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Photo-Oriented Polymer Networks and Method of their Manufacture

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The invention relates to photopolymers with oriented molecular configuration and a process for their manufacture.

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As is known, polymerization can be brought about by photochemical initiation. This so called photopolymerization has many applications, e.g. in fibre production, curing of lacquers or production of printing plates. For the purpose of this description, polymers or composition of polymers which are photochemically modified (referred to as "photopolymerized" hereinafter) by polarized light will be called "photopolymers".

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It is also known that in the so-called stretching of thermoplastics to increase their strength, the amorphous regions are given a parallel alignment. The alignment can be fixed, e.g. by cooling, to produce oriented polymers. Other methods of producing oriented polymers are also known, e.g. uniform alignment in an electric field during polymerization, provided the monomer contains an electric dipole.

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It has surprisingly been discovered that oriented polymers can also be manufactured if photopolymerization is brought about by irradiating a polymerizable material with plain-polarized light. For the purpose of this description, the resulting oriented polymers will be called "oriented photopolymers".

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Particularly preferably, different regions of the polymerizable material are irradiated with light polarized in different directions, or some parts of the polymerizable material are irradiated with plane-polarized light whereas other parts are irradiated with non-polarized light.

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☒	Claim(s) : paged ... 6 ... to paged ... 7 ...	
☒	Abstract : paged ... 8 ... to paged ... 9 ...	
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Preferably, therefore, the photopolymer according to the invention contains variously oriented regions or regions with variously oriented and non-oriented molecular structures.

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Oriented photopolymers have various applications. One special application is to the manufacture of orientation layers in liquid crystal cells. For details of this application, reference should be made to the simultaneous Patent Application No.
10 (RAN 4701/139).

Another application relates to the optical anisotropy of the polymer material produced by orientation. Polymer layers manufactured according to the invention can be used as so-called
15 compensation or retarder layers, e.g. in liquid crystal cells or generally in the optical path of rays of liquid crystal cells, so as to eliminate the typical interfering colours in super-twisted nematic cells. For details of this and other applications, reference should be made to the simultaneous Patent Application No.
20 (RAN 4701/138).

The invention will now be explained in detail with reference to the accompanying drawing and the following Examples.

25 The drawing is a diagram of a simple device for preforming the method according to the invention. A layer 3 of photopolymerizable organic material is disposed on a substrate (e.g. a glass plate) provided with an electrode layer 2. The layer is illuminated with plane-polarized light through a lens 4, optionally
30 with a mask 5 in front. The light comes from a polarizer 6 illuminated with non-polarized UV light 7. The mask 4 can be replaced by an interferometric imaging process using plane-polarized light (UV laser).

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Example 1

A 2% solution of polyvinyl cinnamate (mol. wt. approx. 15000) in methyl cellosolve acetate was poured on to a glass plate

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and dried in air for 20 minutes and then at 90°C on a heating plate. After drying, the layer was not perceptibly double-refracting. The layer was then illuminated at room temperature with the light from a mercury vapour lamp through a polarization
5 filter for 2 hours, whereupon double refraction was observable through a microscope. The double refraction, measured in a sweep compensator, was $\Delta n \cdot d = 250 \text{ nm}$.

Example 2

10

A glass plate was coated with a 2% solution of polyvinyl cinnamate (mol. wt. approx. 15000) in methyl cellosolve acetate in a spin coating process at 200 rpm and dried as per Example 1. After drying, the layer was not birefringent. It was then
15 illuminated as in Example 1. After illumination the layer had an optical path difference $\Delta n \cdot d = 25 \text{ nm}$ and a refractive index of about 1.6. The layer thickness, measured in an interference microscope, was $d = 455 \text{ nm}$.

20

Example 3

A glass plate was coated with a 2% solution of polyvinyl cinnamate (mol. wt. approx. 15000) in methyl cellosolve acetate in a spin coating process at 3000 rpm for about 30 seconds. The
25 thickness of the resulting layer was about 0.1μ . The layer was then dried in air for about 20 minutes and then heated to about 80-90°C for about 20 s. After this pre-treatment, the layer was exposed for about 100 seconds to irradiation with the light of an HgHP lamp at a wavelength λ of about 365 nm through a Glan-
30 Thomson polarizer. The radiation energy was about 15 mW/cm^2 .

The resulting layer was capable of giving a planar orientation to the molecules of an adjacent liquid crystal layer.

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Example 4

In an analogous procedure to Example 1, a layer of a solution of a polyvinyl ester of paramethoxycinnamic acid



(molecular weight approx. 15000-50000) in chlorobenzene and dichloro- ethylene 1:1 was exposed for about 10 seconds to irradiation with plane-polarized light at an intensity of about 0.5 J/cm².

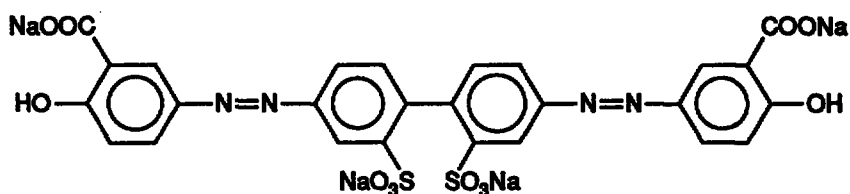
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The resulting layer likewise produced parallel orientation in an adjacent liquid crystal.

Example 5

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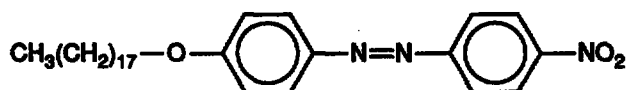
A glass plate was coated with a 1% solution of



15 in an immersion process in water. The resulting layer had a thickness of about 0.07 μ and was irradiated with plane-polarized light at a wavelength $\lambda = 400-500$ nm and an intensity of about 47 mW/cm² for about 8 minutes. The resulting layer likewise produced parallel orientation in an adjacent liquid crystal.

20

Example 6



25 in chloroform was vapour-deposited on a glass plate. The resulting layer, about 1000-2000 Å thick, was irradiated with plane-polarized light at a wavelength $\lambda = 400-550$ nm and an intensity of about 45 mW/cm² for about 3 minutes. The resulting layer likewise produced a parallel orientation in an adjacent liquid
30 crystal.

Example 7

Example 1 was repeated except that illumination was with
35 plane-polarized UV light in two successive stages through masks.



In the first illumination stage, only the part of the layer not covered by the mask was photopolymerized, in the direction determined by the direction of vibration of the electric vector of the plane-polarized light. In the second illumination stage, the mask was removed and irradiation was with UV light vibrating in a direction which had been changed relative to the first illumination stage. The result, on the glass plate, was an orientation pattern oriented in two different directions.

10

Example 8

Example 5 was repeated but non-polarized light was used in the second illumination stage, resulting in an orientation pattern consisting of oriented and non-oriented regions.

15

Example 9

Example 1 was repeated except that the plane-polarized UV light formed an image through a narrow slot on a slowly rotating glass plate, such that the electric vector of the light vibrated parallel to the longitudinal axis of the slot. The rotation of the plate during the polymerization process resulted in a radially oriented polymer.

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Patent Claims

1. A process for the manufacture of an oriented photopolymer, characterized in that photopolymerization is brought about by irradiating a polymerizable material (3) with plane-polarized light (7).
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2. A process according to claim 1, characterized in that different regions of the polymerizable material (3) are irradiated with light polarized in different directions.
10
3. A process according to claim 1, characterized in that some parts of the polymerizable material (3) are irradiated with plane-polarized light whereas other parts are irradiated with non-polarized light.
15
4. A photopolymer with oriented molecular structure, characterized in that it is manufactured by a process according to any of claims 1 to 3.
20
5. A photopolymer according to claim 4, characterized in that its orientation varies from region to region.
6. A photopolymer according to claim 2, characterized in that it contains regions with variously oriented or non-oriented molecular structures.
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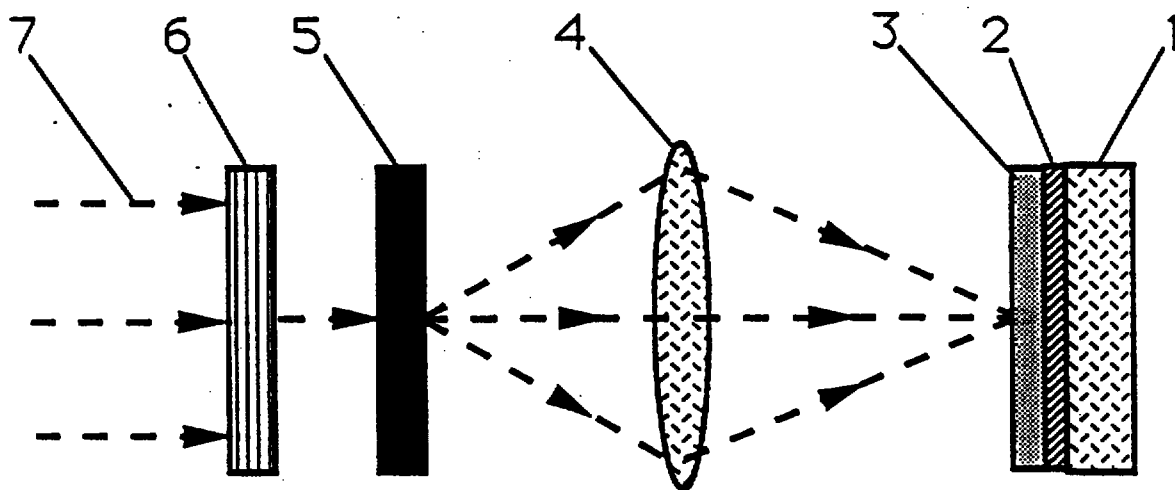
Abstract

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An oriented photopolymer is a polymer where polymerization is initiated by irradiation with plane-polarized light and where the molecular configuration has a preferred orientation as a result of linear polarization. These polymers have
10 optically anisotropic and other novel properties.

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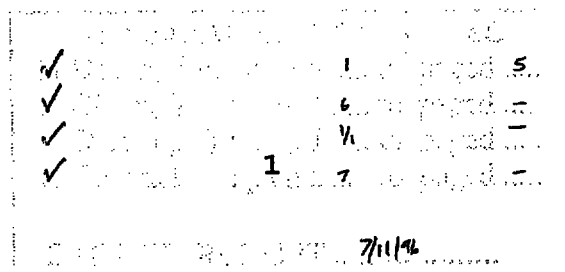


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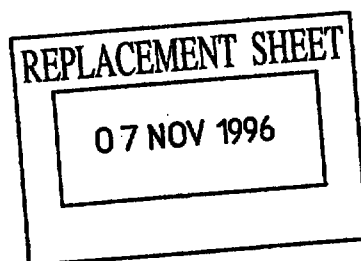
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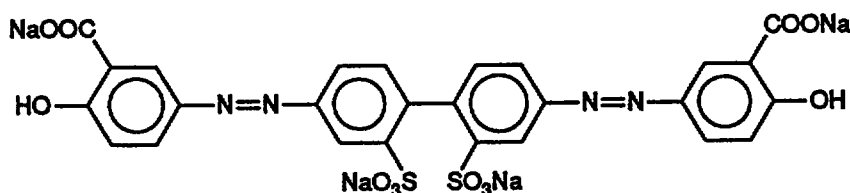
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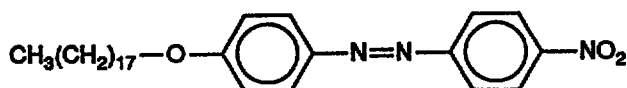
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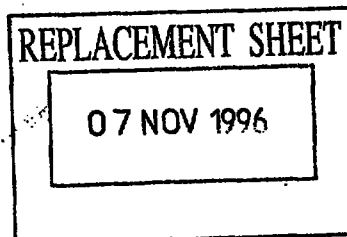
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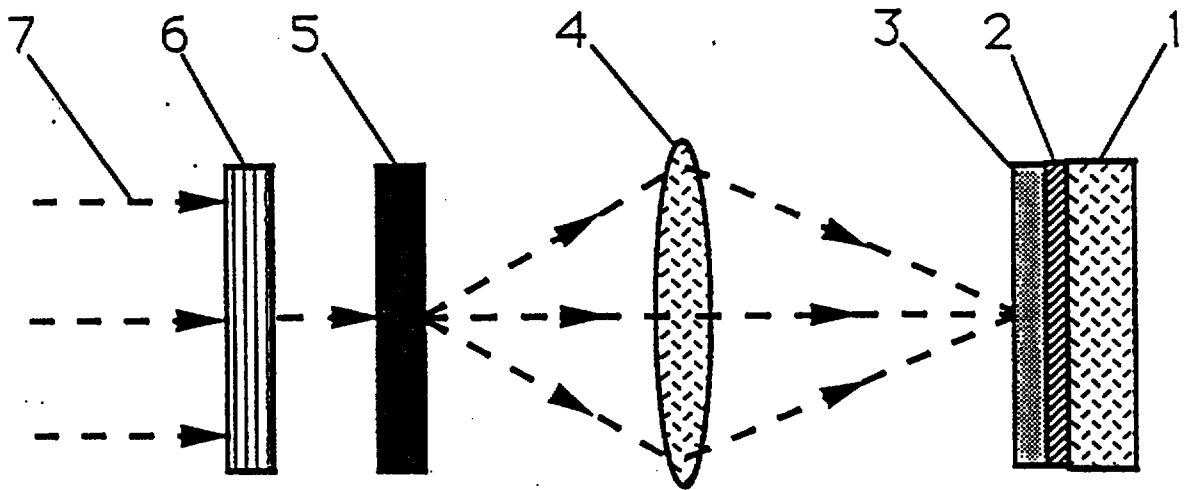
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