

CONTACT LENS HAVING ELEMENT PROTECTION FUNCTION

CROSS-REFERENCE TO RELATED PATENT APPLICATION

Some references, which may include patents, patent applications and
5 various publications, may be cited and discussed in the description of this
disclosure. The citation and/or discussion of such references is provided merely
to clarify the description of the present disclosure and is not an admission that
any such reference is “prior art” to the disclosure described herein. All
references cited and discussed in this specification are incorporated herein by
10 reference in their entireties and to the same extent as if each reference was
individually incorporated by reference.

FIELD OF THE DISCLOSURE

The present disclosure relates to a contact lens, and more particularly to a
15 contact lens having an element protection function.

BACKGROUND OF THE DISCLOSURE

The conventional contact lens can not only provide functions of correcting
vision, treating ophthalmic diseases and having a cosmetic appearance, but can
20 also be combined with one or more electronic components to form a
multifunctional contact lens product. More specifically, a contact lens designed
with a refractive property can be used to correct a wearer’s vision defects such
as nearsightedness, farsightedness and astigmatism. A contact lens provided
with a drug thereon can be used to treat ophthalmic diseases. In order to meet
25 aesthetic requirements, a contact lens can have a color pattern arranged therein
to change the color of the pupil or to display a text or pattern on the pupil. In
addition, a contact lens combined with one or more electronic components such
as electrode(s), sensor(s) or light-emitting component(s) has been developed to
provide different visual effects for the wearer. In other words, the contact lens
30 can have a desired function by embedding therein a functional element such as

a colorant or electronic component.

However, the conventional contact lens product having a function still needs an auxiliary support or insert serving as a carrier of the functional element. There is still much room for improving the structure and material of the carrier.

SUMMARY OF THE DISCLOSURE

In response to the above-referenced technical inadequacies, the present disclosure provides a contact lens having an element protection function, which has a protective layer having a specific composition to provide support and protection for a functional element and is beneficial for increasing production efficiency.

In one aspect, the present disclosure provides a contact lens having an element protection function, which includes a light-permeable body, a functional element and a protective layer. The functional element is disposed on the light-permeable body. The protective layer is disposed on the light-permeable body and covers the functional element. The functional element is completely covered by the light-permeable body and the protective layer to be isolated from an exterior environment. The functional element is formed of a material including a film-forming polymer, a hydrophilic polymer and a solvent.

Furthermore, the light-permeable body has a recessed space recessed from an outer surface thereof, and the protective layer and the functional element are accommodated in the recessed space.

Furthermore, the film-forming polymer is selected from the group consisting of polyether polyols, polyethers, polyester polyols, polyacrylic acid and its derivatives, polymethyl methacrylate and its derivatives, and copolymers of styrene and acrylic acid.

Furthermore, based on the total weight of the protective layer, the content of the film-forming polymer is between 1 % and 60 %.

Furthermore, the hydrophilic polymer is selected from the group consisting of polyvinyl alcohol, celluloses and their derivatives, polyethylene glycol, and polyvinylpyrrolidone and its copolymers.

Furthermore, based on the total weight of the protective layer, the
5 content of the hydrophilic polymer is between 0.1 % and 45 %.

Furthermore, the solvent is selected from the group consisting of water, alcohols and amides, and based on the total weight of the protective layer, the content of the solvent is between 30 % and 90 %.

Furthermore, based on the total weight of the protective layer, the
10 content of the film-forming polymer is between 15 % and 50 %.

Furthermore, based on the total weight of the protective layer, the content of the hydrophilic polymer is between 5 % and 40 %.

Furthermore, the functional element includes at least one of a pattern layer and an electronic component.

15 One of the advantages of the present disclosure is that the contact lens having the element protection function, in which the functional element is completely covered by the light-permeable body and the protective layer to be isolated from the outside and is formed of a material including a film-forming polymer, a hydrophilic polymer and a solvent, provides support and protection
20 for the functional element.

These and other aspects of the present disclosure will become apparent from the following description of the embodiment taken in conjunction with the following drawings and their captions, although variations and modifications therein may be affected without departing from the spirit and scope of the novel
25 concepts of the disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

The present disclosure will become more fully understood from the following detailed description and accompanying drawings.

30 FIG. 1 is a sectional view of a contact lens having an element protection

function according to embodiments of the present disclosure.

FIG. 2 is an enlarged view of a portion II of FIG. 1.

FIG. 3 is a schematic view showing a first step of a method for manufacturing the contact lens having the element protection function according to the embodiments of the present disclosure.

FIG. 4 is a schematic view showing a second step of the method for manufacturing the contact lens having the element protection function according to the embodiments of the present disclosure.

FIG. 5 is a schematic view showing a third step of the method for manufacturing the contact lens having the element protection function according to the embodiments of the present disclosure.

FIG. 6 is a schematic view showing a fourth step of the method for manufacturing the contact lens having the element protection function according to the embodiments of the present disclosure.

FIG. 7 is a schematic view showing a fifth step of the method for manufacturing the contact lens having the element protection function according to the embodiments of the present disclosure.

DETAILED DESCRIPTION OF THE EXEMPLARY EMBODIMENTS

The present disclosure is more particularly described in the following examples that are intended as illustrative only since numerous modifications and variations therein will be apparent to those skilled in the art. Like numbers in the drawings indicate like components throughout the views. As used in the description herein and throughout the claims that follow, unless the context clearly dictates otherwise, the meaning of “a”, “an”, and “the” includes plural reference, and the meaning of “in” includes “in” and “on”. Titles or subtitles can be used herein for the convenience of a reader, which shall have no influence on the scope of the present disclosure.

The terms used herein generally have their ordinary meanings in the art. In the case of conflict, the present document, including any definitions given

herein, will prevail. The same thing can be expressed in more than one way. Alternative language and synonyms can be used for any term(s) discussed herein, and no special significance is to be placed upon whether a term is elaborated or discussed herein. A recital of one or more synonyms does not
5 exclude the use of other synonyms. The use of examples anywhere in this specification including examples of any terms is illustrative only, and in no way limits the scope and meaning of the present disclosure or of any exemplified term. Likewise, the present disclosure is not limited to various embodiments given herein. Numbering terms such as “first”, “second” or “third” can be used
10 to describe various components, signals or the like, which are for distinguishing one component/signal from another one only, and are not intended to, nor should be construed to impose any substantive limitations on the components, signals or the like.

Reference is made to FIG. 1 and FIG. 2. FIG. 1 is a sectional view of a
15 contact lens having an element protection function according to embodiments of the present disclosure, and FIG. 2 is an enlarged view of a portion II of FIG. 1.

The contact lens L having the element protection function at least includes a light-permeable body 1, a functional element 2 and a protective layer 3. Both the functional element 2 and the protective layer 3 are disposed on the light-
20 permeable body 1. It is worth mentioning that, the term “disposed on” as used in the present disclosure is defined to encompass “disposed directly upon an object” and “disposed within the object”. In other words, both the functional element 2 and the protective layer 3 should also be considered as being disposed in the light-permeable body 1.

25 More specifically, the light-permeable body 1 constitutes a main body of the contact lens L, and may be formed of a general hydrogel material (i.e., hydroxyethyl methacrylate-based hydrogel material) or a silicone hydrogel material. The silicone hydrogel material is also called a polysiloxane hydrogel. The light-permeable body 1 may have a semi-permeable property and may
30 contain other additives besides the hydrogel or silicone hydrogel material. The

material of the light-permeable body 1 is not limited in the present disclosure.

In addition, the light-permeable body 1 has an outer surface 11 and an inner surface 12 opposite to the outer surface 11. For example, in the circumstance that the contact lens L is worn by a user, the inner surface 12 of the light-permeable body 1 would contact the eyeball of the user, and the outer surface 11 is distal from the eyeball.

The contact lens L having the element protection function of the present disclosure has a recessed space that is recessed from the outer surface 11 of the light-transmitting body 1. Both the protective layer 3 and the functional element 2 are accommodated in the recessed space.

The functional element 2 is disposed in the light-transmitting body 1, and includes at least one of a pattern layer and an electronic component. For example, the functional element 2 can be a pattern layer for changing a wearer's iris color. The pattern layer can be disposed in the light-transmitting body 1 and corresponds in position to the wearer's pupil and iris. In other words, the pattern layer serving as the functional element 2 is surroundingly disposed in the light-transmitting body 1. Therefore, the pattern layer can cover the wearer's pupil and iris to completely or partially obscure the natural colors of the pupil and the iris, thereby producing a cosmetic effect of the contact lens L.

In another embodiment of the present disclosure, the functional element 2 is an electronic component that may be an electrode, a signal receiver or emitter, a lighting component or a sensor. In the present disclosure, there is no limitation on the kind of element that the functional element 2 is. For example, the functional element 2 is a distance sensor including an emitter and a receiver for measuring a distance between a wearer's eye and an observed object.

The contact lens L having the element protection function of the present disclosure further includes a protective layer 3 having a thickness between 2 μm and 30 μm . As described above, the protective layer 3 is also disposed in the light-transmitting body 1. In the present disclosure, the protective layer 3 can cover the functional element 2. More specifically, in the circumstance that the

functional element 2 is a pattern that is surroundingly disposed in the light-transmitting body 1, the protective layer 3 can be also surroundingly disposed in the light-transmitting body 1. It should be noted that, in an embodiment of the present disclosure, the width of the protective layer 3 is greater than that of the functional element 2 (e.g., pattern layer) to ensure a protective effect to the functional element 2.

In an embodiment of the present disclosure, the functional element 2 is fixed on or connected to the protective layer 3, such that it is supported by the protective layer 3. For example, the functional element 2 includes a gel-typed adhesive and a colorant dispersed in the adhesive. The molecules of the adhesive and the protective layer 3 are bonded together by Van der Waals forces or bonding, such that the functional element 2 is fixed on the protective layer 3.

The functional element 2 and the protective layer 3 are disposed in the light-transmitting body 1 and near the outer surface 11. In other words, in the circumstance that the contact lens L is worn by the user, the functional element 2 and the protective layer 3 are located near the outside of the light-transmitting body 1. In addition, in the embodiments of the present disclosure, the functional element 2 is disposed between the outer surface 11 and the protective layer 3. Therefore, in the circumstance that the functional element 2 is a pattern layer including at least one colorant or color ink, the protective layer 3 can prevent the molecules of the colorant or color ink from diffusing outwardly to the exterior environment of the contact lens L.

In other words, the protective layer 3 can not only provide support to the pattern layer serving as the functional element 2, but can also prevent the outward diffusion of the material molecules such as molecules of a colorant or color ink in the functional element 2. If the material molecules diffuse outwardly, the original pattern or color shown by the pattern layer may be distorted and thus the pattern layer may not produce a predetermined cosmetic effect. In addition, the material molecules diffusing to the exterior environment of the light-transmitting body 1 of the contact lens L may contact the eyeball of

the user and negatively affect the health of the eyeball.

In order to enable the protective layer 3 to provide the functional element 2 and have good compatibility with the light-transmitting body 1, ingredients in the composition of the protective layer 3 and the ratio of the ingredients must be
5 appropriately selected. Furthermore, since different carriers are used to transfer different components of the contact lens L in the manufacturing process of the contact lens L, the ingredients in the composition of the protective layer 3 and the ratio of the ingredients are also selected according to tools or molds used in the manufacturing process. Accordingly, the protective layer 3 can be easily
10 and successfully formed in the light-transmitting body 1 of the contact lens L.

More specifically, the protective layer 3 must have an appropriate viscosity and affinity, which is controlled by selecting the different ingredients in appropriate amounts. For example, if the protective layer 3 has a desired viscosity, it can prevent the material thereof from slipping off or failing to
15 successfully adhere when being transferred between the tools.

In an embodiment of the present disclosure, the material of the protective layer 3 includes a film-forming polymer, a hydrophilic polymer and a solvent. The film-forming polymer is selected from the group consisting of polyether polyols, polyethers, polyester polyols, polyacrylic acid and its derivatives,
20 polymethyl methacrylate and its derivatives, and copolymers of styrene and acrylic acid.

The polyether polyol may have a molecular weight between 5,000 and 500,000, and it may be polyethylene glycol, polypropylene glycol, glycerol or caprolactone. The polyether may have a molecular weight between 5,000 and
25 500,000, and it may be ethylene oxide, propylene oxide or glycerol. The polyester polyol may be formed from oxalic acid, malonic acid or glycerol. The polyacrylic acid may have a molecular weight between 5,000 and 1,500,000, and the derivative thereof may be a salt such as potassium or sodium salt of polyacrylic acid. The polymethyl methacrylate may have a molecular weight
30 between 5,000 and 500,000. The copolymer of styrene and acrylic acid may be

formed from 10-90% styrene and 90-10% acrylic acid.

Based on the total weight of the protective layer 3, the content of the film-forming polymer is between 1 % and 60 %. More specifically, if the content of the film-forming polymer is less than 1 %, the viscosity of the protective layer 3 would be negatively affected and thus the protective layer 3 cannot be fixed at a specific position of the light-transmitting body 1. If the content of the film-forming polymer is greater than 60 %, the protective layer 3 would have excessively high viscosity that is unfavorable for the manufacturing process of the contact lens L. In an embodiment of the present disclosure, based on the total weight of the protective layer 3, the content of the film-forming polymer is between 15 % and 50 %.

The hydrophilic polymer is selected from the group consisting of polyvinyl alcohol, celluloses and their derivatives, polyethylene glycol (PEG), and polyvinylpyrrolidone and its copolymers. The polyvinyl alcohol may have a molecular weight between 500 and 10,000. The cellulose may have a molecular weight between 5,000 and 500,000. The polyethylene glycol may have a molecular weight between 500 and 500,000. The polyvinylpyrrolidone may have a molecular weight between 5,000 and 1,500,000.

Based on the total weight of the protective layer 3, the content of the hydrophilic polymer is between 0.1 % and 45 %. In an embodiment of the present disclosure, the content of the hydrophilic polymer is between 5 % and 40 %. If the content of the hydrophilic polymer is less than 1 %, the viscosity of the protective layer 3 would be negatively affected and thus the protective layer 3 cannot be fixed at a specific position of the light-transmitting body 1. If the content of the hydrophilic polymer is greater than 45 %, the protective layer 3 would have excessively high viscosity that is unfavorable for the manufacturing process of the contact lens L. In addition, the content of the hydrophilic polymer also affects the wearing comfort of the contact lens L.

In the protective layer 3 of the contact lens L according to the embodiments of the present disclosure, the solvent is selected from the group consisting of

water, alcohols and amides. The solvent may be ethanol, propanol, N-methylpyrrolidone, dimethylacetamide or dimethylformamide. Based on the total weight of the protective layer, the content of the solvent is between 30 % and 90 %.

5 With respect to the ingredients in the composition of the protective layer 3 and the ratio of the ingredients, Table 1 below shows Examples 1-6 and Comparative Examples 1-3 which use different film-forming polymers, hydrophilic polymers, and solvents in different amounts to form respective protective layers 3. The evaluation results obtained by Examples 1-6 and
10 Comparative Examples 1-3 are also listed in the table. For the evaluation results, ⊙ represents good performances of film formation and phase transfer, △ represents fair performances of film formation and phase transfer, and × represents poor performances of film formation and phase transfer. It can be observed from Table 1 that the protective layer 3 having specific ingredients in
15 specific amounts can achieve desired performances of film formation and phase transfer.

 More specifically, the content of the solvent of Comparative Examples 1 is less than 30 wt %. The content of the film-forming polymer of Comparative Examples 2 is greater than 60 wt %. The content of the hydrophilic polymer of
20 Comparative Examples 3 is greater than 45 wt %. Thus, Comparative Examples 1-3 cannot obtain good performances of film formation and phase transfer.

Table 1

	Film-forming polymer (wt %)				Hydrophilic polymer (wt %)				Solvent (wt %)			Evaluation results
	Polyether polyol	Styrene/ acrylic acid copolymer	Salt of polyacrylic acid	polymethyl methacrylate	Polyvinyl pyrrolidone	cellulose	PEG	Alcohols	Water	Amides		
Example 1	24.0				15.0			25.0	36.0		⊙	
Example 2	63.0				5.0			5.0	54.0		⊙	
Example 3		3.0	0.1		26.0			70.9			△	
Example 4		8.0	0.1		28.0			63.9			△	
Example 5	32.0					0.5		19.5	48.0		△	
Example 6		10.0		35.1	18.6			4.7	29.5	2.0	⊙	
Comparative Example 1		8.8		24.9	17.4			6.5	17.5	3.0	×	
Comparative Example 2	60		5		1					34	×	
Comparative Example 3		10			20	15	15	6.5	30	3.5	×	

Reference now is made to FIG. 3 to FIG. 7, which are schematic views respectively showing first, second, third, fourth and fifth steps of a method for manufacturing the contact lens L having the element protection function according to the embodiments of the present disclosure. More specifically, at least one forming mold including a lower mold M1 and an upper mold M2 is required for manufacturing the contact lens L having the element protection function.

As shown in FIG. 3, the first step is providing the lower mold M1 that may be made of a metal or non-metal material. For example, the lower mold M1 may be formed from a steel board and have a concave surface that surroundingly defines a groove for accommodating a material. The lower mold M1 is used to carry the material for forming the contact lens L.

As shown in FIG. 4, the second step is disposing the protective layer 3 and the functional element 2 on the lower mold M1. In the embodiment shown by FIG. 3 to FIG. 6, the functional element 2 includes a pattern layer formed from colorant(s). The protective layer 3 and the pattern layer can be disposed in the lower mold M1 by pad printing. More specifically, a transfer pad can be used to carry a material of the protective layer 3, and subsequently transfer the material of the protective layer 3 to a surface of the groove of the lower mold M1. The functional element 2 can be formed on the protective layer 3 in such a manner.

As shown in FIG. 5, the third step is injecting a hydrogel material 1' of the light-permeable body 1 into the groove of the lower mold M1 and subsequently matching the upper mold M2 with the lower mold M1. Accordingly, an accommodating space between the lower mold M1 and the upper mold M2 is filled with the material of the light-permeable body 1. The accommodating space and the contact lens L complement each other in shape. In the third step, the hydrogel material 1' injected into the accommodating space is based on a silicone hydrogel, such that the protective layer 3 and the functional element 2 is covered by the hydrogel material 1' based on the silicone hydrogel.

As shown in FIG. 6, the fourth step is applying lights or heat to the upper mold M2 and the lower mold M1, so as to cure the material (e.g., silicone hydrogel based material) of the light-permeable body 1 in the accommodating space formed by the upper mold M2 and the lower mold M1. For example, UV
5 lights can be used for the curing process. As shown in FIG. 7, the fifth step is removing the upper mold M2 and the lower mold M1. Accordingly, the contact lens L having the element protection function is obtained.

One of the advantages of the present disclosure is that the contact lens having the element protection function, in which the functional element is
10 completely covered by the light-permeable body and the protective layer to be isolated from the outside and is formed of a material including a film-forming polymer, a hydrophilic polymer and a solvent, provides support and protection for the functional element.

More specifically, the protective layer 3 of the contact lens L has a specific
15 composition that has good compatibility with another material (e.g., the hydrogel or silicone hydrogel material of the light-permeable body 1) of the contact lens L. Furthermore, the properties resulted from the composition can allow the material to be effectively transferred between the tools in the manufacturing process of the contact lens L. Therefore, the process yield can
20 be greatly improved.

In addition, the specific composition of the protective layer 3 can not only achieve the effect of supporting the functional element 2 (e.g., a pattern layer or electronic component), but can also prevent the materials (e.g., an adhesive and a colorant) of the functional element 2 from diffusing to an unexpected position
25 in a flowing manner. Therefore, the contact lens L can be prevented from losing an expected cosmetic effect and harming the health of a wearer.

The foregoing description of the exemplary embodiments of the disclosure has been presented only for the purposes of illustration and description and is not intended to be exhaustive or to limit the disclosure to the precise forms
30 disclosed. Many modifications and variations are possible in light of the above

teaching.

The embodiments were chosen and described in order to explain the principles of the disclosure and their practical application so as to enable others skilled in the art to utilize the disclosure and various embodiments and with
5 various modifications as are suited to the particular use contemplated. Alternative embodiments will become apparent to those skilled in the art to which the present disclosure pertains without departing from its spirit and scope.

CLAIMS

What is claimed is:

1. A contact lens having an element protection function, comprising:
a light-permeable body;
a functional element disposed on the light-permeable body; and
a protective layer disposed on the light-permeable body and covering the functional element;
wherein the functional element is completely covered by the light-permeable body and the protective layer to be isolated from an exterior environment, and the protective layer is formed of a material including a film-forming polymer, a hydrophilic polymer and a solvent;
wherein the film-forming polymer is polyether polyol, the hydrophilic polymer is polyvinyl pyrrolidone, and the solvent is a mixture of alcohol and water.
2. The contact lens according to claim 1, wherein the light-permeable body has a recessed space recessed from an outer surface thereof, and the protective layer and the functional element are accommodated in the recessed space.
3. The contact lens according to claim 1, wherein based on the total weight of the protective layer, the content of the film-forming polymer is between 1 % and 60 %.
4. The contact lens according to claim 1, wherein based on the total weight of the protective layer, the content of the hydrophilic polymer is between 0.1 % and 45 %.

5. The contact lens according to claim 1, wherein based on the total weight of the protective layer, the content of the film-forming polymer is between 15 % and 50 %.

6. The contact lens according to claim 1, wherein based on the total weight of the protective layer, the content of the hydrophilic polymer is between 5 % and 40 %.

7. The contact lens according to claim 1, wherein the functional element includes at least one of a pattern layer and an electronic component.