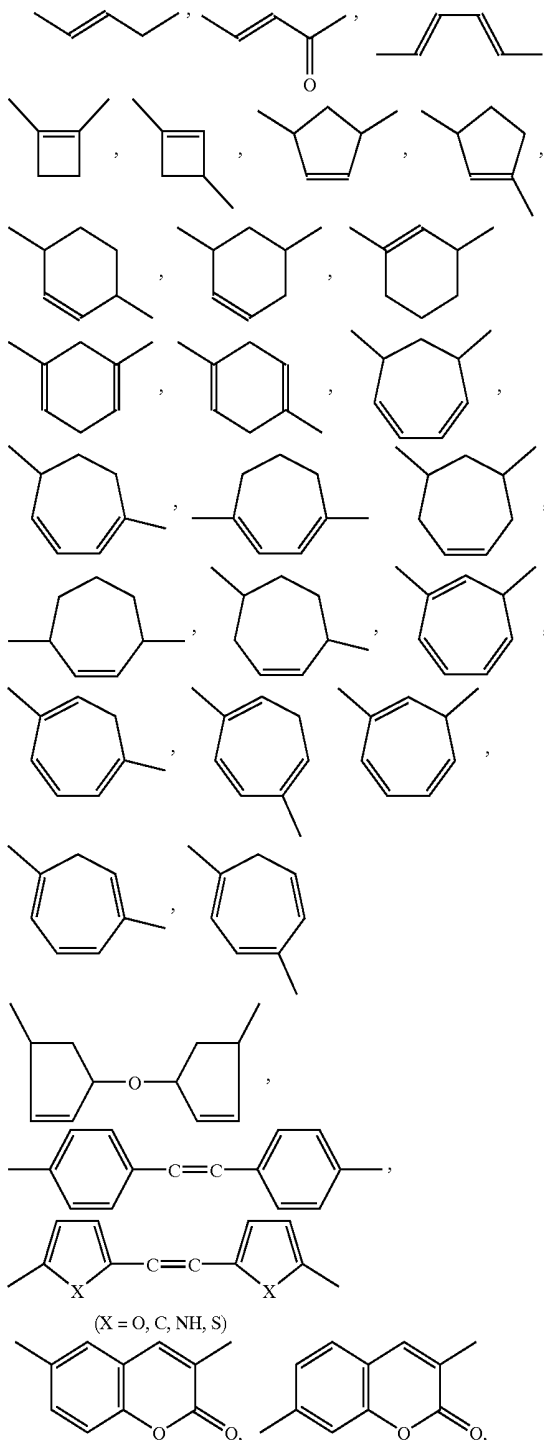
{chemical formula 1}



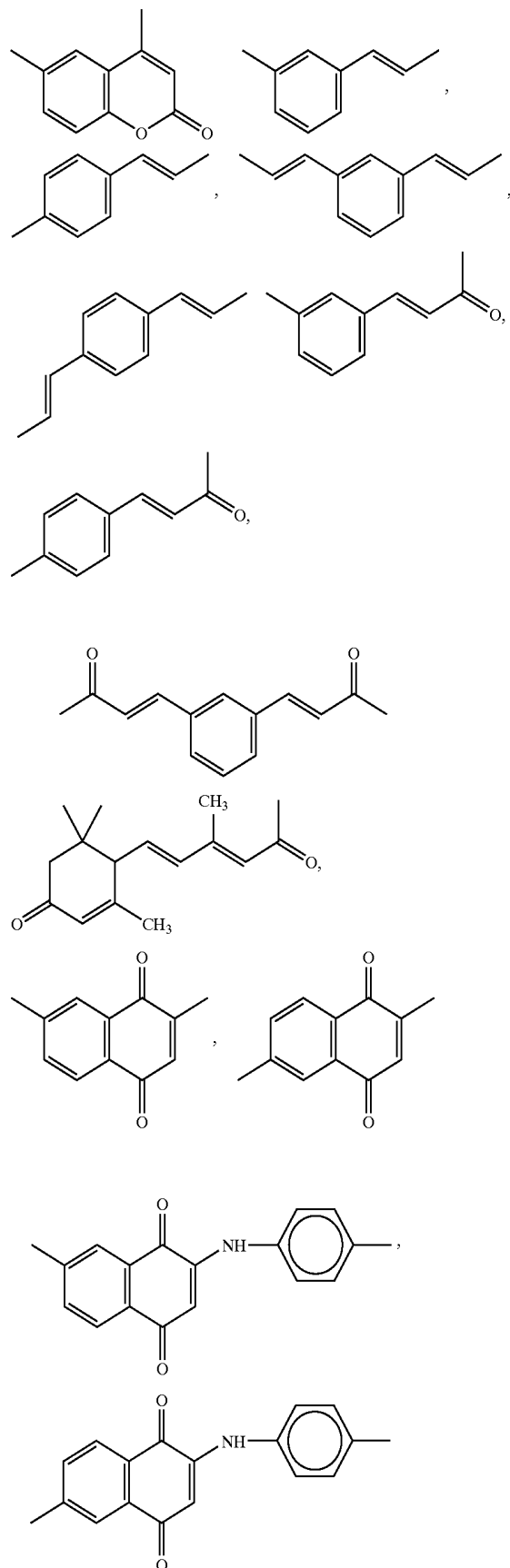
wherein subscripts a, b, and c denote a component ratio of respective monomers, wherein  $0 < a \leq 1$ ,  $0 \leq b < 1$ , and  $0 \leq c < 1$ , and wherein component A, which is a mono-

mer including the photo-reactive ethenyl group, is selected from groups designated in chemical formula 2, substituted-structure groups of chemical formula 2 with a halogen, cyano, nitro, amino group, and other substituted-structure groups with an alkyl and haloalkyl, and cyanoalkyl group having 1 to 10 carbons or an aryl, alkyl, aryl, haloaryl, haloalkyl aryl, nitroaryl, cyanoaryl group having 3 to 8 carbons;

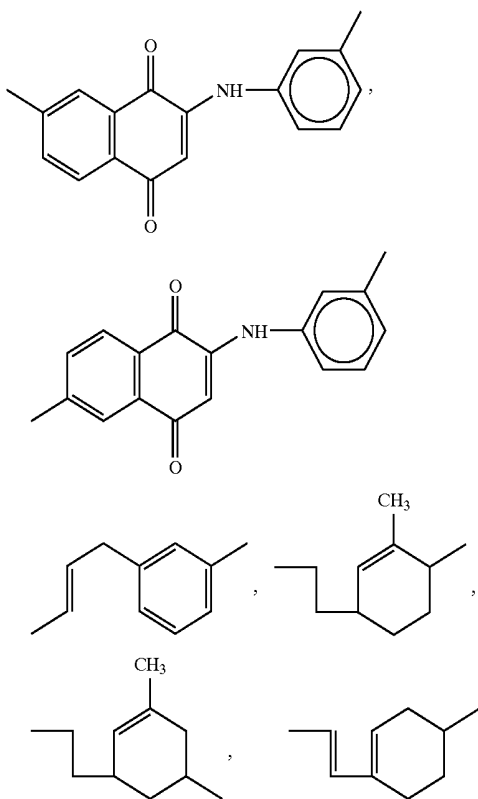
{Chemical Formula 2}



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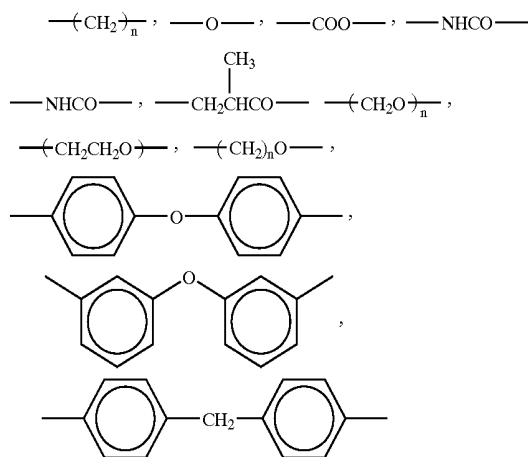


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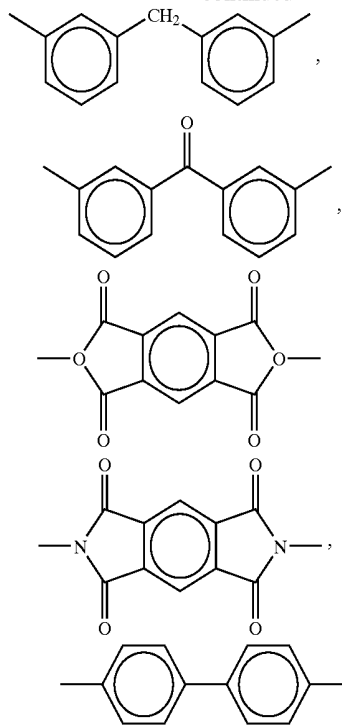


12. The device of claim 11, wherein components B and C are selected independently from groups shown in chemical formula 3, substituted-structure groups of the chemical formula 3 with a halogen, cyano, nitro, amino group, other substituted-structure groups with carbonated groups of which carbon number n lies between 1 and 10 such as an alkyl, haloalkyl, and cyanoalkyl, and other carbonated groups of which carbon number lies between 3 and 8 such as an alkylaryl, a haloaryl, a haloalkylaryl, a nitroaryl, and a cyanoaryl;

{Chemical Formula 3}



-continued



13. The device of claim 10, further comprising at least one thin film transistor including a gate electrode, a semiconductor layer, a source electrode, and a drain electrode.

14. The device of claim 10, wherein the photo-alignment layer is formed by light-irradiation.

15. The device of claim 14, wherein the light-irradiation is irradiated at least once.

16. The device of claim 14, wherein the light is selected from a group consisting of unpolarized light, linearly polarized light and partially polarized light.

17. The device of claim 10, wherein the rubbing alignment layer is selected from a group consisting of polyimide, polyamide, polyamic acid and SiO<sub>2</sub>.

18. A method of fabricating a liquid crystal display device comprising:

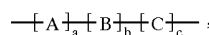
preparing a first substrate and a second substrate;

forming a photo-alignment layer at least on the first substrate, wherein the photo-alignment layer has an ethenyl group at a main chain; and

forming a liquid crystal layer between the first and second substrates.

19. The method of claim 18, wherein the photo-alignment layer is formed of a material having a photo-reactive ethenyl group on a polymer main chain, wherein the polymer is denoted by the following chemical formula 1:

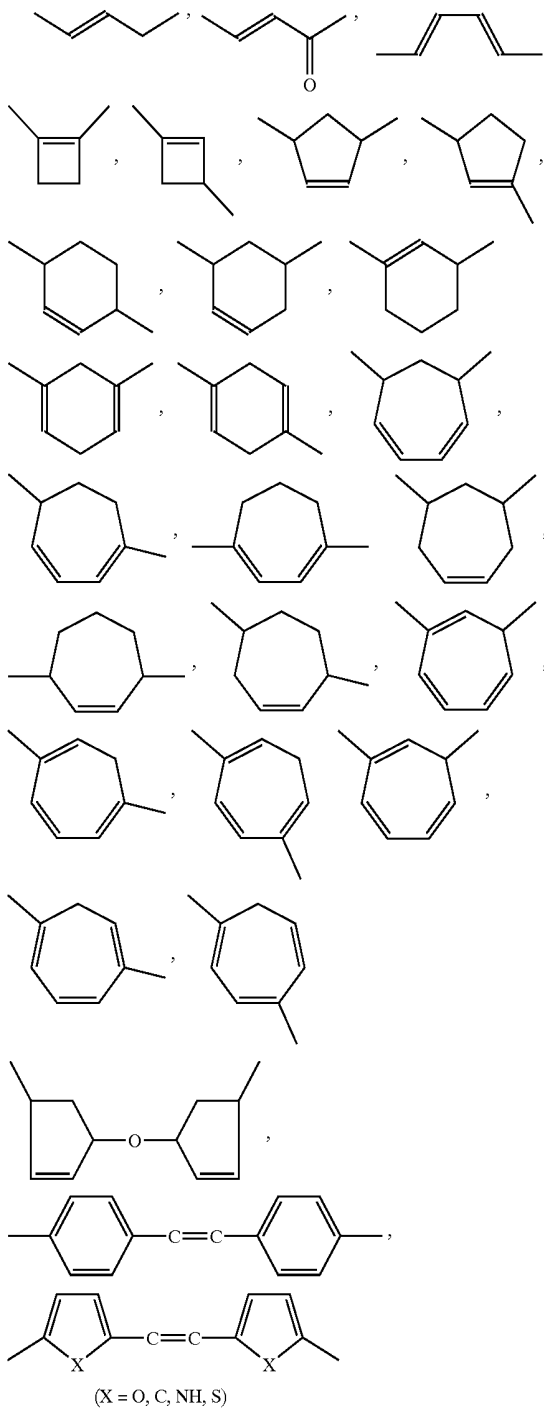
{chemical formula 1}



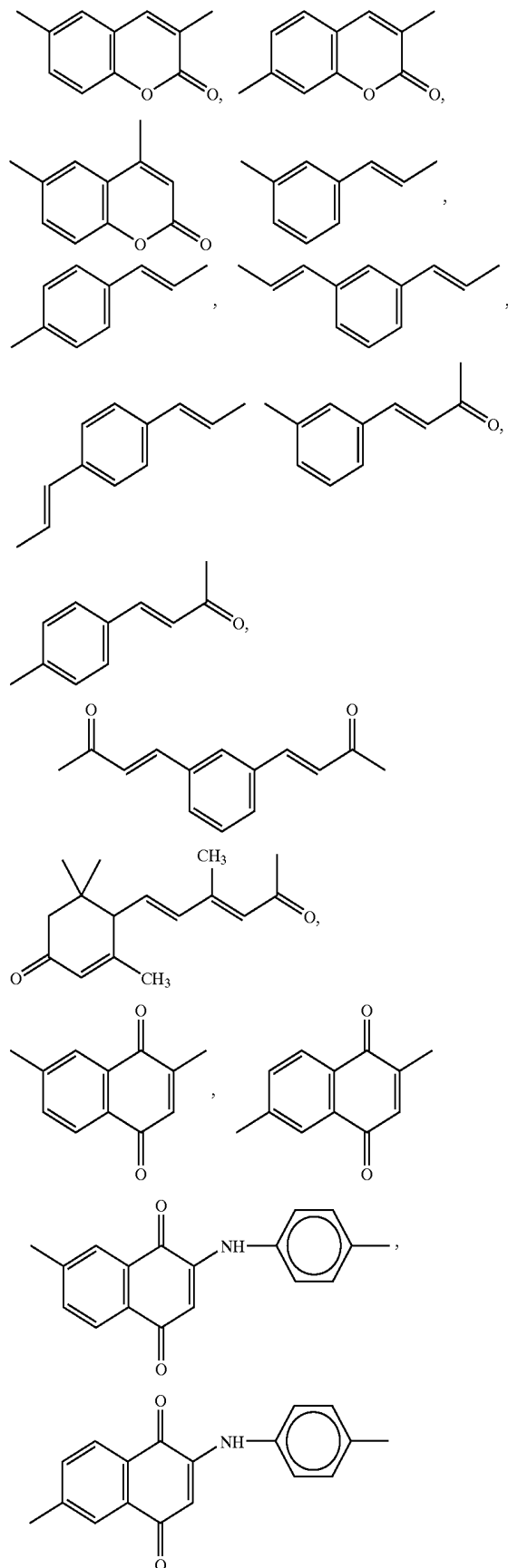
wherein subscripts a, b, and c denote a component ratio of respective monomers, wherein 0 < a ≤ 1, 0 ≤ b < 1, and

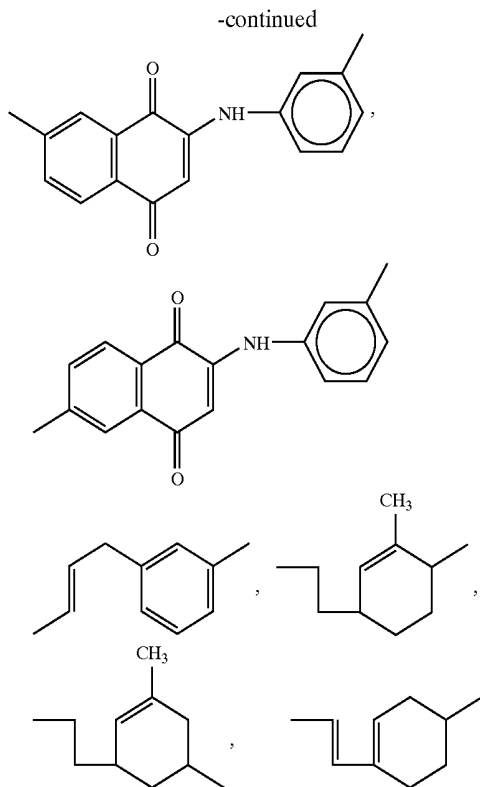
$0 \leq c < 1$ , and wherein component A, which is a monomer including the photo-reactive ethenyl group, is selected from groups designated in chemical formula 2, substituted-structure groups of the chemical formula 2 with a halogen, cyano, nitro, amino group, and other substituted-structure groups with an alkyl and haloalkyl, and cyanoalkyl group having 1 to 10 carbons or an aryl, alkyl, aryl, haloaryl, haloalkyl aryl, nitroaryl, cyanoaryl group having 3 to 8 carbons;

{Chemical Formula 2}



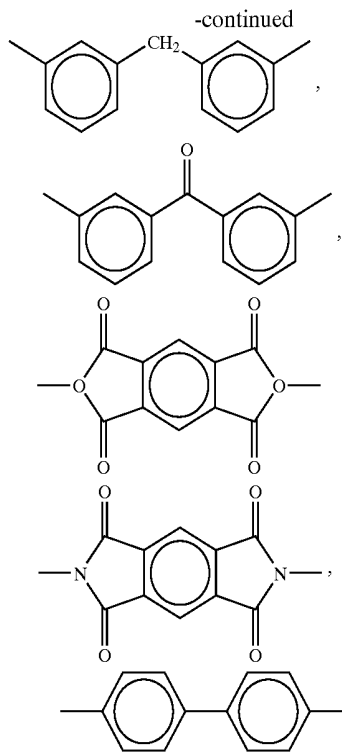
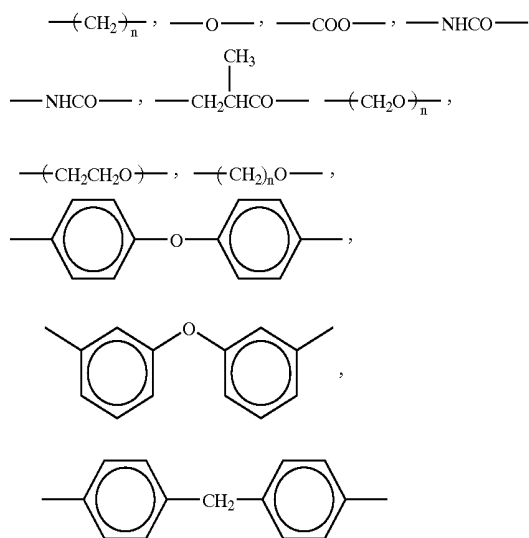
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20. The method of claim 19, wherein components B and C are selected independently from groups shown in chemical formula 3, substituted-structure groups of the chemical formula 3 with a halogen, cyano, nitro, amino group, other substituted-structure groups with carbonated groups of which carbon number n lies between 1 and 10 such as an alkyl, haloalkyl, and cyanoalkyl, and other carbonated groups of which carbon number lies between 3 and 8 such as an alkylaryl, haloaryl, haloalkylaryl, nitroaryl, cyanoaryl;

{Chemical Formula 3}



21. The method of claim 18, further comprising:

- forming a gate line and a crossing data line on the first substrate;
- forming a thin film transistor at a crossing between the gate and data lines; and
- forming a pixel electrode connected to the thin film transistor.

22. The method of claim 18, wherein the photo-alignment layer is formed by light-irradiation.

23. The method of claim 22, wherein the light-irradiation is irradiated at least once.

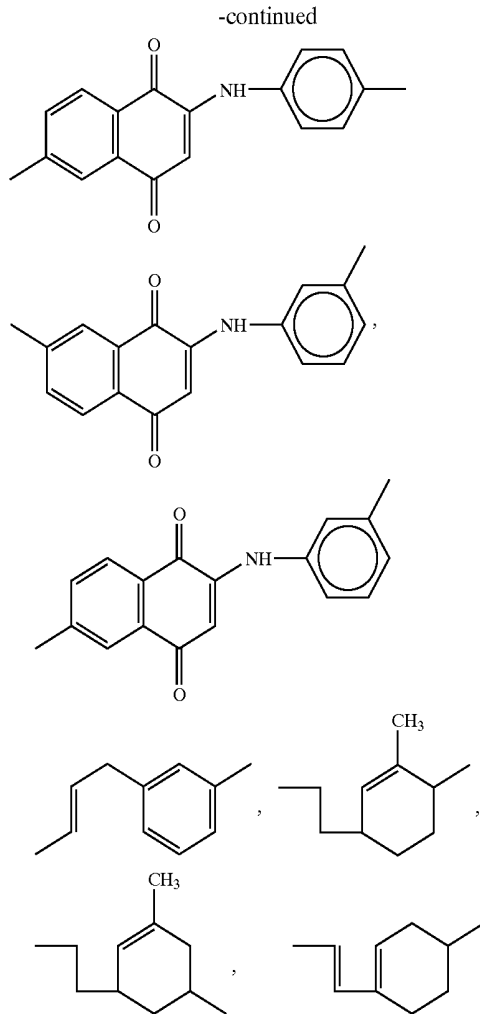
24. The method of claim 22, wherein the light is selected from a group consisting of unpolarized light, non-polarized light, linearly polarized light and partially polarized light.

25. A method of fabricating a liquid crystal display device comprising:

- preparing a first substrate and a second substrate;
- forming a photo-alignment on the first substrate, wherein the photo-alignment layer includes an ethenyl group at a main chain;
- forming a rubbing alignment layer on the second substrate; and
- forming a liquid crystal layer between the first and second substrates.

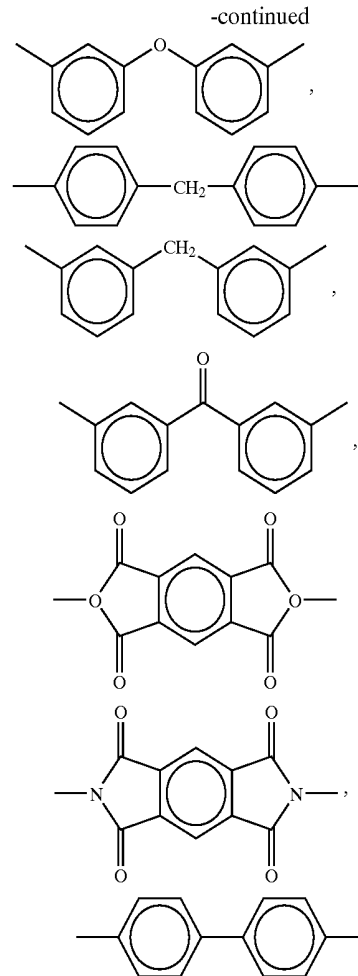
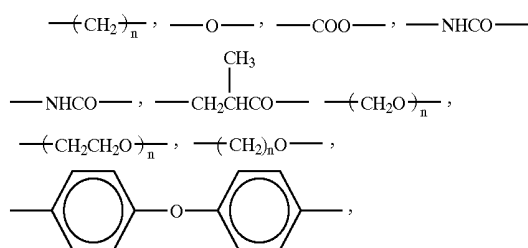
26. The method of claim 25, wherein the photo-alignment layer is formed of material having at least a photo-reactive ethenyl group at a polymer main chain, wherein the polymer is denoted by the following chemical formula 1:





27. The method of claim 26, wherein components B and C are selected from groups shown in chemical formula 3, substituted-structure groups of chemical formula 3 with a halogen, cyano, nitro, amino group, other substituted-structure groups with carbonated groups of which carbon number n lies between 1 and 10 such as an alkyl, haloalkyl, and cyanoalkyl, and other carbonated groups of which carbon number lies between 3 and 8 such as an alkylaryl, haloaryl, haloalkyl aryl, nitroaryl, cyanoaryl;

{Chemical Formula 3}



28. The method of claim 25, further comprising:

forming a gate line and a crossing data line on the first substrate;

forming a thin film transistor at a crossing between the gate and data lines; and

forming a pixel electrode connected to the thin film transistor.

29. The method of claim 25, wherein the photo-alignment layer is formed by light-irradiation.

30. The method of claim 29, wherein the light-irradiation is irradiated at least once.

31. The method of claim 29, wherein a light used for light-irradiation is selected from a group consisting of unpolarized light, non-polarized light, linearly polarized light and partially polarized light.

32. The method of claim 25, wherein the rubbing alignment layer is selected from a group consisting of polyimide, polyamide, polyamic acid and SiO<sub>2</sub>.

\* \* \* \* \*

专利名称(译)	光取向材料和液晶显示装置及其制造方法		
公开(公告)号	<a href="#">US20040022964A1</a>	公开(公告)日	2004-02-05
申请号	US10/630781	申请日	2003-07-31
[标]申请(专利权)人(译)	NAM MI SOOK		
申请(专利权)人(译)	NAM MI SOOK		
当前申请(专利权)人(译)	LG DISPLAY CO. , LTD.		
[标]发明人	NAM MI SOOK		
发明人	NAM, MI SOOK		
IPC分类号	G02F1/1337 G03F7/038 C09K19/00		
CPC分类号	C08G73/02 C08G73/10 G02F1/133711 G02F1/133788 G03F7/0384 Y10T428/1009 Y10T428/1036 Y10T428/1023 Y10T428/1005 Y10T428/10 Y10T428/1018		
优先权	1020000073270 2000-12-05 KR		
其他公开文献	US6797096		
外部链接	<a href="#">Espacenet</a> <a href="#">USPTO</a>		

摘要(译)

光取向材料，使用该光取向材料的液晶显示装置及制造方法。光取向材料是在主链上具有光反应性乙烯基的聚合物。当用作光取向层时，光取向材料能够改善对外部冲击，光和热的对准稳定性。液晶显示装置包括第一基板，第二基板，形成在第一和第二基板之间的液晶层，以及至少形成在第一基板上的光取向层，光取向层由照片形成 - 在主链上具有乙烯基的取向材料。

