METHOD OF MAKING INTRAOCULAR AND CONTACT LENS CONSTRUCTIONS

This application is a division of my copending application Ser. No. 319,622, filed Nov. 9, 1981 U.S. Pat. No. 4,450,593.

BACKGROUND OF THE INVENTION

This invention relates to lens and haptic structures having application as intraocular lens implants, or as extraocular devices for contact application to the cornea, for wear in place of spectacles.

As intraocular devices, such structures and methods of making the same are illustratively treated in my U.S. Pat. No. 4,080,709, and as extraocular devices, such structures are illustratively treated in my U.S. Pat. No. 4,377,329.

Design philosophy behind intraocular and extraocular devices of the character indicated holds that the lens element shall be an optically finished unitary part, and that associated haptic structure shall be a separate thin flexible part or parts devised and assembled for central support of the lens element and for suitably compatible stabilized referencing engagement with adjacent body features.

There is another category of intraocular lens, exemplified by Choyce, et al., U.S. Pat. No. 4,087,866, wherein lens and haptic structure are the integral product of plastic-molding. But such products do not lend themselves to fabrication with glass, nor to known glass-lens finishing techniques. Moreover, injection-molded plastic materials are inherently incapable of providing the optical quality and uniformity that is available from glass and from certain plastic materials which are available in flat-sheet form.

My copending application, Ser. No. 288,217, filed July 29, 1981, Pat. No. 4,402,579 is concerned with structures and methods, involving intraocular and extraocular devices of the character indicated, wherein the starting material is a single flat sheet of glass or suitable plastic, and the present application is concerned with similar devices wherein the starting material is a composite laminate of different materials.

BRIEF STATEMENT OF THE INVENTION

It is an object to provide improved integrally formed lens and haptic structures of the character indicated, specifically involving composite laminated starting material.

A specific object is to provide such structures from a starting composite laminate wherein one lamination is optimized for its optical properties and another lamination is optimized for supporting haptic purposes.

A specific object is to meet the above objects with structures and techniques which utilize flat composite laminated sheet material as the starting and only material of the ultimate product.

The invention achieves these objects and certain further features by employing suitably coordinated masking and etching steps to determine in one of at least two composite laminations the peripheral contour of the ultimate central lens and in another of the laminations the thickness and fenestration detail of the ultimate thin flexible haptic formations; since these lens and haptic formations are from laminated starting materials; the haptic formations remain effectively integral with and extend radially outward of the lens blank. In all cases, the starting material is flat composite laminated-sheet stock, of thickness to provide for the overall ultimate axial extent of the lens. Lens-surface curvature may be developed prior to but is preferably developed after haptic formation. The masking and fenestration detail are provided via photo-etch techniques and are applicable to mass production of plural duplicates of the identical lens-and-haptic structures from a single composite laminated sheet, through formative operations performed concurrently and in common on all structures of a given sheet.

DETAILED DESCRIPTION OF THE INVENTION

Illustrative structures and techniques of the invention will be described in detail in conjunction with the accompanying drawings, in which:

FIG. **1** is a plan view of a single-piece effectively integrally formed lens and haptic construction of the invention;

FIG. **2** is an enlarged sectional view, taken at **2**—**2** in FIG. **1**;

FIG. **3** is a further-enlarged schematic sectional representation of sheet of composite laminated starting material, for the aspect depicted in FIG. **2**, i.e., what begins as shown in FIG. **3** ultimately becomes what is shown in FIG. **2**;

FIGS. **4** and **5** are diagrams similar to FIG. **3**, to show the result of different intermediate steps in proceeding from the material of FIG. **3** to the product of FIG. **2**;

FIGS. **3A** and **4A** are sectional views, and FIGS. **3B** and **4B** are diagrammatic representations to show use of different masks to create the respective intermediate stages of FIGS. **4** and **5**;

FIGS. **6** and **7** are views similar to FIGS. **4** and **5**, to illustrate two different finishing steps for the product of FIGS. **1** and **2**; and

FIGS. **8** and **9** are similar fragmentary plan views of two alternative multiple-structure layouts on a single sheet of starting material, for mass-production purposes.

In the form of FIGS. **1** and **2**, the invention is shown in application to an extraocular or contact-lens assembly, strongly resembling multiple-component structure as disclosed in my said U.S. Pat. No. 4,377,329, but in reality comprising a central lens **10** and haptic structure **11** which are effectively integral with each other, being the product of selectively etched reduction from starting material in the form of flat composite laminated sheet stock, of thickness T_1+T_2, as shown in FIG. **3**, wherein T_1 is the thickness of one (**12**) of the composite laminations (shown for glass) and T_2 is the thickness of the other (**13**) of the composite laminations (shown for plastic). The lamination **12** is of thickness to permit ultimate lens formation therefrom, and the lamination **13** is of thickness to serve ultimate haptic formation therefrom; the composite laminated stock is selected for inertness to body fluids.

For convenience, dimensional symbols have been applied to identify: lens **10** diameter at D_1, which may be in the range of 6 to 9 mm; an inner circumferential haptic band or ledge **14**, which is preferably at least 0.40 mm wide, to account for its outer diameter D_2 in the range of 6.5 to 9.5 mm; with retained bonded lap to the rim of lens **10**; and haptic outer diameter D_3 which may be in the range up to 20 mm, and thus in excess of the 12 to 14 mm diameter of the iris of an eye. It will be understood that haptic **11** may be characterized by very substantial fenestration, meaning that the structure is pri-