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Amended claims in accordance with Rule 137(2) EPC.

(54) METHOD OF MANUFACTURING A GLOVE AND A GLOVE

(57) In the method a glove is manufactured, which glove comprises a top layer (10), an outer surface (12) and an inner surface, which inner surface is configured to be in skin contact when the glove is worn in hand. The method comprises a step of covering the outer surface at least partly with nanometric-sized material having photocatalytic properties. The photocatalytic properties of the material means, that the nanometric-sized material acts as light-activated antimicrobial agent.

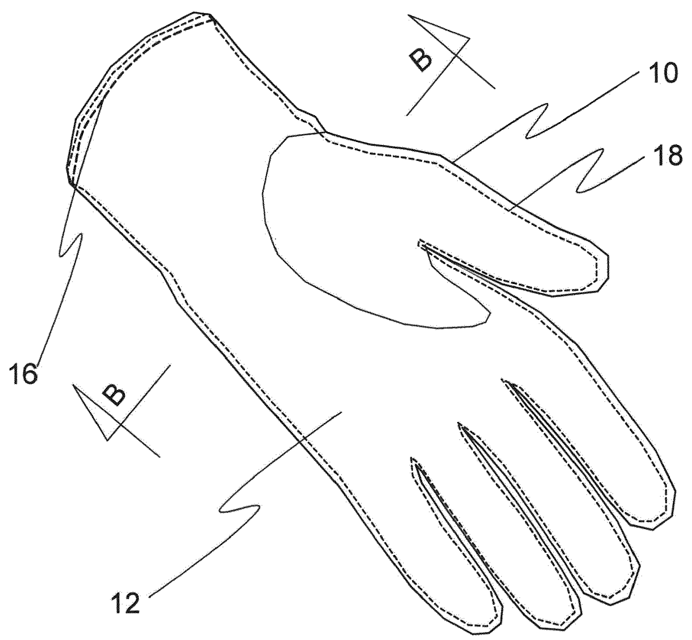

Fig. 2a

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Description

Technical Field

[0001] The invention is related to a method of manufacturing a glove, which glove comprises a top layer, an outer surface and an inner surface, which inner surface is configured to be in skin contact when the glove is worn in hand. The invention is further related to a glove manufactured by the method.

Background Art

[0002] Pathogens, such as bacteria and viruses cause diseases, which may be difficult to cure and require a long time to recover. Some diseases may even fatal. On way to reduce the risk of having a contamination of harmful pathogens is to wear gloves. By wearing gloves skin contacts with possibly contaminated surfaces can be reduced. Gloves are widely used in occupations and workplaces, where there is an increased risk of being infected by harmful pathogens. However, when the gloves are removed from hand the risk of coming into contact with the pathogens remaining on the outer surface or absorbed into the outer layer of the glove is high. The risk of being infected is especially high when removing and putting on gloves made for permanent or long-lasting wearing, such as working gloves and gloves meant for outdoor use. Thus, gloves are effective in avoiding contamination only, if the outer surface is free from pathogens and toxic compounds. Gloves lose their protective effect easily in everyday use, where occasional undressing of the gloves is necessary.

[0003] It is known to treat the outer surface of gloves with disinfectant agents. However, some known disinfectants contain toxic chemicals or substances, such as silver, which are hazardous to health. Further, many disinfectants loosen from the glove during use and washing of the glove, whereby the disinfecting properties of the glove weaken.

[0004] An object of the invention is to provide a method for manufacturing a glove and a glove, with which drawbacks relating to the prior are can be reduced.

[0005] The object of the invention is achieved with a method and a glove which are characterized in what is disclosed in the independent patent claims. Some preferred embodiments of the invention are disclosed in the dependent claims.

Summary of the invention

[0006] The present invention relates to a method of manufacturing a glove, which glove comprises a top layer, an outer surface and an inner surface, which inner surface is configured to be in skin contact when the glove is worn in hand. Said method comprises a step of covering the outer surface at least partly with nanometric-sized material having photocatalytic properties. The photocatalytic properties of the material means, that the nanometric-sized material act as light- activated antimicrobial agent. Preferably, said method further comprises a step of covering also the inner surface at least partly with nanometric-sized material having photocatalytic properties.

[0007] In a preferred embodiment of the method according to the invention the outer surface or inner surface is at least partly covered with material comprising nanoparticles made of semiconductive material. Preferably, the nanoparticles comprise titanium dioxide $Ti0_2$, iron oxide Fe_2O_3, tungsten trioxide WO_3, zinc oxide ZnO or silicon carbide SiC.

[0008] In a second preferred embodiment of the method according to the invention solution containing nanometric-sized material having photocatalytic properties is sprayed on the outer surface and the sprayed solution is allowed to dry to a coating at least partly covering the outer surface.

[0009] In a third preferred embodiment of the method according to the invention the top layer is soaked in a solution containing nanometric-sized material having photocatalytic properties to impregnate the top layer with the solution and the soaked top layer is allowed to dry.

[0010] In yet another preferred embodiment of the method according to the invention the top layer is manufactured of fabrics or of threads which fabrics or threads are at least partly covered with nanometric-sized material having photocatalytic properties before the top layer is manufactured.

[0011] In yet another preferred embodiment of the method according to the invention the outer surface is exposed to light radiation to activate the photocatalytic properties of the nanometric-sized material. Preferably the exposure to light radiation is made during the drying phase of the glove.

[0012] A glove according to the invention comprises a top layer, an outer surface and an inner surface, which inner surface is configured to be in skin contact when the glove is worn in hand. Said outer surface is at least partially covered with nanometric-sized material having photocatalytic properties. Also, the inner surface may be at least partly covered with nanometric-sized material having photocatalytic properties.

[0013] In a preferred embodiment of the glove according to the invention the outer surface or inner surface is at least partly covered with material comprising nanoparticles made of semiconductive material. Preferably, the nanoparticles comprise titanium dioxide $Ti0_2$, iron oxide Fe_2O_3, tungsten trioxide WO_3, zinc oxide ZnO or silicon carbide SiC.

[0014] In a second preferred embodiment of the glove according to the invention the top layer is made of genuine leather.

[0015] In yet another preferred embodiment of the glove according to the invention the top layer is made of knitted or woven fabric or textile.

[0016] In yet another preferred embodiment of the glove according to the invention the top layer is made of natural or synthetic rubber, plastic, water repellent or waterproof fabric or polyurethane-coated textile.

[0017] An advantage of the invention is, that it enhances the protective effect of gloves by reducing the risk of being infected when gloves are removed and reused.

[0018] Another advantage of the invention is, that it reduces the need and use of disposable gloves, which saves material and environment.

[0019] A further advantage of the invention is, that the achieved photocatalytic antimicrobial property is long-lasting and durable.

Brief Description of Drawings

[0020] In the following the invention will be described in detail, by way of examples, with reference to the accompanying drawings in which,

Fig. 1a shows one preferred embodiment of a glove according to the invention seen obliquely from above,

Fig. 1b shows a cross-section of the embodiment of the glove depicted in fig. 1a,

Fig. 2a shows another preferred embodiment of a glove according to the invention seen obliquely from above and

Fig. 2b shows a cross-section of the embodiment of the glove depicted in fig. 2a.

Detailed Description

[0021] In figure 1a an embodiment of the glove according to the invention is shown oblique from above. In fig. 1b a cross-section the glove of fig. 1a along line A-A is depicted. In the following both figures are explained simultaneously.

[0022] The glove is a known handheld garment comprising a top layer 10, which has a shape of a hand. The top layer can be made by knitting or by sewing pieces of fabrics or leather together to a desired shape. Further, it is possible to make the top layer from castable material, such as natural or synthetic rubber or plastic by using a mould having a shape of a hand. The top layer 10 has an outer surface 12 and an inner surface 14 (fig. 1b). Here the inner surface is defined to be the surface, which is configured to be in skin contact, when the glove is worn in hand. The outer surface is the surface of the top layer, which remains visible, when a hand is inserted inside the glove.

[0023] In the method according to the invention the outer surface is at least partly covered with nanometric-sized material having photocatalytic properties. The photocatalytic properties of the material mean, that the nanometric-sized material acts as light-activated antimicrobial agent, which inactivate pathogen and infectants remaining on the outer surface of the glove. The nanometric-sized material particles, i.e. nanoparticles, adhere to outer surface forming a coating at least partly covering the outer surface. Inactivated pathogens and infectants may include bacteria, viruses and/or fungus. Inactivation here means making the pathogens harmless either by killing them or by significantly reducing their ability to reproduce on animate or inanimate surface and/or infect a human being.

[0024] The photocatalytic coating can be made by immersing, i.e. dipping the substantially ready-made glove into a solution containing a solvent and nanoparticles made of semiconductive material. Preferably, the nanoparticles comprise titanium dioxide $Ti0_2$, iron oxide Fe_2O_3, tungsten trioxide WO_3, zinc oxide ZnO or silicon carbide SiC. Preferably the solvent is a water/ethanol solution where the proportion of ethanol may be 50-99 % of the total volume of the solution. The concentration of the nanoparticles in the solution may be 10-20 g /l. The soaked glove is then lifted out of the solution and allowed to dry completely. In room temperature a drying period of 24 hours is usually sufficient. The drying period can be significantly reduced by performing the drying in an elevated temperature in an oven. In 110 °C temperature the drying period may few hours.

[0025] When the glove dries the solid particles of the solution. i.e. the nanoparticles form a network and adhere on the inner and outer surface of the top layer. If the top layer is knitted or woven fabric or textile or other fibrous, water permeable material, the particles form a covering around the fibres of the top layer. Thus, the whole top layer material becomes covered with nanoparticles. If the top layer is made of substantially waterproof material, such as genuine leather, natural or synthetic rubber, plastic, water repellent or waterproof fabric or PU-coated textile, a coating in a form of thin molecular net containing nanoparticles is formed and adhered to the inner and outer surfaces of the glove.

[0026] In a second preferred embodiment of the invention the photocatalytic coating is made by spraying a solution containing nanoparticles made of semiconductive material in a water/ethanol solvent on the outer surface 12 of the glove. The sprayed solution is allowed to dry to a coating on the outer surface. Preferably, the nanoparticles in the sprayed solution comprise titanium dioxide $Ti0_2$, iron oxide Fe_2O_3, tungsten trioxide WO_3, zinc oxide ZnO or silicon carbine SiC. A single spray treatment may comprise a number of consecutive sprayings and a drying period between each spraying. The number of sprayings in a single spray treatment may be 2 to 5, preferably 3. The drying period between each spraying may be 10 to 30 minutes. During drying periods between consecutive spraying the gloves may be placed into an oven or to another space having an elevated temperature.

[0027] After the coating containing photoactive nanoparticles is formed on to the outer surface of the glove, the outer surface is exposed to light radiation to activate the photocatalytic properties of the nanoparticles. Preferably the exposure to light radiation is done during the drying phase of the gloves. The length of the drying phase can be adjusted by regulating the intensity of the light radiation. The higher is the intensity of the light radiation, the shorter is the drying phase.

[0028] During light exposure the nanoparticles absorb energy form the radiated light creating electron-hole pairs in the nanoparticle. These activated nanoparticles can form redox reactions with the pathogens, such as bacteria, viruses and/or fungus present of the surface of the glove. The wavelength of the light used in the radiation can be chosen according to the used nanoparticle material. The light used in the radiation may be ultraviolet light or visible light. When exposed to light radiation having sufficient intensity for a sufficient length of time in the manufacturing phase of the glove the photoactive properties of the nanoparticles are activated. The light exposure can be made with high-power lamps. Once activated the photocatalytic property of the nanoparticle coating remains on the surface of the glove.

[0029] When the gloves are used in illuminated environment, the nanoparticles constantly make photocatalytic reactions with pathogens adhered to the outer surface of the glove thereby inactivating the pathogens. The nanoparticles can make photocatalytic inactivating reactions with numerous bacteria and viruses including SARS, MERS, influenza virus, H1N1 and human coronavirus. The amount of illumination needed for starting the photocatalytic reaction when the gloves are used is much lower than in the activation phase. As a rule of thumb one can say, that if there is enough light for reading, there is enough light for the photocatalytic reaction also. The illumination can be natural illumination, i.e. sunlight or artificial illumination created by lamps.

[0030] In the aforementioned embodiment of method using soaking the whole top layer 10 of the glove becomes impregnated with the solution and a coating containing photoactive nanoparticles is formed also on the inner surface 14 of the top layer 10. Since the inner surface of the glove is not exposed to the light radiation during normal use of the glove, the photocatalytic, pathogens inactivating property in the inner surface has only limited use. However, this photocatalytic property of the inner surface can be utilized to disinfect the inner surface when deeded by turning the top layer inside-out and placing the turned gloves in to an illuminated space for a period of time. This disinfection can be done for example during night, when the gloves are not used.

[0031] In figure 2a a second embodiment of the glove according to the invention is seen oblique from above. In fig. 2b a cross-section the glove of fig. 2a along line B-B is depicted. In the following both figures are explained simultaneously.

[0032] The embodiment of the glove depicted in figs. 2a and 2b differs from the embodiment of figs. 1a and 1b in that it further comprises a lining 18 inside the top layer 10.The lining and the top layer have a substantially similar shape, but the lining is slightly smaller, which makes possible to insert the lining inside the top layer. In the embodiment of figs 2a and 2b the inner surface of the glove, which is defined to be the surface, which is configured to be in skin contact, when the glove is worn in hand, is now the inner surface 14a of the lining 18. One purpose of the lining is to increase the comfort of the use of the glove. Therefore, the lining is usually made of soft knitted or woven fabric or textile. The lining is attached to the top layer 10 by joint knitting 16 locating in the edge of the wrist surrounding area of the glove.

[0033] The formation of a coating containing nanoparticles having photocatalytic properties on the outer surface of the glove shown in figs 2a and 2b can be made in a similar way as to the gloves shown in figs. 1a and 1b, i.e. by immersing the substantially ready-made glove into a solution containing nanoparticles in a water/ethanol solvent and or by spraying said solution on the outer surface 12 of the glove. In the embodiment where the glove is immersed into the solution the top layer becomes impregnated as explained above. If the top layer is made of substantially waterproof material, such as leather, natural or synthetic rubber, plastic, water repellent or waterproof fabric or PU-coated textile, a thin coating containing pathogen inactivating compounds is formed and adhered to the inner and outer surfaces of the top layer. This soaking treatment is a possible treatment method for gloves, if the material of the outer surface of the glove can withstand soaking and wetting.

[0034] If the outer surface of the glove cannot withstand soaking or wetting without harmful side-effects, such as colour chances, it is advisable to create the nanoparticle coating by spraying solution containing nanoparticles on the outer surface 12 of the glove. This method is especially suitable for gloves, in which the top layer is made of genuine or synthetic leather. In gloves, where the nanoparticles are sprayed on the outer surface of the glove, the lining of the glove can be left without nanoparticle coating.

[0035] However, in the embodiment, where the whole glove is soaked in the solution also water permeable lining material becomes impregnated with the solution and on the inner surface 14a of the lining a coating containing nanoparticles is formed. The photocatalytic property of the inner surface of the lining can be utilized to disinfect the inner surface when deeded by pulling the lining out of the top layer, turning the top layer inside-out and exposing the turned lining to a light radiation for a period of time.

[0036] It is also possible to leave the lining 18 without the coating containing nanoparticles also in the embodiment of the method using soaking. This can be done by pulling the lining out of the top layer, soaking only the top layer in the solution containing nanoparticles and returning the lining back inside the top layer, after the top layer is dry.

[0037] Above, some preferred embodiments of the invention are explained. The invention is not limited to the solutions described above, but the inventive idea can be applied in numerous ways within the scope of the claims.

Reference Signs:

[0038]

10	top layer
12	outer surface
14	inner surface
14a	inner surface of the lining
16	joint knitting
18	lining

Claims

1. A method of manufacturing a glove, which glove comprises a top layer (10), an outer surface (12) and an inner surface (14), which inner surface is configured to be in skin contact when the glove is worn in hand, **characterized in that**, said method comprises a step of covering the outer surface (12) at least partly with nanometric-sized material having photocatalytic properties.

2. A method according to claim 1, **characterized in that** said method further comprises a step of covering the inner surface (14) at least partly with nanometric-sized material having photocatalytic properties.

3. A method according to claim 1 or 2, **characterized in that** the outer surface (12) or the inner surface (14) is at least partly covered with material comprising nanoparticles made of semiconductive material.

4. A method according to claim 3, **characterized in that** the nanoparticles comprise titanium dioxide $Ti0_2$, iron oxide Fe_2O_3, tungsten trioxide WO_3, zinc oxide ZnO or silicon carbide SiC.

5. A method according to any of the claims 1 to 4, **characterized in that** a solution containing nanometric-sized material having photocatalytic properties is sprayed on the outer surface (12) and the sprayed solution is allowed to dry to a coating at least partly covering the outer surface (12).

6. A method according to claim any of the claims 1 to 4, **characterized in that** the top layer (10) is soaked in a solution containing nanometric-sized material having photocatalytic properties to impregnate the top layer (10) with the solution and soaked top layer (10) is allowed to dry.

7. A method according to claim1 to 4, **characterized in that** the top layer (10) is manufactured of fabrics or of threads which fabrics or threads are at least partly covered with nanometric-sized material having photocatalytic properties before the top layer (10) is manufactured.

8. A method according to any of the claims 1 to 7, **characterized in that** the outer surface (12) is exposed to light radiation to activate the photocatalytic properties of the nanometric-sized material.

9. A glove comprising a top layer (10), an outer surface (12) and an inner surface (14), which inner surface (14) is configured to be in skin contact when the glove is worn in hand, **characterized in that** said outer surface (12) is at least partially covered with nanometric-sized material having photocatalytic properties.

10. A glove according to claim 9, **characterized in that**, the inner surface (14) is at least partly covered with nanometric-sized material having photocatalytic properties.

11. A glove according to claim 9 or 10, **characterized in that**, the outer surface (12) or inner surface (14) is at least partly covered with material comprising nanoparticles made of semiconductive material.

12. A glove according to any of the claims 9 to 11, **characterized in that**, the nanoparticles comprise titanium dioxide $Ti0_2$, iron oxide Fe_2O_3, tungsten trioxide WO_3, zinc oxide ZnO or silicon carbide SiC.

13. The glove according to any of the claims 9 to 12, **characterized in that** the top layer (10) is made of genuine leather.

14. The glove according to any of the claims 9 to 12, **characterized in that** the top layer (10) is made of knitted or woven fabric or textile.

15. The glove according to any of the claims 9 to 12, **characterized in that** the top layer (10) is made of natural or synthetic rubber, plastic, water repellent or waterproof fabric or polyurethane-coated textile.

Amended claims in accordance with Rule 137(2) EPC.

1. A method of manufacturing a glove, which glove comprises a top layer (10), which top layer is made of genuine or synthetic leather, an outer surface (12) and an inner surface (14), which inner surface is configured to be in skin contact when the glove is worn in hand, **characterized in that**, said method comprises a step of covering the outer surface (12) at least partly with nanometric-sized material having photocatalytic properties.

2. A method according to claim 1, **characterized in that** said method further comprises a step of covering the inner surface (14) at least partly with nanometric-sized material having photocatalytic properties.

3. A method according to claim 1 or 2, **characterized in that** the outer surface (12) or the inner surface (14) is at least partly covered with material comprising nanoparticles made of semiconductive material.

4. A method according to claim 3, **characterized in that** the nanoparticles comprise titanium dioxide $Ti0_2$, iron oxide Fe_2O_3, tungsten trioxide WO_3, zinc oxide ZnO or silicon carbide SiC.

5. A method according to any of the claims 1 to 4, **characterized in that** a solution containing nanometric-sized material having photocatalytic properties is sprayed on the outer surface (12) and the sprayed solution is allowed to dry to a coating at least partly covering the outer surface (12).

6. A method according to claim any of the claims 1 to 4, **characterized in that** the top layer (10) is soaked in a solution containing nanometric-sized material having photocatalytic properties to impregnate the top layer (10) with the solution and soaked top layer (10) is allowed to dry.

7. A method according to any of the claims 1 to 6, **characterized in that** the outer surface (12) is exposed to light radiation to activate the photocatalytic properties of the nanometric-sized material.

8. A glove comprising a top layer (10), which top layer is made of genuine or synthetic leather, an outer surface (12) and an inner surface (14), which inner surface (14) is configured to be in skin contact when the glove is worn in hand, **characterized in that** said outer surface (12) is at least partially covered with nanometric-sized material having photocatalytic properties.

9. A glove according to claim 8, **characterized in that**, the inner surface (14) is at least partly covered with nanometric-sized material having photocatalytic properties.

10. A glove according to claim 8 or 9, **characterized in that**, the outer surface (12) or inner surface (14) is at least partly covered with material comprising nanoparticles made of semiconductive material.

11. A glove according to any of the claims 8 to 10, **characterized in that**, the nanoparticles comprise titanium dioxide $Ti0_2$, iron oxide Fe_2O_3, tungsten trioxide WO_3, zinc oxide ZnO or silicon carbide SiC.

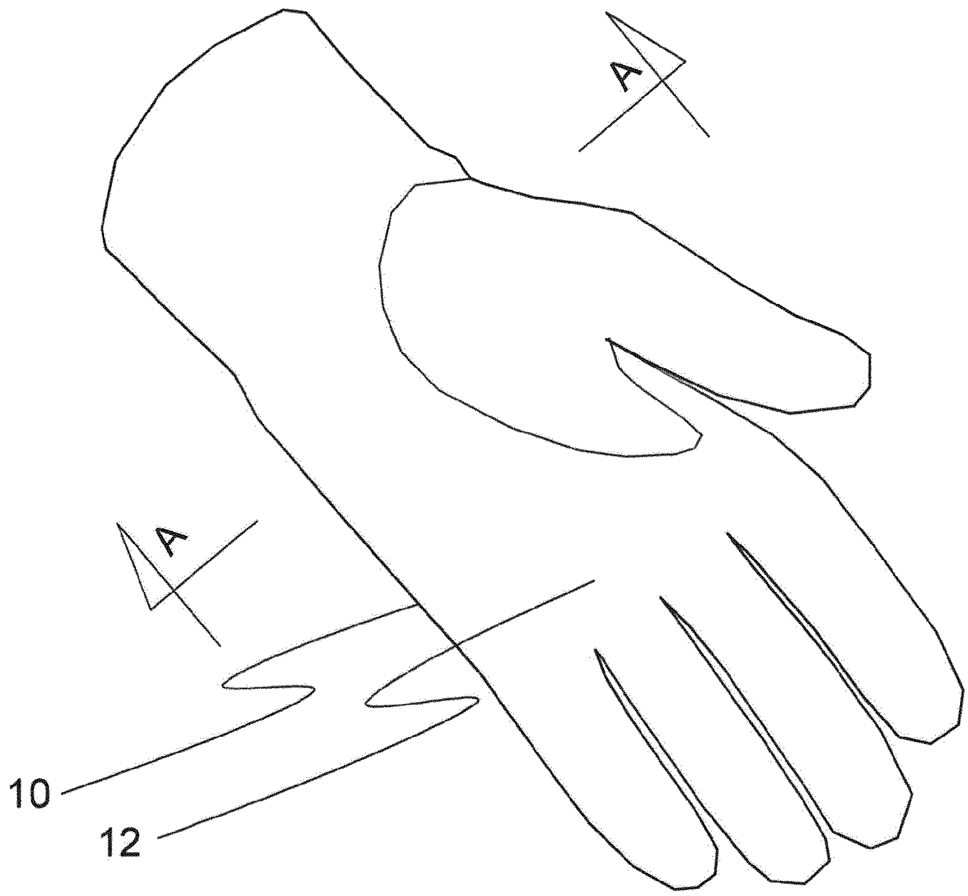

Fig. 1a

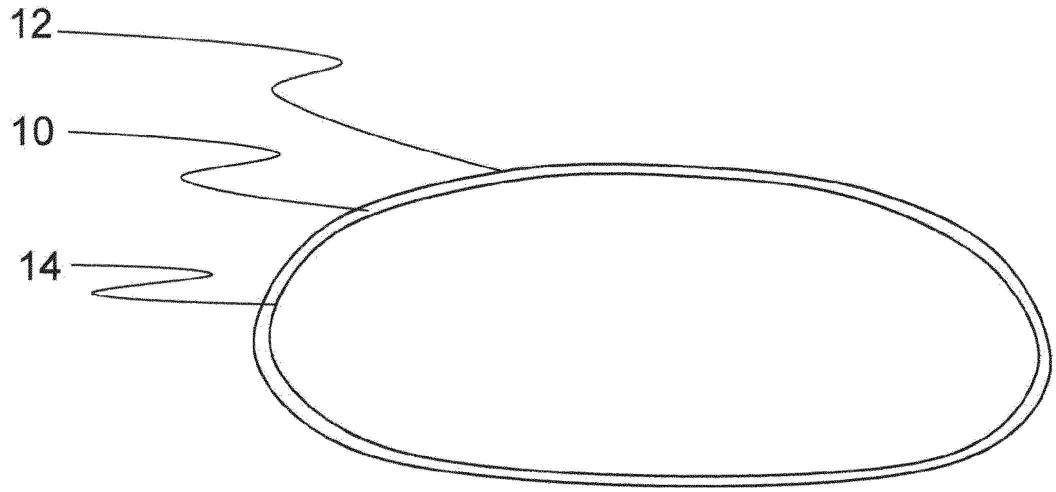

Fig. 1b

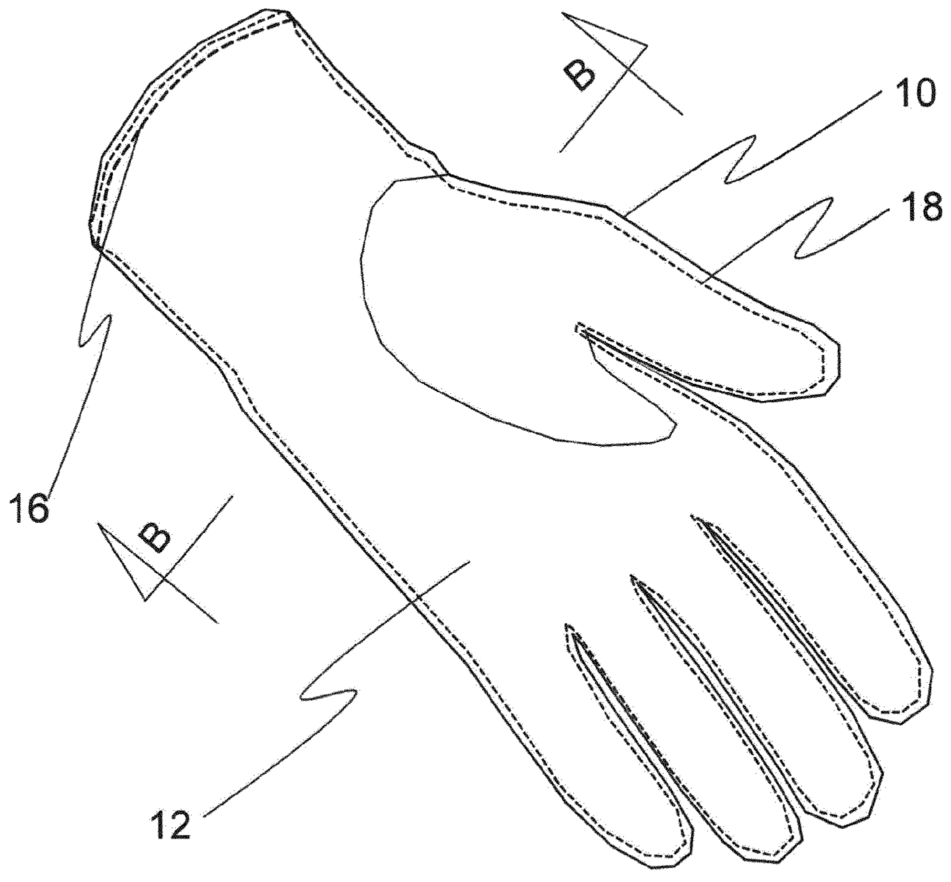

Fig. 2a

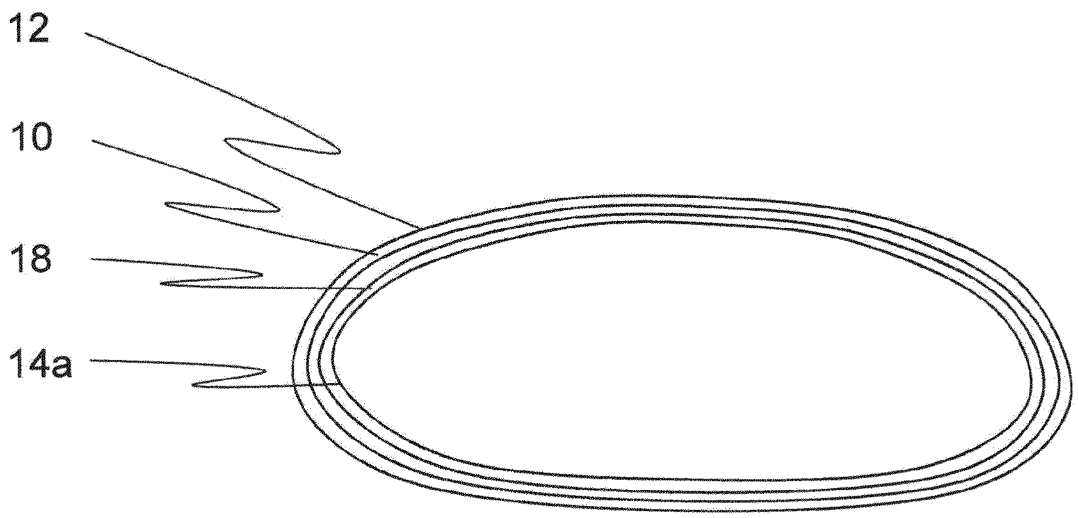

Fig. 2b

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EUROPEAN SEARCH REPORT

Application Number
EP 20 19 9187

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 03/056951 A2 (BERNARD TECHOLOGIES INC [US]; LELAH MICHAEL D [US] ET AL.) 17 July 2003 (2003-07-17) * page 1, line 4 - line 6 * * page 16, line 16 - line 18 * * page 23, line 3 - line 30 * -----	1-15	INV. A41D19/00
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TECHNICAL FIELDS SEARCHED (IPC)

A41D

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
The Hague	9 February 2021	van Voorst, Frank

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 20 19 9187

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09-02-2021

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