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]

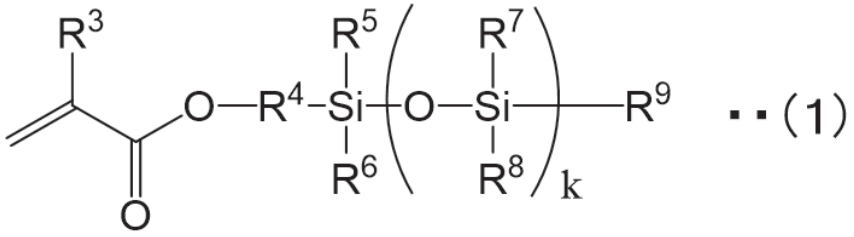
The following aspects of the present invention are provided.

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 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:

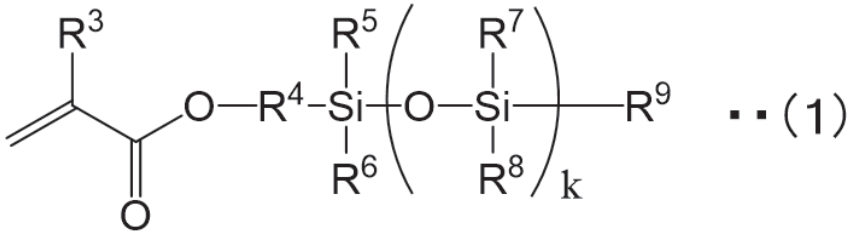
(a) a water content of the medical device in hydrated state is in a range of 28% by mass or more and 50% by mass or less;

(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 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 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.

10. The medical device according to any one of claims 1 to 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.

11. The medical device according to any one of claims 1 to 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.

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

13. The medical device according to any one of claims 1 to 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.

14. A method for producing the medical device according to any one of claims 1 to13, 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.