

CONTACT LENS PACKAGE WITH MICRO-TEXTURED INTERIOR BOWL SURFACE

Technical Field

[0001] The present invention relates generally to packaging for contact lenses, and more specifically to a contact lens blister pack having a textured interior bowl surface for reducing the incidence of surface chip defects on the contact lens.

Background

[0002] Contact lenses are commonly packaged in blister packs. Blister packs come in many different forms, and typically include a shell having a concave bowl or cavity formed therein, and a removable cover adhered over the bowl to retain the contact lens and a dose of saline therein and maintain sterility. The contact lens may be subjected to in-package quality assurance inspection while within the bowl of the package.

[0003] Surface chip defects can occur on a contact lens when the front curve of the contact lens adheres to the interior surface of the package's bowl, for example, before the saline dosing process or during autoclaving. The adhesion of the contact lens to the packaging surface may be so great that small chips are torn off of the front face of the contact lens as the lens detaches from the package, creating surface chip defects.

[0004] Surface chip defects sometimes result in a lower quality product, reduced efficiency, and increased manufacturing costs. Accordingly, it can be seen that needs exist in the contact lens manufacturing field for reducing the incidence of surface chip defects.

Summary

[0005] In example embodiments, the present invention relates to an improved packaging shell for contact lenses that reduces the incidence and/or severity of surface chip defects. One or more micro-textured patterns applied to regions or zones of the

interior surface of the bowl of the package shell reduce adhesion of the lens. In example forms of the invention, the regions or zones to which the micro-textured patterns are applied are concentric, adjacent, or otherwise configured relative to one another. Transitions between the micro-textured patterns applied to the regions or zones may be smooth and continuous, or alternatively may be discrete or discontinuous.

[0006] In one aspect, the present invention relates to a packaging shell for a contact lens. The packaging shell includes a cavity for receiving the contact lens, the cavity having an interior surface. At least a portion of the interior surface of the cavity has a micro-textured pattern thereon, wherein the micro-textured pattern is formed of a plurality of microstructures, the microstructures having a substantially rounded dome-like configuration.

[0007] In another aspect, the invention relates to a container for a contact lens. The container includes a cavity having an interior surface defining first and second zones of microstructure patterns. The first zone includes microstructures having a first configuration and the second zone includes microstructures having a second configuration, wherein the first configuration is different from the second configuration.

[0008] In still another aspect, the invention relates to a method of preventing adherence of a contact lens to a contact lens package, the method including applying a micro-textured pattern to an interior surface of the contact lens package.

[0009] In another aspect, the invention relates to a method of manufacturing a contact lens package. The method includes the steps of applying an inverse micro-textured pattern to a mold surface of a mold, and forming the contact lens package in the mold and thereby transferring a mirror image of the inverse micro-textured pattern of the mold surface onto the formed contact lens package.

[0010] In another aspect, the invention relates to a method of in-package inspection of a contact lens within a contact lens package. The method includes the steps of capturing an image of the contact lens within the package, and analyzing the

image of the contact lens to determine whether it contains a lens defect. The contact lens package has an interior surface with a micro-textured pattern applied thereon, and the micro-textured pattern is not indicated as the lens defect in the analysis of the image.

[0011] These and other aspects, features and advantages of the invention will be understood with reference to the drawing figures and detailed description herein, and will be realized by means of the various elements and combinations particularly pointed out in the appended claims. It is to be understood that both the foregoing general description and the following brief description of the drawings and detailed description of the invention are exemplary and explanatory of preferred embodiments of the invention, and are not restrictive of the invention, as claimed.

Brief Description of the Drawings

[0012] **FIGURE 1** is a top plan view of a blister pack container shell for a contact lens according to an example embodiment of the present invention.

[0013] **FIGURE 2** is a microscopic view of an example form of a micro-textured pattern applied to a container shell for a contact lens according to an embodiment of the present invention.

[0014] **FIGURE 3** is a detailed cross sectional view showing the inner bowl surface of a container shell for a contact lens having a micro-textured pattern applied thereon, and containing a contact lens, according to an embodiment of the present invention.

[0015] **FIGURE 4** is a top plan view of a blister pack container shell for a contact lens according to another example embodiment of the present invention.

[0016] **FIGURE 5** is a top plan view of a blister pack container shell for a contact lens according to still another example embodiment of the present invention.

Detailed Description of Example Embodiments

[0017] The present invention may be understood more readily by reference to the following detailed description of the invention taken in connection with the accompanying drawing figures, which form a part of this disclosure. It is to be understood that this invention is not limited to the specific devices, methods, conditions or parameters described and/or shown herein, and that the terminology used herein is for the purpose of describing particular embodiments by way of example only and is not intended to be limiting of the claimed invention. Any and all patents and other publications identified in this specification are incorporated by reference as though fully set forth herein.

[0018] Also, as used in the specification including the appended claims, the singular forms “a,” “an,” and “the” include the plural, and reference to a particular numerical value includes at least that particular value, unless the context clearly dictates otherwise. Ranges may be expressed herein as from “about” or “approximately” one particular value and/or to “about” or “approximately” another particular value. When such a range is expressed, another embodiment includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by use of the antecedent “about,” it will be understood that the particular value forms another embodiment.

[0019] With reference now to the drawing figures, wherein like reference numbers represent corresponding parts throughout the several views, **FIGURE 1** shows a blister pack container shell 10 for storing a contact lens according to an example embodiment of the invention. U.S. Patent No. 5,609,246 to Borghorst et al is incorporated herein by reference for additional details regarding the general construction of an example form of blister pack container. It will be understood, however, that the present invention is suitable for application to a variety of different container formats, and is not limited to the particular container styles identified.

[0020] The container shell 10 comprises a body 12 having a generally concave bowl or cavity 20 formed therein. The bowl or cavity 20 has a smoothly curved inner

surface 21 for containing the contact lens and a dose of saline therein. An attachment zone is optionally provided on the body 12 surrounding the bowl 20 for releasably attaching a cover sheet (unshown) over the bowl to retain the lens and saline within the bowl and prevent contamination.

[0021] The inner surface 21 of the bowl 20 has a micro-texture pattern 22 applied thereon, an example embodiment of which can be seen more clearly in the microscopic view of **FIGURE 2**. In this example embodiment, the micro-texture pattern 22 is a dotted or stippled pattern, comprising a multiplicity of micro-structures 24 having a substantially uniform dome-like or rounded configuration repeated in a generally regular pattern. In this embodiment, the individual micro-structures 24 of the pattern 22 have a diameter or cross-wise dimension of between about 18-24 μm (micrometers) and are generally shaped as a convex dome or mound projecting outwardly from the inner surface 21 of the bowl. The micro-structures 24 are spaced about 18-24 μm from one another, center to center, and optionally can partially overlap one another as seen in **FIGURE 2**. In example embodiments, the inner surface 21 of the bowl 20 has an overall root-mean square (RMS) surface roughness value range between 1-11 μm . In alternate embodiments, a higher or lower RMS surface roughness is provided along one or more portions of the inner surface 21.

[0022] In alternate embodiments, the individual micro-structures can take the form of a concavely recessed cup or bowl, angular peaks or ridges, raised flats, and/or other geometric forms; and may be uniform or non-uniform in configuration and distribution along substantially all of the inner surface 21 of the bowl 20, or along one or more portions of the inner surface of the bowl. Preferably, the micro-texture pattern 22 is applied to the inner surface of the bowl at least in the region of the central, lowermost nadir of the bowl 20. The micro-texture pattern 22 can take different forms, including, but not limited to, a wave-like pattern, a jagged pattern, or a grid-like pattern or the like, each pattern formed of a multiplicity of micro-structures that are replicated along at least a portion of the bowl surface to create the pattern.

[0023] Optionally, the micro-structures 24 of the micro-texture pattern 22 have different sizes in different regions of the bowl 20. In an example embodiment, the

micro-structures 24 near the center of the bowl 20 have a greater diameter of about 24 μm while the micro-structures nearer the peripheral sides of the bowl have a lesser diameter of about 18 μm . The size change of the micro-structures 24 can be gradual and substantially continuous along the extent of the micro-texture pattern 22, or can change from a greater dimension to a smaller dimension at a sharp pattern transition.

[0024] In example modes of manufacture according to the present invention, the container shell 10 is formed by injection molding in a metal mold. The micro-texture pattern 22 on the container shell 10 can be formed by application of a mirror-image pattern on the mold, which is then transferred onto the container shell during the molding process; or alternatively the micro-texture pattern can be directly formed on each container shell. In particular embodiments, the micro-texture pattern 22 is formed by Electrical Discharge Machining (EDM) of the corresponding mold surface that forms the bowl of the blister pack, by shot-peening (for example using microbeads of glass or other material applied at a high velocity to the mold surface) the mold surface, or by other machining or metal forming methods.

[0025] **FIGURE 3** shows a side view of a contact lens 14 resting on the surface 21 of the cavity 20, according to an example mode of use of the present invention. The detailed view of **FIGURE 3** shows the rounded microstructures 24 supporting the contact lens 14 at discrete spaced points along the lens surface, reducing the surface area of contact and reducing the potential for the lens to adhere to the bowl of the shell, and thereby reducing or eliminating the incidence of chip formation upon detachment of the lens from the bowl.

[0026] **FIGURE 4** shows a blister pack container shell 210 according to another embodiment of the invention. The container shell 210 comprises a body 212 and a bowl or cavity 220 having an inner surface 221. The inner surface 221 comprises a plurality of zones including a center zone 224, a first or inner annular ring zone 226, and a second or outer annular ring zone 228 (all delineated by dashed lines). The center zone 224 is generally positioned in the center of the bowl or cavity 220, having a circular shape with diameter of about 10 mm. The first annular ring zone 226 is positioned concentrically with the center zone. The inner diameter of the first annular ring zone

226 is about 10 mm while the outer diameter of the annular ring zone 26 expands radially about 2 mm, resulting in an outer diameter of about 14 mm. The second annular ring zone 228 is also positioned concentrically with the center zone. The inner diameter of the second annular ring zone 28 is about 14 mm, while the outer diameter of the second annular ring zone 228 is about 20 mm. All three zones are sized to cooperatively cover a large percentage of the area of the surface 221. The zones represent areas or regions on the inner surface 221 of the bowl comprising micro-texture patterns having different RMS surface roughness values or value ranges. For example, the center zone 224 of an embodiment of the invention has an overall RMS surface roughness value of 1.5 μm , the first annular ring zone 226 has a RMS surface roughness value range between 2-4 μm , and the second annular ring zone has a RMS surface roughness value range between 3-11 μm . The areas of the surface 221 not designated by a zone optionally have a RMS surface roughness value range between 1-11 μm . The change in RMS surface roughness from zone to zone can be gradual and substantially continuous across a transition region around the areas indicated by the broken lines, or can be abrupt wherein the broken lines represent a discrete transition. The dimensions and layout of the zones for this embodiment are exemplary and not limiting of the scope of the invention, and one skilled in the art would appreciate that depending on the size of the bowl 220, the dimensions of the zones, as well as the RMS surface roughness values or value ranges, could differ from the specified values.

[0027] **FIGURE 5** shows a blister pack container shell 310 according to another embodiment of the present invention. The container shell 310 comprises a body 312 and a bowl or cavity 320 having an inner surface 321 thereon, said surface 321 comprising a plurality of zones. The plurality of zones include a center zone 334, a first side zone 336, and a second side zone 338 (all delineated by dashed lines). The zones represent areas on the surface 321 having a micro-texture pattern that has a specified RMS surface roughness value or value range that differs from a surrounding surface and/or that differs from another zone. For example, in a particular embodiment of the invention, the center zone 334 has an overall RMS surface roughness value range between 1-1.9 μm ; and the first side zone 336 and the second side zone 338 have an

overall RMS surface roughness value range between 3-11 μm , and more preferably between 4-8 μm . In this embodiment, the zones 334, 336, and 338 are generally elliptical in shape, with the major axes of the ellipses generally aligned. The center zone 334 is centered within the cavity 320 and larger than the side zones, while the first side zone 336 and second side zone 338 are positioned adjacent to and along either side of the center zone 334. Each zone is sized to each cover roughly 25% of the cavity 320. The areas of the surface 321 not designated by a zone optionally have a RMS surface roughness value range of 1-11 μm . The change in RMS surface roughness from zone to zone, or from a zone to an area not designated by a zone can be gradual or abrupt. The layout of the zones for this embodiment are exemplary and not limiting of the scope of the invention, and the size, configurations and layout of the zones, as well as the RMS surface roughness values or value ranges of the zones, may differ depending on the intended application.

[0028] The present invention further comprises a method for performing an In-Package Inspection (IPI) of a contact lens while it is housed within the bowl of a blister pack container shell. In an example inspection method according to the present invention, a light source is directed towards the blister pack and a camera captures an image of the cavity with the contact lens resting therein using the light source as a backdrop. The light source illuminates any possible surface defects on the contact lens, which images of which are then captured on image by the camera. The top face of the blister pack will be understood to be the view represented by **FIGURE 1**. The light source can be shone upon the top, bottom, or side faces of the blister pack. One method of conducting the IPI is by having a light source placed above the blister pack and capturing an image of the bottom of the cavity. Another method of conducting the IPI is by having a light source placed below the blister pack and capturing an image of the top of the cavity. Still another example method would be to have the light source placed either below or above the blister pack and capturing an image of either the top or the bottom of the cavity. Still another method of inspection would be to have the light source placed above, below or on either side of the blister pack and capturing an image

of the opposite side of the blister pack. The captured image(s) can be analyzed by visual inspection or by computerized inspection algorithms.

[0029] In order for the IPI to be carried out successfully, a certain amount of light transmittance percentage through the container shell bowl is desirable, since the IPI process utilizes light to inspect the contact lens. Accordingly, the container shell is optionally formed of a transparent or translucent material. The specified configurations of the micro-texture pattern on the surface result in relatively little or no negative impact upon the yield and inspection efficiency of the In-Packaging Inspections. More specifically, the light transmittance through the cavity is maintained at a percentage suitable for inspection, even with the presence of the micro texture pattern. Expected adverse effects due to the presence of the micro-texture pattern, such as light scattering or light reflecting, are not found to interfere with the IPI process, and the micro-texture pattern is not recognized as a surface defect. In alternate modes of inspection according to the present invention, computerized inspection algorithms may account for the micro-texture surface pattern and filter it out of the inspection analysis.

[0030] While the invention has been described with reference to preferred and example embodiments, it will be understood by those skilled in the art that a variety of modifications, additions and deletions are within the scope of the invention, as defined by the following claims.

What is Claimed is:

1. A packaging shell for a contact lens, comprising:

a cavity for receiving the contact lens, the cavity having an interior surface, at least a portion of the interior surface of the cavity having a micro-textured pattern thereon;

wherein the micro-textured pattern comprises a plurality of microstructures, the microstructures having a substantially rounded dome-like configuration.

2. The packaging shell of Claim 1, wherein the microstructures have a substantially uniform configuration across the portion of the interior surface of the cavity having the micro-textured pattern applied thereon.

3. The packaging shell of Claim 1, wherein the microstructures are repeated in a generally regular pattern along the portion of the interior surface of the cavity having the micro-textured pattern applied thereon.

4. The packaging shell of Claim 1, wherein the microstructures have a cross-wise dimension of between about 18-24 μm .

5. The packaging shell of Claim 1, wherein the microstructures are spaced about 18-24 μm from one another, center to center.

6. The packaging shell of Claim 1, wherein the microstructures partially overlap one another.

7. The packaging shell of Claim 1, wherein the portion of the interior surface of the cavity having the micro-textured pattern thereon has an overall root mean square surface roughness of between 1-11 μm .

8. The packaging shell of Claim 1, wherein the interior surface of the cavity comprises a plurality of zones, each zone having microstructures of different dimensions thereon.

9. The packaging shell of Claim 8, wherein a first zone of the plurality of zones is located near a central portion of the cavity and a second zone of the plurality of zones is located away from the central portion of the cavity, and wherein the microstructures of the first zone have a greater dimension and the microstructures of the second zone have a lesser dimension.
10. The packaging shell of Claim 9, wherein the greater dimension is about 24 μm and the lesser dimension is about 18 μm .
11. The packaging shell of Claim 8, wherein a gradual microstructure transition is defined between the zones.
12. The packaging shell of Claim 8, wherein a sharp microstructure transition is defined between the zones.
13. The packaging shell of Claim 8, wherein the plurality of zones comprise a center zone and at least one annular zone surrounding the center zone.
14. The packaging shell of Claim 13, wherein the center zone has a diameter of about 10 mm.
15. The packaging shell of Claim 13, wherein the annular zone has an outer diameter of about 14 mm.
16. The packaging shell of Claim 13, wherein the center zone has an overall root mean square surface roughness of about 1.5 μm .
17. The packaging shell of Claim 13, wherein the annular zone has an overall root mean square surface roughness of about 2 - 11 μm .
18. The packaging shell of Claim 13, wherein the annular zone has an overall root mean square surface roughness of about 2 - 4 μm .
19. The packaging shell of Claim 8, wherein the plurality of zones comprise a center zone, a first annular zone surrounding the center zone, and a second annular zone surrounding the first annular zone.

20. The packaging shell of Claim 19, wherein the first annular zone has an inner diameter of at least 10 mm and an outer diameter of about 14 mm.
21. The packaging shell of Claim 19, wherein the second annular zone has an outer diameter of about 20 mm.
22. The packaging shell of Claim 19, wherein the center zone has an overall root mean square surface roughness of about 1.5 μm , the first annular zone has an overall root mean square surface roughness of about 2 - 4 μm , and the second annular zone has an overall root mean square surface roughness of about 3 - 11 μm .
23. The packaging shell of Claim 8, wherein the plurality of zones comprise a first elliptical zone and a second elliptical zone, the first and second elliptical zones each defining a generally elliptical outer periphery, major axes of the generally elliptical outer peripheries of the first and second elliptical zones being aligned generally parallel to one another.
24. The packaging shell of Claim 23, further comprising a third elliptical zone, the second and third elliptical zones being arranged on opposite sides of and being smaller than the first elliptical zone.
25. The packaging shell of Claim 23, wherein the first elliptical zone has an overall root mean square surface roughness of about 1 – 1.9 μm , and the second elliptical zone has an overall root mean square surface roughness of about 3 – 11 μm .
26. The packaging shell of Claim 23, wherein the second elliptical zone has an overall root mean square surface roughness of about 4 – 8 μm .
27. The packaging shell of Claim 1, wherein the microstructures are transferred from a mold used to form the packaging shell, the mold comprising a mold surface having an inverse microstructure pattern thereon that corresponds inversely to the cavity of the packaging shell.
28. The packaging shell of Claim 27, wherein the inverse microstructure pattern is formed by electrical discharge machining of the mold surface.

29. The packaging shell of Claim 27, wherein the inverse microstructure pattern is formed shot-peening the mold surface.
30. The packaging shell of Claim 1, wherein the microstructures comprise a configuration that is not recognized as a lens defect during in-package inspection of a contact lens within the packaging shell.
31. A container for a contact lens, the container comprising a cavity having an interior surface defining first and second zones of microstructure patterns, wherein the first zone comprises microstructures having a first configuration and wherein the second zone comprises microstructures having a second configuration, the first configuration being different from the second configuration.
32. The container of Claim 31, wherein the first microstructure configuration has a greater crosswise dimension than the second microstructure configuration.
33. The container of Claim 32, wherein the crosswise dimension of the first microstructure configuration is about 24 μm and the crosswise dimension of the second microstructure configuration is about 18 μm .
34. The container of Claim 31, wherein the first zone has a greater surface roughness than the second zone.
35. The container of Claim 33, wherein the RMS surface roughness of the first zone is less than 4 μm , and the RMS surface roughness of the second zone is at least 2 μm .
36. The container of Claim 31, wherein the first zone is a central zone and the second zone is a peripheral zone.
37. The container of Claim 36, wherein the peripheral zone is annularly shaped and surrounds the central zone.
38. The container of Claim 36, further comprising a third peripheral zone, and wherein the second zone and the third zone are positioned on opposite sides of the central zone.

39. A method of preventing adherence of a contact lens to a contact lens package, said method comprising applying a micro-textured pattern to an interior surface of the contact lens package.

40. The method of Claim 39, wherein the micro-textured pattern comprises a plurality of microstructures, the microstructures having a substantially rounded dome-like configuration.

41. The method of Claim 39, wherein the micro-textured pattern comprises a first zone of microstructures having a first configuration and a second zone of microstructures having a second configuration, the first configuration being different from the second configuration.

42. A method of manufacturing a contact lens package comprising:

applying an inverse micro-textured pattern to a mold surface of a mold; and

forming the contact lens package in the mold and thereby transferring a mirror image of the inverse micro-textured pattern of the mold surface onto the formed contact lens package.

43. The method of Claim 42, wherein the micro-textured pattern comprises a plurality of microstructures, the microstructures having a substantially rounded dome-like configuration.

44. The method of Claim 42, wherein the micro-textured pattern comprises a first zone of microstructures having a first configuration and a second zone of microstructures having a second configuration, the first configuration being different from the second configuration.

45. A method of in-package inspection of a contact lens within a contact lens package, the method comprising:

capturing an image of the contact lens within the package; and

analyzing the image of the contact lens to determine whether it contains a lens defect;

wherein the contact lens package comprises an interior surface having a micro-textured pattern applied thereon, and wherein the micro-textured pattern is not indicated as the lens defect.

46. The method of Claim 45, wherein the micro-textured pattern comprises microstructures having a dimension too small to indicate the presence of the lens defect.

47. The method of Claim 45, wherein the micro-textured pattern is filtered out of the analyzing of the image of the contact lens.