

ULTRAVIOLET LIGHT ABSORBING INTRAOCULAR IMPLANTS

This is a continuation of copending application Ser. No. 07/735,161 filed on Jul. 23, 1991 now abandoned which is a continuation of application Ser. No. 07/617,959, filed on Nov. 26, 1990 now abandoned, which is a continuation of application Ser. No. 07/443,875 filed on Nov. 30, 1989, now abandoned, which is a continuation of application Ser. No. 06/599,005, filed Apr. 11, 1984, now abandoned.

BACKGROUND OF THE INVENTION

Certain injuries to the eye and certain diseases to the eye (e.g. cataracts) require surgical removal of the eye lens. Removal of the natural lenses of the eye is known as aphakia which must be corrected by the use of a corrective lens in order to restore vision. Generally, intraocular implants are used to correct aphakia and restore vision. These implants may be permanently placed in the anterior or posterior chamber of the eye. Intraocular implants have an optical lens and a haptic for fixation of the lens, by a surgeon, in the anterior or posterior chamber of the eye. However, even with the most suitable of lenses, vision is not as desirable as it should be for the aphakic individual since such lenses do not adequately compensate for certain changes in light transmission which occur in the absence of the natural human crystalline lens. The result is potential damage to the retina due to increased ultraviolet light transmission.

A considerable portion of incident light entering the eye is absorbed and only the unabsorbed or transmitted portion strikes the retina. Natural light encompasses the entire spectrum of wavelengths in the ultraviolet, visible and infrared radiation ranges. Various artificial light sources also contain many wavelengths.

The crystalline lens of the eye preferentially absorbs a substantial portion of ultraviolet radiation. Accordingly, it is desirable that the lenses of intraocular implants for aphakic individuals, absorb at least 90% of light in the 300 to about 380 nm range but transmit most of the light in the visible spectrum. In addition, intraocular implant lenses are preferably made of a thermoplastic polymer and optically clear, inert to the eye, biocompatible and have a specific gravity of less than about 1.7.

Polymethylmethacrylate sometimes referred to as "PMMA", and various copolymers thereof, have the desired properties discussed above and have been used to make intraocular lenses as well as haptics. PMMA has physical properties which permit it to be formed into intraocular optic lenses that are relatively thin in cross section and, because of PMMA's relatively low specific gravity, about 1.4 or lower, such lenses are relatively comfortable in the eye. However, PMMA, and copolymers thereof have a serious disadvantage in that they are substantially transparent to ultraviolet radiation which, if transmitted to the retina, can cause eye injury. To avoid this disadvantage intraocular lenses have been fabricated from glass which can absorb ultraviolet radiation. However, compared to PMMA which is relatively easy to machine, glass lenses of relatively thin cross sections are much more difficult to produce. Furthermore since glass lenses have a specific gravity of 2.5 or higher such lenses are relatively heavy and therefore mitigate against the use of such lenses in aphakic individuals.

To overcome the disadvantage of PMMA lenses to ultraviolet radiation transmission, natural and synthetic crystals have also been used to construct intraocular lenses. U.S. Pat. No. 4,079,470 discloses a chemically durable optical implant lens formed from a low density natural or synthetic crystal, such as Corundum, Sapphire, Ruby, Sircon, Strontium, Diamond or Anatase. Because of the ability of these materials to absorb ultraviolet radiation such crystals provide an advantage over lenses made from PMMA. However, as with glass, it is more difficult to produce intraocular lenses which have relatively thin cross sections from these crystals. In general, lenses made from such crystals must be considerably thicker than lenses made from PMMA. Crystal lenses like glass lenses, are relatively heavy due to their high specific gravity, about 3.5 or higher, and larger size. Consequently, such crystal lenses are also heavier than the natural lenses of the human eye, and may also impose an undesirable strain to the eye. For these and other reasons, intraocular lenses made from PMMA, tend to be preferred over synthetic or natural crystals and glass lenses.

There is a need for an intraocular implant having an optical lens which is nontoxic, biocompatible and which absorbs a high percentage of ultraviolet light and does not contain leachable or potentially harmful ultraviolet light absorbing additives.

There is also a need for an intraocular optical lens material made of a thermoplastic polymer which is strong, ductile and easily machined or molded into thin sections and having a specific gravity less than about 1.7 and preferably about 1.4 or lower, which is chemically inert and stable, is biocompatible, nonleachable by fluids of the eye, is optically clear and absorbs a major portion of harmful ultraviolet light.

SUMMARY OF THE INVENTION

In accordance with the present invention, novel intraocular implants are provided which have optical lenses that are light, non-toxic, biocompatible, nonleachable in the presence of eye fluids and absorb at least 90% of the ultraviolet light in the 300-380 nm wavelength range but are transparent to most of the visible radiation. The intraocular implants will have a haptic for fixation in the posterior or anterior chamber of the eye.

The haptics of the intraocular implant may have a variety of shapes and can be made of a variety of thermoplastic polymers which are biocompatible, chemically inert, light weight (i.e. have a specific gravity of less than 1.7) strong, tough and flexible and are inert to the fluids in the eye. Such haptics may be made of polypropylene, aromatic polycarbonates, aromatic polyesters, aromatic polyimides, aromatic polyethersulfones, etc.

The intraocular lens of the present invention will have optically finished front and back surfaces and a shape and size approximating the human lens and will be made of an optical quality thermoplastic polymer having a specific gravity of less than about 1.7, said thermoplastic polymer having uniformly distributed throughout an ultraviolet light absorbing effective amount in the 300-380 nm range of 2-(hydroxy, lower alkylphenyl) benzotriazole which, optionally, may be halogen (e.g. chlorine) substituted in one or more of the 4, 5, 6 or 7 positions.

The intraocular lenses are formulated so that the ultraviolet radiation absorbing substance is nonleacha-