

CONTACT LENS MOULD

A technique, which has recently become popular for the manufacture of ophthalmic correction contact lenses from plastics material, is known as cast moulding. In this technique, two plastics mould parts with convex and concave moulding surfaces are injection moulded from master dies and are subsequently juxtaposed to provide a moulding cavity between the convex and concave moulding surfaces. A polymerisable liquid moulding material is cast and polymerised within the moulding cavity to form a contact lens, whereafter the mould parts are separated to release the lens and are disposed of.

There have been various proposals for enabling such mould parts to approach one another, to reduce slightly the thickness of the moulding cavity, in order to accommodate shrinkage of the liquid moulding material during polymerisation of the material. One such proposal has involved the provision on one of the mould parts of a flexible lip which engages the other mould part to define the periphery of the moulding cavity, the lip flexing to accommodate the shrinkage. A second proposal has involved providing a flexible diaphragm portion of one of the mould parts, the diaphragm portion moving towards the other mould part to accommodate the shrinkage. None of these are entirely satisfactory as they involve uncertain variation in the shape, edge or thickness of the lens.

In accordance with the present invention, a method of moulding an ophthalmic contact lens, utilizes a pair of plastics mould parts which comprises a first part with a concave moulding surface; and a second part with a convex moulding surface; the mould parts being arranged to be juxtaposed and urged together to define between the two surfaces a moulding cavity for moulding the contact lens; and the periphery and the separation of the two moulding surfaces being defined by the abutment of a rigid annular projection on one of the first or second mould parts with

the convex or concave moulding surface of the other mould part respectively, the projection presenting, in axial section, an annular nose with an included angle of between 80° and 100°, preferably substantially 90°; the method comprising the steps of filling the moulding cavity with polymerisable material and holding the mould parts juxtaposed while curing the polymerisable material, the material from which at least the mould part carrying the annular projection is formed being thermoplastics and that material, and the curing temperature and time all being such that shrinkage of the polymerisable material during curing is at least partly compensated by plastic flow of the annular projection allowing the two mould parts to approach one another more closely.

The first mould part with the concave moulding surface will normally be used with the surface facing upwardly. A quantity of liquid polymerisable material is dosed onto the concave moulding surface and the second mould part with the convex moulding surface facing downwardly is then lowered into the first mould part displacing excess polymerisable material into an annular reservoir formed between the mould parts above and around the moulding cavity. The two mould parts are urged axially, or bonded, together, and then heated in an oven to cure the polymerisable material. The engagement of the rigid annular projection on one mould part with the moulding surface of the other mould part effectively seals the periphery of the moulding cavity and separates the moulding cavity from the reservoir. During the curing, the polymerisable material shrinks and this is primarily accommodated, by the plastic flow, i.e. creep yield, of the annular projection. However, the seal may not be complete and during the early part of the curing process, when the viscosity of the polymerisable material is still low, some of the liquid polymerisable material may be drawn past the annular projection from the reservoir into the moulding cavity. However, as the curing

progresses, the viscosity of the polymerisable material increases until it is too thick to be drawn through the

seal, effectively sealing the joint. Thereafter shrinkage is accommodated by the plastic flow of the annular projection.

5 The mould parts are usually cast from an injection mouldable thermoplastic polymeric material. Polyolefins such as polypropylene are particularly suitable for their release properties, and food grades are normally used for purity.

10 In order to provide the necessary plastic flow of the annular projection, it has been found that the mould part carrying the annular projection should be made of a thermoplastics material preferably having a yield stress in the range 10 to 40, preferably substantially 30 MNm^{-2} , after 24 hours at 20°C . In practice curing temperatures in the 15 range of 30 to 80°C , preferably substantially 37°C , and a curing time of 6 to 48 hours, preferably substantially 22 hours, are suitable.

The invention will now be described by way of example with reference to the accompanying drawings, in which:-

20 Figure 1 is an axial section of one mould; Figure 2 is an enlargement of the part ringed in Figure 1;

Figures 3 and 4 correspond to Figures 1 and 2, respectively, but show a second mould; and,

25 Figure 5 corresponds to Figure 2 but shows the mould parts after curing.

The first mould shown in Figures 1, 2 and 5 has parts 3 and 4, of which the first part 3 provides a part spherical concave moulding surface 5 and the second part 4 provides a convex moulding surface 6. The moulding 30 surfaces define between them a moulding cavity 7 when the parts 3 and 4 are brought into mutual abutment and in coaxial alignment. The abutment occurs around an annular zone, part of which is ringed in Figure 1, and which is 35 shown in more detail in Figures 2 and 5. Radially outwardly and above the abutment, the mould parts 3 and 4 define between upward cylindrical extensions an annular

reservoir 8. The abutment is provided by an annular projection 9 on the mould part 4, in the form of an angular nose having substantially vertical and substantially horizontal flanks 10 and 11.

5 In use, the mould part 3 is supported and liquid moulding material is poured in. The part 4 is then lowered coaxially into the part 3, displacing some of the liquid material into the reservoir 8, but leaving the moulding cavity 7 full of the material. The angular nose 9 abuts
10 against the surface 5 and substantially seals the periphery of the cavity. With the two mould parts held together, they are then transferred into an oven in which the assembly is heated so that the polymerisable material cures and solidifies. During the curing, the polymerisable
15 material shrinks by up to 20% in volume. During an initial part of the curing, some of the liquid polymerisable material may be drawn passed the nose 9 to replenish the cavity 7 from the reservoir 8. However, with increasing viscosity, this becomes impossible and the shrinkage of the
20 material in the cavity 7 draws the two mould parts axially together with a force sufficient to cause plastic flow of the edge of the nose 9, so that it becomes permanently deformed and adopts the shape shown at 9A in Figure 5, and thereby allowing the moulding surfaces 5 and 6 to approach
25 one another more closely. After curing of the material, the mould parts are separated and the moulded lens, which has been moulded in the cavity 7, recovered.

The second mould shown in Figures 3 and 4 differs from the first in that the nose 9, with substantially vertical and substantially horizontal flanks 10 and 11 is formed
30 integrally with the mould part 3. Operation and plastic flow of the nose 9 is otherwise the same as with the first mould.

CLAIMS



1. A method of moulding an ophthalmic contact lens, utilizes a pair of plastics mould parts which comprises a first part with a concave moulding surface; and a second part with a convex moulding surface; the mould parts being arranged to be juxtaposed and urged together to define between the two surfaces a moulding cavity for moulding the contact lens; and the periphery and the separation of the two moulding surfaces being defined by the abutment of a rigid annular projection on one of the first or second mould parts with the convex or concave moulding surface of the other mould part respectively, the projection presenting, in axial section, an annular nose with an included angle of between 80° and 100° , the method comprising the steps of filling the moulding cavity with polymerisable material and holding the mould parts juxtaposed while curing the polymerisable material, the material from which at least the mould part carrying the annular projection is formed being thermoplastics and that material, and the curing temperature and time all being such that shrinkage of the polymerisable material during curing is at least partly compensated by plastic flow of the annular projection allowing the two mould parts to approach one another more closely.

2. A method according to claim 1, in which the mould part carrying the projection is made of a thermoplastics material having a yield stress in the range 10 to 40 MNm^{-2} , after 24 hours at 20°C .

3. A method according to claim 2, in which the yield stress is substantially 30 MNm^{-2} .

4. A method according to any one of the preceding claims, in which the curing temperature is in the range of 30 to 80°C .



5. A method according to claim 4, in which the curing temperature is substantially 37°C.
 6. A method according to any one of the preceding claims, in which the curing time is 6 to 48 hours.
 7. A method according to claim 6, in which the curing time is substantially 22 hours.
 - 10 8. A method of moulding an ophthalmic contact lens, substantially as described with reference to the accompanying drawings.
-