dryness, it is considered to be necessary for the ophthalmic lens to maintain its surface wettability for a long time. However, in the currently used ophthalmic lens, there was still a problem in maintaining the surface wettability for a long time. Since the modified surface layer of the ophthalmic lens requires to be a very thin layer with respect to the substrate, it is difficult to maintain the surface wettability for a long time as compared with other medical devices which are physically capable of retaining water in a surface layer by thickening the surface layer.

[0008]

In the medical electrode for skin, it is important that the surface wettability of the electrode can be maintained for a long time in order to maintain the contact resistance with the skin.

[0009]

Embodiments of the present invention have been made in view of aforementioned problems of prior art. Thus, embodiments of the present invention provide a medical device which is capable of maintaining the surface wettability for a long time.

[Solution to Problem]

[0010]

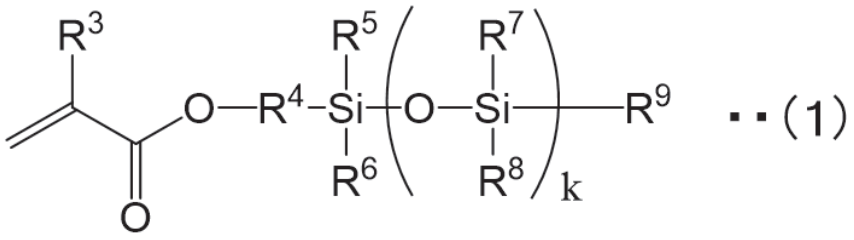
The following aspects of the present invention are provided.

According to a first aspect of the present invention, there is provided a medical device including a substrate and a polymer layer, wherein the polymer layer is provided on at least a part of a surface of the substrate and satisfies the following requirements:

(a) a water content of the medical device in hydrated state is in a range of 28% by mass or more and 50% by mass or less;

(b) the substrate ~~has~~includes a 2-alkoxyethyl group and a unit derived from the following general formula (1); and

(c) the polymer layer contains one type of a carboxylic acid group-containing polymer and one type of a copolymer having an amide structure;



wherein, in the general formula (1), R^3 represents a hydrogen atom or a methyl group; R^4 represents a divalent organic group having 1 to 20 carbon atoms; R^5 to R^8 each independently

represents an alkyl group having 1 to 20 carbon atoms or an aryl group having 6 to 20 carbon atoms; R^9 represents an optionally substituted alkyl group having 1 to 20 carbon atoms or an optionally substituted aryl group having 6 to 20 carbon atoms; and k represent an integer in a range of 1 to 200.

According to a second aspect of the present invention, there is provided a method for producing the above medical device, which includes a step of disposing the substrate in a solution containing one type of the carboxylic acid group-containing polymer and heating at 50°C or higher, and a step of disposing the substrate subjected to the step of heating at 50°C or higher in a solution containing a copolymer having an amide structure whose initial pH is adjusted in a range of 2 to 6, and heating at 60°C or higher.

[Advantageous Effects of Invention]

[0011]

According to embodiments of the present invention, it is possible to obtain a medical device capable of maintaining surface wettability for a long time.

[Brief Description of the Drawings]

[0012]

FIG. 1 is a top view of an aluminum pedestal in which a lens-shaped medical device is disposed.

FIG. 2 is a side view of an aluminum pedestal in which a lens-shaped medical device is disposed.

FIG. 3 is an example of the measurement results of a wet value (Fluidity factor) by multi speckle-diffusing wave spectroscopy (hereinafter referred to as MS-DWS method).

[Description of Embodiments]

[0013]

The present invention has the following structures. The present invention is directed to a medical device comprising a substrate and a polymer layer, wherein the polymer layer is provided on at least a part of a surface of the substrate and satisfies the following requirements:

(a) a water content of the medical device in hydrated state is in a range of 28% by mass or more and 50% by mass or less;

(b) the substrate has a 2-alkoxyethyl group; and

(c) the polymer layer contains one type of a carboxylic acid

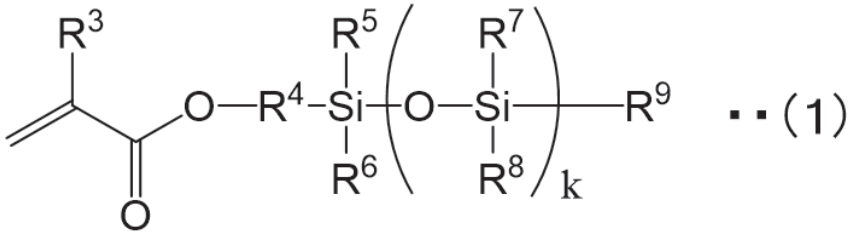
[CLAIMS]

1. A medical device comprising a substrate and a polymer layer, wherein the polymer layer is provided on at least a part of a surface of the substrate and satisfies the following requirements:

(a) a water content of the medical device in hydrated state is in a range of 28% by mass or more and 50% by mass or less;

(b) the substrate includes ~~has~~ a 2-alkoxyethyl group and a unit derived from the following general formula (1); and

(c) the polymer layer contains one type of a carboxylic acid group-containing polymer and one type of a copolymer having an amide structure;



wherein, in the general formula (1), R^3 represents a hydrogen atom or a methyl group; R^4 represents a divalent organic group having 1 to 20 carbon atoms; R^5 to R^8 each independently represents an alkyl group having 1 to 20 carbon atoms or an aryl group having 6 to 20 carbon atoms; R^9 represents an optionally substituted alkyl group having 1 to 20 carbon atoms or an optionally substituted aryl group having 6 to 20 carbon atoms; and k represent an integer in a range of 1 to 200.

2. The medical device according to claim 1, wherein the 2-alkoxyethyl group is a 2-methoxyethyl group.

3. The medical device according to claim 1, wherein the 2-alkoxyethyl group is a 2-ethoxyethyl group.

4. The medical device according to any one of claims 1 to 3, wherein the carboxylic acid group-containing polymer has a weight-average molecular weight in a range of 10,000 or more and 500,000 or less.

5. The medical device according to any one of claims 1 to 4, wherein the substrate has the 2-alkoxyethyl group in a range of 5% by mass or more and 25% by mass or less.

6. The medical device according to any one of claims 1 to 5, wherein a wet value half-life derived from the following equation (I) and equation (II) is in a range of 160 seconds or more and 5,000 seconds or less:

$$Ln(F) = -At + B \quad (I)$$

$$\text{wet value half-life} = Ln(2/A) \quad (II)$$

where F represents a wet value (Fluidity factor) obtained by the MS-DWS method and t represents the time (seconds); equation (I) is a linear approximation of a relationship between the logarithm of the wet value F and the time t; A represents an inclination of an approximate straight line of equation (I) and B represents the intercept.

7. The medical device according to any one of claims 1 to 6, wherein a dry elastic modulus ratio represented by the following equation (III) is in a range of 0.1 or more and 10 or less.

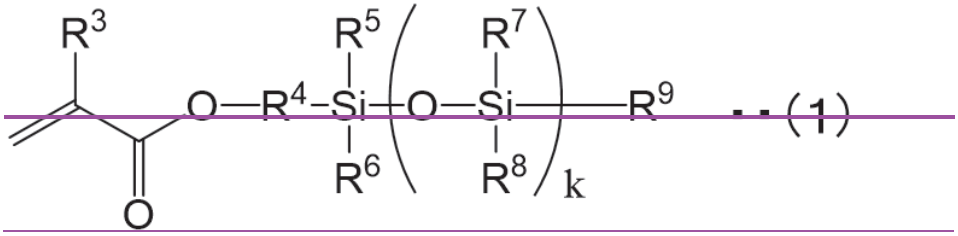
Dry elastic modulus ratio = tensile elastic modulus in

dry state/tensile elastic modulus in hydrated state (III)

8. The medical device according to claim 7, wherein the tensile elastic modulus in dry state is in a range of 0.1 MPa or more and 3.5 MPa or less.

~~9. The medical device according to any one of claims 1 to 8, wherein the substrate includes a unit derived from the following general formula (1):~~

~~[Chemical Formula 1]~~



~~wherein, in the general formula (1), R^3 represents a hydrogen atom or a methyl group; R^4 represents a divalent organic group having 1 to 20 carbon atoms; R^5 to R^8 each independently represents an alkyl group having 1 to 20 carbon atoms or an aryl group having 6 to 20 carbon atoms; R^9 represents an optionally substituted alkyl group having 1 to 20 carbon atoms or an optionally substituted aryl group having 6 to 20 carbon atoms; and k represent an integer in a range of 1 to 200.~~

~~10~~9. The medical device according to any one of claims 1 to ~~9~~8, wherein the carboxylic acid group-containing polymer is one or more types selected from the group consisting of polymethacrylic acid, polyacrylic acid, polyvinylbenzoic

acid, poly(thiophene-3-acetic acid), polymaleic acid, poly(meth)acryloyloxyethyl-succinic acid, poly(meth)acryloyloxyethyl hexahydrophthalic acid, poly(meth)acryloyloxyethyl-phthalic acid, poly(meth)acryloyloxyethyl-2-hydroxyethyl-phthalic acid, polynorbornenecarboxylic acid, poly(meth)acryloyloxyethyl succinate, and salts thereof.

~~11~~10. The medical device according to any one of claims 1 to ~~10~~9, wherein the copolymer having an amide structure is one or more types selected from the group consisting of a (meth)acrylic acid/N-vinylpyrrolidone copolymer, a (meth)acrylic acid/N,N-dimethylacrylamide copolymer, a 2-acrylamide-2-methylpropanesulfonic acid/N-vinylpyrrolidone copolymer and a 2-acrylamide-2-methylpropanesulfonic acid/N,N-dimethylacrylamide copolymer.

~~12~~11. The medical device according to any one of claims 1 to ~~11~~10, wherein the substrate is a cured product of a composition for forming a substrate, wherein

the composition for forming a substrate includes a polymerizable compound having a 2-alkoxyethyl group, an acylphosphine oxide-based polymerization initiator and an intramolecular hydrogen abstraction type polymerization initiator, and includes the acylphosphine oxide-based polymerization initiator in a range of 0.05% by mass to 0.4% by mass and the intramolecular hydrogen abstraction type polymerization initiator in a range of 0.2% by mass to 20% by mass.

~~13~~12. The medical device according to any one of claim ~~12~~11, wherein the intramolecular hydrogen abstraction type polymerization initiator is methyl benzoylformate.

~~14~~13. The medical device according to any one of claims 1 to ~~13~~12, which is an ophthalmic lens, a dermal covering material, a wound dressing material, a skin protection material, a skin medicine carrier, an infusion tube, a gas delivery tube, a drain tube, a blood circuit, a covering tube, a catheter, a stent, a sheath, a tube connector, an access port or an endoscopic dressing material.

~~15~~14. A method for producing the medical device according to any one of claims 1 to ~~14~~13, which comprises:

a step of disposing the substrate in a solution containing one type of the carboxylic acid group-containing polymer and heating at 50°C or higher, and

a step of disposing the substrate subjected to the step of heating at 50°C or higher in a solution containing a copolymer having an amide structure whose initial pH is adjusted in a range of 2 to 6, and heating at 60°C or higher.