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(54) **PROCESS FOR CONTROLLING THE POLISHING PROCESS OF AN OPTICAL ELEMENT**

VERFAHREN ZUR STEUERUNG DES POLIERVERFAHRENS EINES OPTISCHEN ELEMENTS

PROCÉDÉ DE CONTRÔLE DU PROCÉDÉ DE POLISSAGE D'UN ÉLÉMENT OPTIQUE

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Description

[0001] The invention relates to a process for controlling the polishing process of an optical element, such an ophthalmic lens.

[0002] In this text, the word "polishing" is meaning in fact the smoothing and the polishing per se. The smoothing consists to suppress material on a depth comprised between 50 and 200 microns, and, after smoothing, the polishing per se consists to suppress material on a depth comprised between 3 and 50 microns.

[0003] Ophthalmic lenses require high quality standard, therefore high quality manufacturing process is to be used in order to obtain high quality ophthalmic lenses.

[0004] Cast molding requires the use of two complementary molds in which the lens material is added by gravity casting. These molds present a specific design corresponding to the desired lens design. Therefore, new manufacturing techniques including cutting specially digital surfacing and polishing steps are used.

[0005] In the art of lens manufacture, a finished lens is usually made from a semi-finished lens blank by using new technologies like digital surfacing. Semi-finished lens blanks have usually optically finished front surfaces. Then, they are cut, polished and coated to produce finished uncut lenses. Finished uncut lenses are then edged to the proper frontal shape and edge contour to fit into spectacle/glasses frames or other mounting structures.

[0006] To generate a desired prescription for a lens, calculations are required to determine the topography of the surfaces of the lens, namely its back surface if semi-finished lens blank is used. Such calculations typically involve variables that include the front surface radii of the semi-finished blank, the index of refraction of the lens blank material, prescription values of the desired lens, statutory values regarding minimum lens thickness, and the physical dimensions of the frame or mounting structure.

[0007] After the appropriate accuracy and smoothness is achieved in the cutting process, the surface is then polished and coated to produce a surface of optical quality. The optically finished lens is then edged to the proper shape and edge profile to fit into or with the frame for which the lens was made.

[0008] Today there are processes for controlling the process of manufacturing, but these processes do not permit to control easily the polishing quality. When the lens presents a defect, it is difficult to detail, if the defect comes from the cutting process or from the polishing process.

[0009] Indeed, in spite of the use of a detailed process of polishing, the performances of polishing can change in the time because of the adjustment of the operator, the conditions of the polishing bathes and the ambient temperature.

[0010] It could be planned to control the polishing process with a 3D measuring machine, but such machine is a heavy, complex and long working system which is not compatible with the production means.

[0011] The goal of the present invention is to provide a mechanical process for controlling the polishing process of an optical element, specially an ophthalmic lens or an ophthalmic mold, which is efficient, simple and rapid to use in workstation.

[0012] The document US-A-6 558 586 discloses a process for measuring and/or controlling a polishing process of an ophthalmic element comprising the steps of manufacturing a cavity on the surface of the element to be polished, operating the polishing process, and considering the element, in order to check that the cavity is suppressed.

[0013] The invention relates to a process for measuring and/or controlling a polishing process of an ophthalmic element comprising the steps of

- manufacturing at least two cavities on the surface of the element to be polished, the depth of the first cavity being smaller than the depth of the second cavity
- operating the polishing process
- considering the element, in order to check that the first cavity is suppressed and that the second cavity is present.

[0014] By ophthalmic element, it is understood ophthalmic lens or ophthalmic mold.

[0015] According to a first preferred embodiment, the process for controlling a polishing process of an ophthalmic element comprises the steps of:

- predetermining the reference value of the depth of the material to be suppressed by polishing,
- manufacturing at least two cavities on the surface of the element to be polished, the depth of the first cavity being smaller than said reference value and the depth of the second cavity being greater than said reference value, the difference between the depths of the cavities and said reference value being comprised between 0,5 and 50 microns,
- operating the polishing process,
- considering the element, in order to check that the first cavity is suppressed and that the second cavity is present.

[0016] Preferably, two sets of cavities are manufactured, the constant depth of the first set being smaller than said reference value and the constant depth of the second set being greater than said reference value.

[0017] A plurality of cavities can be manufactured, with different depths according to a predetermined increment.

[0018] Said pitch is preferably comprised between 0,5 and 10 microns.

[0019] Said cavities can be holes disposed according a regular geometric form.

[0020] In case of polishing of progressive lens or mold to manufacture it, said cavities can be disposed in its near vision zone.

[0021] Said cavities are disposed in its far vision zone.

[0022] Said cavities are disposed in its progression corridor, between its far vision zone and its near vision zone.

[0023] Said cavities are grooves.

[0024] According to a second preferred embodiment, the process for measuring a polishing process of an ophthalmic element comprises the steps of:

- choosing points on the surface of the element,
- manufacturing a plurality of holes near each said point, each hole of each plurality of holes having a different depth with a increment equal to the searched precision,
- operating a controlled polishing process,
- considering the element, in order to determine the polished depth at each said point.

[0025] Non limited embodiments of the invention will now be described with reference to the accompanying drawings.

Figure 1 and 2 are views in vertical section of an ophthalmic element, illustrating a first embodiment the process according to the invention.

Figure 3 and 4 are front views of an ophthalmic element, illustrating a second embodiment of the process according to the invention.

Figure 5 is a front view of progressive ophthalmic lens, illustrating a third embodiment of the process according to the process according to the invention.

[0026] The figure 6 is a view in vertical section of an ophthalmic element.

[0027] Figures 7 to 9 are front views of an ophthalmic element, illustrating a process of measuring a polishing process, according to the invention.

[0028] The process for controlling a polishing process of a surfaced ophthalmic element 1 comprising the steps of:

- predetermining the reference value X of the depth of the material to be suppressed by polishing, the reference value of smoothing being comprised between 50 and 200 microns and the reference value of polishing per se being comprised between 3 and 50 microns,
- manufacturing at least two micro-holes 2, 3, with a diameter comprised between 10 and 100 microns, on the surface of the element to be polished, the depth of the first hole 2 being smaller than the reference value X and the depth of the second hole 3 being greater than the reference value X, the difference between the the depths of the holes 2, 3 and said reference value X being comprised between à 0,5 and 50 microns, as illustrated in figure 1,
- operating the smoothing or polishing process,
- considering the element 1, in order to check that the first hole 2 is suppressed and that the second hole 3 is present, as illustrated in figure 2.

[0029] In fact, on figure 1, two sets of holes S_1 , S_2 are manufactured, the constant depth of the first set S_1 , for example three holes 2, being smaller than the reference value X and the constant depth of the second set S_2 , for example two holes 3, being greater than the reference value X.

[0030] For a preferred example, appropriated to ophthalmic lens or to ophthalmic mold, the reference value is comprised between 15 and 20 microns and the depth of the first holes 2 is equal to 15 microns and the depth of the second holes 3 is equal to 20 microns.

[0031] According to this first embodiment of the invention, as represented, the process of controlling permit to check that the depth of the material suppressed by polishing is effectively comprised between 15 and 20 microns. In other case, if some second holes 3 are suppressed or if some first holes 2 are always present, the polishing process presents a defect.

[0032] The precision of the controlling can be increased by manufacturing of a plurality of holes, with different depths according to a predetermined increment, preferably comprised between 0,5 and 10 microns.

[0033] The holes can be advantageously linear grooves, preferably disposed according a regular geometric form, for example according to concentric circles, squares or diameters. They could present specific sections, for example with form of cross, in order to be differentiated easily.

[0034] The figure 3 illustrates such second embodiment, where the surface have a revolution symmetry and where a

plurality of holes G_i is manufactured according to several radius, associated to a set of constant distances to the center of the ophthalmic element, with different depths according to a predetermined increment, for example equal to 1 micron.

[0035] After polishing, the element is as illustrated in the figure 4, the present holes demonstrate that the polishing is not uniform and that the quantity of material suppressed by polishing is smaller in the vicinity of the edges of the element and higher in the vicinity of the centre of the element.

[0036] Preferably, the controlling is made in critical places of the ophthalmic element.

[0037] The figure 5 illustrates such case of a progressive ophthalmic lens.

[0038] Advantageously, the holes or the grooves can be disposed in its near vision zone and/or in its far vision zone.

[0039] The holes or the grooves G_i are disposed in the progression corridor PW, between the far zone and the near zone of the lens.

[0040] In the represented example in figure 5, other grooves G_i' are disposed in concentric circles too.

[0041] The holes or grooves can be manufactured by means of a laser or mechanically. They can be manufactured directly in the generating or cutting machine.

[0042] The final determination of the subsisting holes or grooves can be made by a simple visualization, by means of an arc lamp in reflective or transmissive mode or by means of a camera.

[0043] The process according to the invention can be applied to an ophthalmic lens or to a mold to manufacture it.

[0044] The preferred embodiments of the process according to the invention have been described here above.

[0045] The invention concerns also a more basic process that comprises the steps of:

- predetermining the reference value X of the depth of the material to be suppressed by polishing,
- manufacturing only one micro-hole 2 or 3 or only one set of micro-holes S_1 or S_2 on the surface of the element to be polished, the depth of the hole or the set of holes being smaller than said reference value or being greater than said reference value,
- operating the polishing process,
- considering the element 1, in order to check that the hole 2 or 3 or the set of holes S_1 or S_2 is suppressed or present.

[0046] Although this embodiment of process does not give a complete control, it can be applied in order to control the polishing in some specific cases, for example when the polishing is supposed to suppress a quantity of material too small or too great, or when the uniformity of the polishing is to control.

[0047] More generally, the reference value X of the depth p of the material to be suppressed by polishing is not constant for one cut ophthalmic element 1 and the invention proposes for measuring a polishing in order to determine the reference surface L of polishing, as represented on the figure 6.

[0048] As detailed here above, this variable depth is comprised between 50 and 200 microns for the step of smoothing and between 3 and 50 microns for the step of polishing per se.

[0049] According to the invention, the process for measuring a polishing process of an ophthalmic element 1, for example in order to determine the formed reference surface L, comprises the steps of:

- choosing points P_i on the surface of the element 1, preferable regularly distributed on the surface of the element,
- manufacturing a plurality of micro-holes near each said point P_i , each hole MH_j of each plurality of holes having a different depth with a increment equal to the searched precision,
- operating a controlled polishing process,
- considering the element 1, in order to determine the polishing depth at each said point P_i .

[0050] According to a preferred embodiment illustrated on figure 7, the process to determinate the reference surface L consists to choose some points P_i on the cut element and to realise a plurality of micro-holes MH_j around and in vicinity of these points. The number of holes is at least equal to

$1 + \text{higher natural value of } [(\text{maximal depth} - \text{minimal depth}) / \text{increment}],$

with maximal depth equal to 200 microns and minimal depth equal to 50 microns, for smoothing,

with maximal depth equal to 50 microns and minimal depth equal to 3 microns, for polishing per se.

[0051] For example, twenty holes can be made around each point. Each hole of this plurality of holes has a different depth from one micron to twenty microns, with a regular increment equal to one micron.

[0052] The element is then polished with a correct and controlled process and according to the present holes, the reference value X in said points can be defined with a precision of one micron, as illustrated on figures 8 and 9.

[0053] Such process can be used by repartition of each plurality of holes of different ophthalmic elements.

Claims

1. Process for measuring and/or controlling a polishing process of an ophthalmic element (1) comprising the steps of
 - manufacturing at least two cavities (2, 3) on the surface of the element to be polished, the depth of the first cavity (2) being smaller than the depth of the second cavity (3)
 - operating the polishing process
 - considering the element (1), in order to check that the first cavity (2) is suppressed and that the second cavity (3) is present.
2. Process for controlling a polishing process of an ophthalmic element (1), according to claim 1, comprising the steps of:
 - predetermining the reference value (X) of the depth of the material to be suppressed by polishing,
 - manufacturing at least two cavities (2, 3) on the surface of the element to be polished, the depth of the first cavity (2) being smaller than said reference value and the depth of the second cavity (3) being greater than said reference value, the difference between the depths of the cavities (2, 3) and said reference value (X) being comprised between 0,5 and 50 microns,
 - operating the polishing process,
 - considering the element (1), in order to check that the first cavity (2) is suppressed and that the second cavity (3) is present.
3. Process according to the preceding claim, **characterized in that** two sets of cavities (S_1 , S_2) are manufactured, the constant depth of the first set (S_1) being smaller than said reference value and the constant depth of the second set (S_2) being greater than said reference value.
4. Process according to one of preceding claims, **characterized in that** a plurality of cavities (G_i) is manufactured, with different depths according to a predetermined increment.
5. Process according to claim 4, **characterized in that** said pitch is comprised between 0,5 and 10 microns.
6. Process according to one of preceding claims, **characterized in that** said cavities are holes disposed according a regular geometric form.
7. Process for controlling a polishing process of progressive lens or mold to manufacture it, according to one of preceding claims, **characterized in that** said cavities are disposed in its near vision zone.
8. Process for controlling a polishing process of progressive lens or mold to manufacture it, according to one preceding claim, **characterized in that** said cavities are disposed in its far vision zone.
9. Process for controlling a polishing process of progressive lens or mold to manufacture it, according to one preceding claim, **characterized in that** said cavities (G_i) are disposed in its progression corridor (PW), between its far vision zone and its near vision zone.
10. Process according to one of preceding claims, **characterized in that** said cavities are grooves.
11. Process for measuring a polishing process of an ophthalmic element (1), according to claim 1, comprising the steps of:
 - choosing points (P_i) on the surface of the element (1),
 - manufacturing a plurality of holes near each said point (P_i), each hole (MH_i) of each plurality of holes having a different depth with a increment equal to the searched precision,
 - operating a controlled polishing process,
 - considering the element (1), in order to determine the polished depth at each said point (P_i).

Patentansprüche

1. Verfahren zum Messen und/oder zur Steuerung eines Polierverfahrens eines ophthalmischen Elements (1), das die folgenden Schritte umfasst:

- Herstellen von mindestens zwei Aushöhlungen (2, 3) in der Oberfläche des zu polierenden Elements, wobei die Tiefe der ersten Aushöhlung (2) geringer als die Tiefe der zweiten Aushöhlung (3) ist,
 - Durchführen des Polierverfahrens,
 - Kontrollieren des Elements (1) zum Überprüfen, dass die erste Aushöhlung (2) unterdrückt wurde und die zweite Aushöhlung (3) vorhanden ist.

2. Verfahren zum Steuern eines Polierverfahrens eines ophthalmischen Elements (1) nach Anspruch 1, das die folgenden Schritte umfasst:

- Vorbestimmen des Bezugswerts (X) der Tiefe des durch Polieren zu unterdrückenden Materials,
 - Herstellen von mindestens zwei Aushöhlungen (2, 3) in der Oberfläche des zu polierenden Elements, wobei die Tiefe der ersten Aushöhlung (2) geringer als der Bezugswert ist und die Tiefe der zweiten Aushöhlung (3) größer als der Bezugswert ist, wobei der Unterschied zwischen den Tiefen der Aushöhlungen (2, 3) und dem Bezugswert (X) zwischen 0,5 und 50 μm liegt,
 - Durchführen des Polierverfahrens,
 - Kontrollieren des Elements (1) zum Überprüfen, dass die erste Aushöhlung (2) unterdrückt wurde und die zweite Aushöhlung (3) vorhanden ist.

3. Verfahren nach dem vorherigen Anspruch, **dadurch gekennzeichnet, dass** zwei Sätze von Aushöhlungen (S_1 , S_2) hergestellt werden, wobei die konstante Tiefe des ersten Satzes (S_1) geringer als der Bezugswert ist und die konstante Tiefe des zweiten Satzes (S_2) größer als der Bezugswert ist.

4. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** mehrere Aushöhlungen (G_i) mit verschiedenen Tiefen gemäß einem vorbestimmten Inkrement hergestellt werden.

5. Verfahren nach Anspruch 4, **dadurch gekennzeichnet, dass** die Steigung zwischen 0,5 und 10 μm liegt.

6. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Aushöhlungen Löcher sind, die gemäß einer regelmäßigen geometrischen Form angeordnet sind.

7. Verfahren zum Steuern eines Polierverfahrens eines Gleitsichtglases oder einer Form zu seiner Herstellung, nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Aushöhlungen in seinem Nahsichtbereich angeordnet sind.

8. Verfahren zur Steuerung eines Polierverfahrens eines Gleitsichtglases oder einer Form zu seiner Herstellung, gemäß einem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** die Aushöhlungen in seinem Fernsichtbereich angeordnet sind.

9. Verfahren zur Steuerung eines Polierverfahrens eines Gleitsichtglases oder einer Form zu seiner Herstellung, nach einem vorhergehenden Anspruch, **dadurch gekennzeichnet, dass** sich die Aushöhlungen (G_i) in seinem Gleitsichtbereich (PW) zwischen seinem Fernsichtbereich und seinem Nahsichtbereich befinden.

10. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** es sich bei den Aushöhlungen um Rillen handelt.

11. Verfahren zum Messen eines Polierverfahrens eines ophthalmischen Elements (1) nach Anspruch 1, das die folgenden Schritte umfasst:

- Auswählen von Punkten (P_i) auf der Oberfläche des Elements (1),
 - Herstellen einer Mehrzahl von Löchern in der Nähe jedes Punkts (P_i), wobei jedes Loch (MH_i) jeder Mehrzahl von Löchern eine unterschiedliche Tiefe mit einem Inkrement gleich der gesuchten Präzision aufweist,
 - Durchführen eines gesteuerten Polierverfahrens,
 - Kontrollieren des Elements (1), um die polierte Tiefe an jedem Punkt (P_i) zu bestimmen.

Revendications

1. Procédé de mesure et/ou de contrôle d'un procédé de polissage d'un élément ophtalmique (1) comprenant les étapes consistant à

- fabriquer au moins deux cavités (2, 3) sur la surface de l'élément à polir, la profondeur de la première cavité (2) étant inférieure à la profondeur de la deuxième cavité (3),
 - effectuer le procédé de polissage,
 - examiner l'élément (1), afin de vérifier que la première cavité (2) est supprimée et que la deuxième cavité (3) est présente.

2. Procédé de contrôle d'un procédé de polissage d'un élément ophtalmique (1), selon la revendication 1, comprenant les étapes consistant à :

- prédéterminer la valeur de référence (X) de la profondeur du matériau à supprimer par polissage,
 - fabriquer au moins deux cavités (2, 3) sur la surface de l'élément à polir, la profondeur de la première cavité (2) étant inférieure à ladite valeur de référence et la profondeur de la deuxième cavité (3) étant supérieure à ladite valeur de référence, la différence entre les profondeurs des cavités (2, 3) et ladite valeur de référence (X) étant comprise entre 0,5 et 50 μm ,
 - effectuer le procédé de polissage,
 - examiner l'élément (1), afin de vérifier que la première cavité (2) est supprimée et que la deuxième cavité (3) est présente.

3. Procédé selon la revendication précédente, **caractérisé en ce que** deux ensembles de cavités (S_1 , S_2) sont fabriqués, la profondeur constante du premier ensemble (S_1) étant inférieure à ladite valeur de référence et la profondeur constante du deuxième ensemble (S_2) étant supérieure à ladite valeur de référence.

4. Procédé selon l'une des revendications précédentes, **caractérisé en ce qu'une** pluralité de cavités (G_i) est fabriquée, avec différentes profondeurs selon un incrément prédéterminé.

5. Procédé selon la revendication 4, **caractérisé en ce que** ledit pas est compris entre 0,5 et 10 μm .

6. Procédé selon l'une des revendications précédentes, **caractérisé en ce que** lesdites cavités sont des trous disposés selon une forme géométrique régulière.

7. Procédé de contrôle d'un procédé de polissage d'une lentille progressive ou d'un moule pour la fabriquer, selon l'une des revendications précédentes, **caractérisé en ce que** lesdites cavités sont disposées dans sa zone de vision de près.

8. Procédé de contrôle d'un procédé de polissage d'une lentille progressive ou d'un moule pour la fabriquer, selon une revendication précédente, **caractérisé en ce que** lesdites cavités sont disposées dans sa zone de vision de loin.

9. Procédé de contrôle d'un procédé de polissage d'une lentille progressive ou d'un moule pour la fabriquer, selon une revendication précédente, **caractérisé en ce que** lesdites cavités (G_i) sont disposées dans son couloir de progression (PW), entre sa zone de vision de loin et sa zone de vision de près.

10. Procédé selon l'une des revendications précédentes, **caractérisé en ce que** lesdites cavités sont des sillons.

11. Procédé de mesure d'un procédé de polissage d'un élément ophtalmique (1), selon la revendication 1, comprenant les étapes consistant à :

- choisir des points (P_i) sur la surface de l'élément (1),
 - fabriquer une pluralité de trous près de chaque dit point (P_i), chaque trou (MH_j) de chaque pluralité de trous ayant une profondeur différente avec un incrément égal à la précision recherchée,
 - effectuer un procédé de polissage contrôlé,
 - examiner l'élément (1), afin de déterminer la profondeur polie au niveau de chaque dit point (P_i).

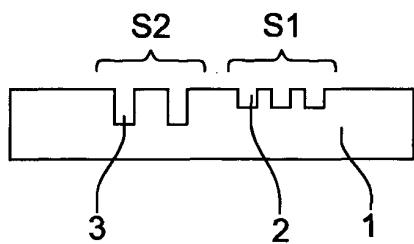


Fig. 1

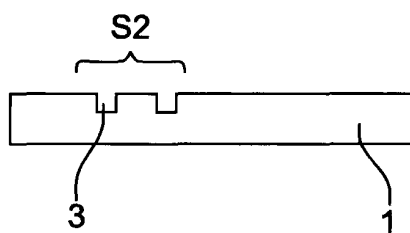


Fig. 2

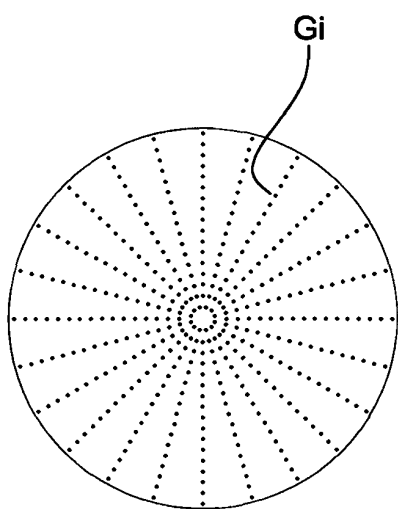


Fig. 3

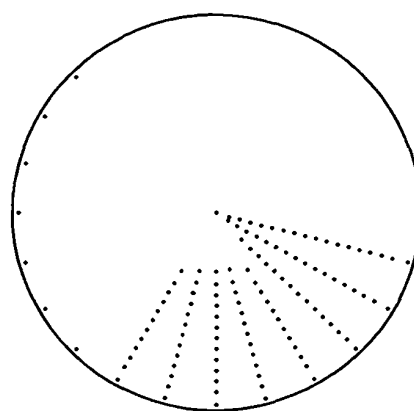


Fig. 4

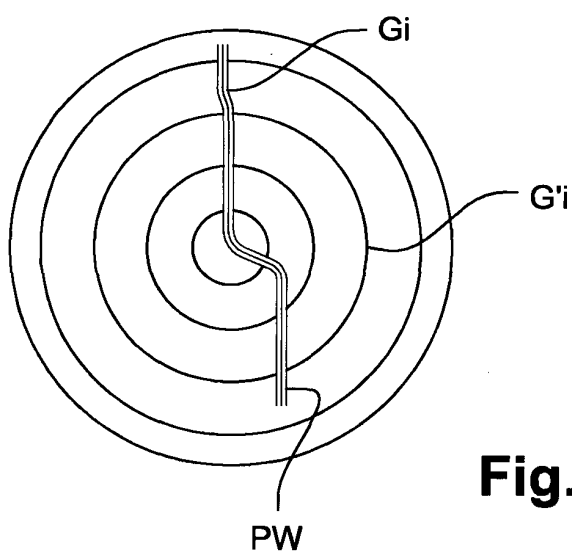


Fig. 5

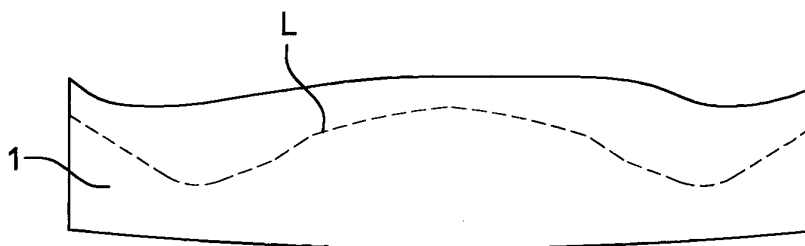


Fig. 6

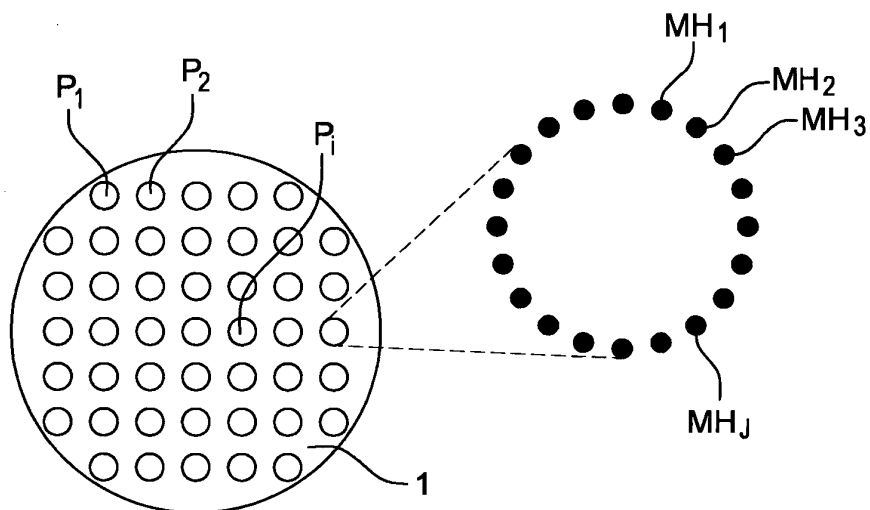


Fig. 7

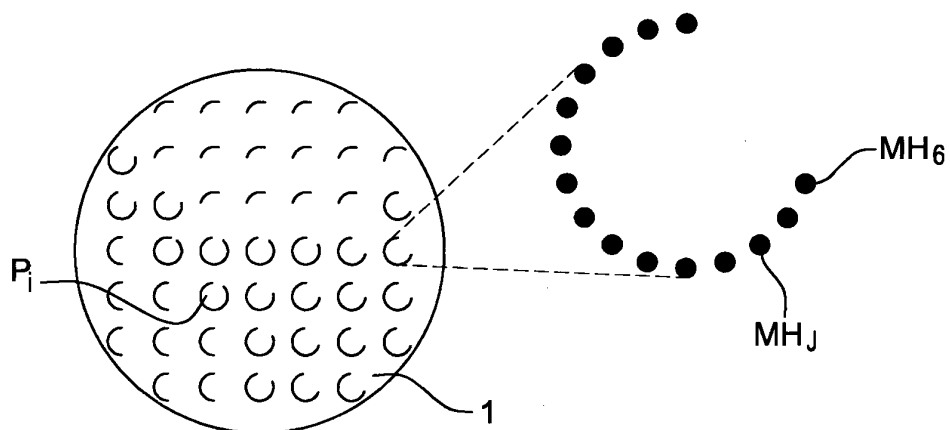


Fig. 8

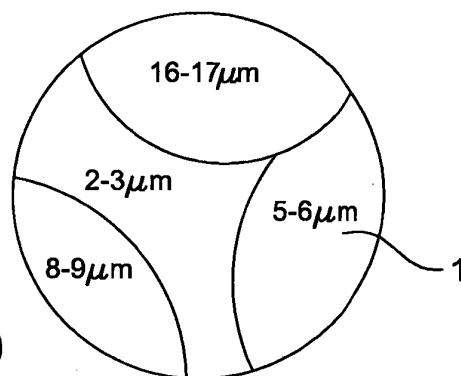


Fig. 9

REFERENCES CITED IN THE DESCRIPTION

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