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3,728,315

COPOLYMERIZED HARD PLASTIC HYDROGEL COMPOSITIONS

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7 Claims

ABSTRACT OF THE DISCLOSURE

A shape-retaining cross-linked polymer formed from monomers including from about 20% to about 35% by weight of the copolymer of an alkylene glycol methacrylate, said alkylene having from one to three carbon atoms, from about 5% to about 35% by weight of the copolymer of a hydroxy alkyl methacrylate, said alkyl having from one to three carbon atoms, and from about 55% to about 70% by weight of the copolymer of a compound being a member selected from the group consisting of ethyl methacrylate and n-butyl methacrylate and a contact lens formed therefrom.

BACKGROUND OF THE INVENTION

Various types of plastic materials especially adapted for use as contact lenses have been proposed and are known in the art. It has been found to be especially useful to utilize plastic materials which are hydrophilic in this art field since the ability to absorb and retain water has been found to be a useful characteristic where such plastic materials are formulated into contact lenses. In this connection, there has been a great deal of effort in two directions, one direction pointing to the production of hard plastic contact lenses, which are fairly rigid in structure, and not particularly hydrophilic or wettable and the other direction pointing in the area of soft plastic contact lenses, which are more pliable and therefore, of greater comfort when worn on the eye.

Various types of such hydrophilic plastic materials are disclosed in U.S. Pat. No. 3,220,960 which discloses various forms of cross-linked hydrophilic polymers and articles made therefrom, the final composition being a copolymer resulting from the copolymerization of a monomer having a polymerizable vinyl group such as styrene, with a small amount of a monomer having such groups as divinyl benzene, inorganic divinyl solutions resulting in a gel formed by cross-linked corresponding polymers and the solvent. U.S. Pat. No. 3,503,942 also discloses various forms of hydrophilic polymers and aqueous reaction media having a cross-linked polymeric hydrogel structure and have desirable properties. Such compositions are disclosed to be useful primarily as contact lenses for the reason that the polymer structure which results from the method and formulation set forth therein has a soft but elastic consistency and has a degree of permeability to afford ease of fluid transfer from the cornea of the eye.

The polymeric structures disclosed in the aforementioned patents, while having some modicum of success in terms of use as contact lenses, nevertheless have exhibited problems in terms of being machinable, or being so hydrophilic as to cause undue expansion of the material and oftentimes such expansion causes a change in the refractive index of the material, necessitating further adjustments after the contact lens has been formed.

In addition to the above, my co-pending application entitled "Copolymerized Hydrogel Compositions" filed on Oct. 19, 1970, under Ser. No. 82,105 also disclosed a composition which results in a soft plastic hydrogel composition which is particularly effective for use in a contact lens since the resulting composition has a low expansion

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ratio upon hydration, and is nevertheless sufficiently soft, resilient and flexible while at the same time being completely machinable whereby to provide all of the necessary characteristics required for contact lenses.

In my aforementioned co-pending application, the gist of the invention disclosed and claimed therein is to formulate a soft plastic hydrogel composition which is particularly suitable and useful as a contact lens. It has become apparent, however, that there is still a desire and need for a contact lens formed of a hard plastic material which will incorporate therein all of the necessary characteristics required for contact lenses, such as good optics, machinability, and compatibility with the cornea of the eye as well as with the tear fluid existing therein. One of the problems associated with the present hard plastic contact lenses is that such hard plastic contact lenses are not sufficiently hydrophilic so as to allow the tear fluid to flow across the surface of the lens. The result is that the tear fluid tends to be repulsed by the plastic material leaving dry spots between the inner surface of the contact lens and the cornea of the eye. This results in irritation to the eye of the user and is not particularly desirable.

It is therefore the principal object of this invention to provide a hydrophilic cross-linked copolymeric hydrogel material which has a relatively low expansion ratio upon hydration and which is still sufficiently hard so as to be machinable without at the same time affecting the optics of the material.

In connection with the foregoing object, it is still another object of the present invention to provide a contact lens formed of the aforementioned hydrogel material which is extremely compatible with the cornea of the eye and the tear fluid, thereby permitting the user thereof to enjoy longer wearing time with greater comfort.

Still another object of the present invention is to provide a shape-retaining hydrogel body having a relatively low expansion ratio which includes from about 20% to about 35% by weight of the total composition of an alkylene glycol methacrylate wherein the alkylene chain has from one to three carbon atoms, from about 5% to about 35% by weight of the total composition of a hydroxy alkyl methacrylate wherein the alkyl group has from one to three carbon atoms, and from about 55% to about 70% by weight of the composition of a member selected from the group consisting of ethyl methacrylate and n-butyl methacrylate.

Yet a further object of the present invention is to provide a hydrophilic shape-retaining hydrogel body of the type set forth above, wherein the composition consists of from about 20% to about 35% by weight of the composition of triethylene glycol dimethacrylate, from about 5% to about 35% by weight of the composition of hydroxy ethyl methacrylate, and from about 55% to about 70% by weight of the composition of n-butyl methacrylate.

In connection with the foregoing object, it is yet another object of this invention to provide a hydrophilic shape-retaining hydrogel body of the type set forth, which includes 29% of triethylene glycol dimethacrylate, 14% of hydroxy ethyl methacrylate and 57% of n-butyl methacrylate, the aforementioned percentages being by weight of the final composition.

Still another object of the present invention is to provide a method for forming a cross-linked hydrophilic hydrogel body having a low expansion ratio, which comprises the steps of mixing together from about 20% to about 35% by weight of the total composition of an alkylene glycol methacrylate, the alkylene group having from one to three carbon atoms, from about 5% to about 35% by weight of the composition of a hydroxy alkyl methacrylate, the alkyl group having from one to three carbon atoms, and from about 55% to about 70% by weight of