

Claims

1. Method for an automated in-line determination of the center thickness (55) of an ophthalmic lens (5) in an automated manufacturing line for ophthalmic lenses, the method comprising the steps of:
 - providing an inspection cuvette (2) comprising an optically transparent bottom (21) having a concave inner surface (210) and containing the ophthalmic lens (5) immersed in a liquid, and positioning the inspection cuvette (2) at a first inspection location (800) of an inspection module (1) of the automated manufacturing line;
 - providing an interferometer (3) comprising a light source and a focusing probe (30), the focusing probe focusing light coming from the light source to a set position (310) of the ophthalmic lens at the center of the concave inner surface of the optically transparent bottom of the inspection cuvette, and the focusing probe (30) further directing light reflected at the boundary (510) between the back surface (51) of the ophthalmic lens and the liquid on the one hand as well as light reflected at the boundary (500) between the front surface (50) of the ophthalmic lens and the liquid or light reflected at the boundary (502) between the front surface (50) of the ophthalmic lens (5) and the concave inner surface (210) of the optically transparent bottom (21) of the inspection cuvette (2) on the other hand to a detector of the interferometer (3);
 - determining the center thickness (55) of the ophthalmic lens (5) from the signals generated at the detector by the light reflected at the respective boundary (510;500,502) at the back surface (51) and at the front surface (50) of the ophthalmic lens (5).
2. Method according to claim 1, wherein the step of determining the center thickness (55) of the ophthalmic lens (5) comprises
 - in case the ophthalmic lens (5) rests on the concave inner surface (210) of the optically transparent bottom (21) of the inspection cuvette (2), selecting the signal

generated by the light reflected at the boundary (502) between the front surface (50) of the ophthalmic lens and the concave inner surface (210) of the optically transparent bottom (21) of the inspection cuvette (2) as well as the signal generated by the light reflected at the boundary (510) between the back surface (51) of the ophthalmic lens (5) and the liquid;

- in case the ophthalmic lens (5) is floating at a distance above the concave inner surface (210) of the optically transparent bottom (21) of the inspection cuvette (2), selecting the signal generated by the light reflected at the boundary (500) between the front surface (50) of the ophthalmic lens (5) and the liquid as well as the signal generated by the light reflected at the boundary (510) between the back surface (51) of the ophthalmic lens (5) and the liquid.

3. Method according to claim 1 or claim 2, wherein the step of determining the center thickness (55) of the ophthalmic lens (5) comprises
 - counting the number of signals generated by the light reflected at the respective boundary (510;500,502), and
 - for a counted number of two signals, selecting the two signals for determining the center thickness (55) of the ophthalmic lens (5),
 - for a counted number of three signals, ignoring the signal corresponding to the light reflected at the boundary (200) between the concave inner surface (210) of the optically transparent bottom (21) of the inspection cuvette (2) and the liquid, and selecting the remaining two signals for determining the center thickness (55) of the ophthalmic lens (5).
4. Method according to any one of the preceding claims, further comprising the steps of
 - comparing the determined center thickness (55) of the ophthalmic lens (5) with a predetermined set value for the center thickness and
 - identifying the ophthalmic lens (5) as having an unacceptable center thickness if the determined center thickness (55) is outside a predetermined range of tolerance

around the predetermined set value for the center thickness, or

- identifying the ophthalmic lens (5) as having an acceptable center thickness if the determined center thickness (55) is within the predetermined range of tolerance around the predetermined set value for the center thickness, and

- removing the ophthalmic lens (5) from the manufacturing line in case the ophthalmic lens has been identified as having an unacceptable center thickness (55), but further processing the ophthalmic lens (5) in the manufacturing line in case the ophthalmic lens (5) has been identified as having an acceptable center thickness (55).

5. Method according to any one of the preceding claims, comprising the steps of:

- providing a plurality of inspection cuvettes (2), each inspection cuvette (2) comprising an optically transparent bottom (21) having a concave inner surface (210) and containing an ophthalmic lens (5) immersed in a liquid, and positioning the plurality of inspection cuvettes (2) at the first inspection location (800) of the inspection module (1);

- providing a plurality of focusing probes (30) corresponding to the plurality of inspection cuvettes (2), each of the focusing probes (30) focusing light to a set position (310) of the ophthalmic lens (5) at the center of the concave inner surface of the optically transparent bottom of a corresponding inspection cuvette (2), and each of the focusing probes (30) directing light reflected at the respective boundary (510;500,502) at the back surface (51) and at the front surface (50) of the respective ophthalmic lens (5) to the detector of the interferometer (3); and

- determining the center thickness (55) of each ophthalmic lens (5).

6. Method according to claim 5, wherein focusing light to the set position (310) of the ophthalmic lens (5) is performed sequentially for the plurality of inspection cuvettes (2) by directing light from the light source of the interferometer (3) via a first focusing probe (30) of the plurality of focusing probes to the set position (310) of the ophthalmic lens (5) contained in a first inspection cuvette (2) of the plurality of

inspection cuvettes, subsequently directing light from the light source of the interferometer via a second focusing probe (30) to the set position of the ophthalmic lens (5) contained in a second inspection cuvette (2) of the plurality of inspection cuvettes, and so on, until light from the light source of the interferometer (1) is directed via a last focusing probe (30) of the plurality of focusing probes to the set position (310) of the ophthalmic lens (5) contained in a last inspection cuvette (2) of the plurality of inspection cuvettes.

7. Method according to claim 6, wherein sequentially focusing light to a set position (310) of the ophthalmic lens (5) for the plurality of inspection cuvettes (2) comprises
 - providing a plurality of deflectors ($41_1, 41_2, 41_3, \dots, 41_{n-1}, 41_n$) corresponding to the plurality of focusing probes (30), the individual deflectors of the plurality of deflectors ($41_1, 41_2, 41_3, \dots, 41_{n-1}, 41_n$) each being capable of being switched between an active state, in which the respective deflector ($41_1, 41_2, 41_3, \dots, 41_{n-1}, 41_n$) directs light coming from the light source of the interferometer to the corresponding focusing probe (30) and in which the respective deflector ($41_1, 41_2, 41_3, \dots, 41_{n-1}, 41_n$) directs light reflected at the respective boundary (510, 500, 502) to the detector of the interferometer (3), and a passive state, in which the respective deflector allows the light coming from the light source to pass to the next deflector which is in the active state and which is arranged in an optical path of the light, and
 - sequentially switching a first deflector (41_1) of the plurality of deflectors ($41_1, 41_2, 41_3, \dots, 41_{n-1}, 41_n$) from the active state to the passive state after determining the center thickness (55) of the ophthalmic lens (5) contained in the first inspection cuvette (2), switching a second deflector (41_2) of the plurality of deflectors ($41_1, 41_2, 41_3, \dots, 41_{n-1}, 41_n$) from the active state to the passive state after determining the center thickness (55) of the ophthalmic lens (5) contained in the second inspection cuvette (2), and so on, until switching a second last deflector (41_{n-1}) of the plurality of deflectors ($41_1, 41_2, 41_3, \dots, 41_{n-1}, 41_n$) from the active state to the

passive state after determining the center thickness (55) of the ophthalmic lens (5) contained in the second last inspection cuvette (2), and then determining the center thickness (55) of the ophthalmic lens contained in the last inspection cuvette (2) with the last deflector (41_n) being in the active state.

8. Method according to any one of claims 1 to 7, further comprising the steps of
 - after determination of the center thickness (55) of the ophthalmic lens (5) contained in the inspection cuvette (2) or after determination of the center thicknesses (55) of the ophthalmic lenses (5) contained in the plurality of inspection cuvettes (2), moving the inspection cuvette (2) containing the ophthalmic lens (5) or the plurality of inspection cuvettes (2) containing the ophthalmic lenses (5) from the first inspection location (800) to a second inspection location (900), and
 - at the second inspection location (900) performing an in-line optical inspection of the ophthalmic lens (5) contained in the inspection cuvette (2) or of the ophthalmic lenses (5) contained in the plurality of inspection cuvettes (2) for the presence of other deficiencies.
9. Method according to any one of claims 5 to 8, further comprising the step of individually adjusting each focusing probe (30) of the plurality of focusing probes so as to focus light coming from the light source of the interferometer (3) to the corresponding set position (310) of the ophthalmic lens (5) at the center of the concave inner surface (210) of the optically transparent bottom (21) of the respective inspection cuvette (2) of the plurality of inspection cuvettes (2).
10. Method according to any one of the preceding claims, wherein the method is performed in an automated manufacturing line for manufacturing soft contact lenses.

11. An automated manufacturing line for manufacturing ophthalmic lenses (5), for example soft contact lenses, the manufacturing line comprising:
- a production module for manufacturing ophthalmic lenses (5);
 - an inspection module (1) for inspecting the manufactured ophthalmic lenses (5), the inspection module (1) comprising an interferometer and a plurality of focusing probes (30) being arranged at a first inspection location (800) and being capable of being optically connected to the interferometer (3), for inspection of ophthalmic lenses (5) being contained in a plurality of inspection cuvettes (2) corresponding to the plurality of focusing probes (30), each inspection cuvette (2) comprising an optically transparent bottom (21) having a concave inner surface (210) and containing the ophthalmic lens (5) immersed in a liquid,
- wherein in operation the inspection module (1) performs the method according to any one of claims 5 to 10.

Claims

1. Method for an automated in-line determination of the center thickness (55) of an ophthalmic lens (5) in an automated manufacturing line for ophthalmic lenses, the method comprising the steps of:

- providing an inspection cuvette (2) comprising an optically transparent bottom (21) having a concave inner surface (210) and containing the ophthalmic lens (5) immersed in a liquid, and positioning the inspection cuvette (2) at a first inspection location (800) of an inspection module (1) of the automated manufacturing line;

- providing an interferometer (3) comprising a light source and a focusing probe (30), the focusing probe focusing light coming from the light source to a set position (310) of the ophthalmic lens at the center of the concave inner surface of the optically transparent bottom of the inspection cuvette, and the focusing probe (30) further directing light reflected at the boundary (510) between the back surface (51) of the ophthalmic lens and the liquid on the one hand as well as light reflected at the boundary (500) between the front surface (50) of the ophthalmic lens and the liquid or light reflected at the boundary (502) between the front surface (50) of the ophthalmic lens (5) and the concave inner surface (210) of the optically transparent bottom (21) of the inspection cuvette (2) on the other hand to a detector of the interferometer (3);

- determining the center thickness (55) of the ophthalmic lens (5) from the signals generated at the detector by the light reflected at the respective boundary (510;500,502) at the back surface (51) and at the front surface (50) of the ophthalmic lens (5),

- wherein the method is performed in an automated manufacturing line for manufacturing soft contact lenses.