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

(54) **PROTECTIVE GLOVE WITH SERVICE LIFE INDICATOR LAYER**

(57) A protective glove (100, 200, 300) formed of multiple layers including a first protective layer (110, 310) having a top surface and a bottom surface, an indicator layer (115, 315, 320, 325, 330) embedded in the glove at the bottom surface of the first protective layer and formed of a material that changes color of a solution when exposed to the solution penetrating the first protective layer, wherein the change in color of the solution becomes visible from the top surface of the first protective layer, and a second protective layer (120, 310) formed such that the indicator layer is between the second protective layer and the first protective layer.

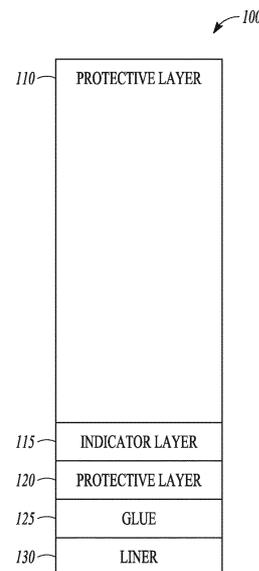


FIG. 1

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Description

Background

[0001] The protective gloves for process industries (petrochemical, chemical, food, beverage, and pharmaceutical) are constructed to assure people safety under harsh chemical, mechanical and electrical conditions. The glove suppliers provide a big product catalog, where different types of gloves are recommended for different type of chemicals to be handled. Depending on the application and chemical products to which they are exposed, the gloves may have a different type of material and a different thickness of the layers from which they are made of.

[0002] In many countries, such as European countries, the gloves have to pass mechanical (EN 388), thermal (EN511), and chemical standards, such as a European standards (EN 374-2, EN 374-3) before they are sent to the market. In addition to these standards, the gloves should comply with the standard EN 420, which specifies general criteria for comfort, size, dexterity, labeling, and heavy metal content and pH content. Each standard defines exact test and acceptance conditions for the gloves exposed to critical mechanical, thermal, chemical agents. There may be various levels of performance specified by the different standards. For instance a first level may specify the test and acceptance conditions for the least aggressive value of the externally applied agent and the highest level may be associated with the most aggressive value of the externally applied agent.

[0003] For example, the standard EN-374-2 characterizes the permeability features of the gloves and it specifies a method for testing the protective gloves resistance to permeation of chemical products (penetration). In the same idea, the standard EN374-3 includes the standard EN 374-2 requirements, and in addition, it requires that the protective glove to pass the performance level 2 of chemical resistance for at least three chemical products (like, methanol, sulfuric acid 96%, 40% sodium hydroxide, tetrahydrofuran, acetone, carbon disulfide, ethyl acetate, etc.) This performance level 2 for chemical resistance means that the permeation time (test made according to the standard) should be higher than or equal to 30 minutes, when the glove is exposed continuously to that chemical.

[0004] A catalog of gloves for chemical protection during handling of acids and alkalis, for example, would include as suitable the latex gloves which can be used in harsh applications for food and beverage industry where cleaning with high concentrated cleaning agents are the most used. Such latex gloves meet the above standard and they are also accompanied by a wide list of permeation data. Related to the protective gloves described above, we need to mention that their use in the field is made most of the time without keeping a clear evidence of the time of use during their lifetime, and so in many cases they can be used for a much shorter time with

respect to their designed lifetime. On the other hand, the suppliers themselves may be conservative in specifying the level of performance, which means that even if the real level of performance may be 4, the supplier would specify 3, which is lower than 4.

Summary

[0005] A protective glove formed of multiple layers including a first protective layer having a top surface and a bottom surface, an indicator layer embedded in the glove at the bottom surface of the first protective layer and formed of a material that changes color of a solution when exposed to the solution penetrating the first protective layer, wherein the change in color of the solution becomes visible from the top surface of the first protective layer, and a second protective layer formed such that the indicator layer is between the second protective layer and the first protective layer.

[0006] A protective glove formed of multiple layers including a first protective layer formed in the shape of a protective glove and having a top surface and a bottom surface, a bromophenol blue pH indicator layer embedded in the glove at the bottom surface of the first protective layer that changes color when exposed to a solution penetrating the first protective layer, wherein the change in color becomes visible from the top surface of the first protective latex layer, and a second protective layer formed such that the indicator layer is between the second protective layer and the first protective layer.

[0007] A method of forming a protective glove, the method including dip coating a hand shaped former into a bath to form a first protective layer having a first thickness, forming an indicator layer on the first protective layer, and dip coating the hand shaped former into a bath to form a second protective layer having a second thickness.

Brief Description of the Drawings

[0008]

FIG. 1 is a block diagram of multiple layers of a protective glove having an embedded indicator layer according to an example embodiment.

FIG. 2 is a representation of a glove illustrating indicator text appearing with a selected lifetime of the glove remaining according to an example embodiment.

FIG. 3 is a block diagram of multiple layers of a protective glove having multiple embedded indicator layers according to an example embodiment.

Detailed Description

[0009] In the following description, reference is made to the accompanying drawings that form a part hereof, and in which is shown by way of illustration specific em-

bodiments which may be practiced. These embodiments are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that structural, logical and electrical changes may be made without departing from the scope of the present invention. The following description of example embodiments is, therefore, not to be taken in a limited sense, and the scope of the present invention is defined by the appended claims.

[0010] Suppliers of protective gloves may be conservative in specifying the level of performance of the gloves that they sell. Even if the real level of performance may be 4, the supplier would specify 3, representing a shorter period of time than the actual performance of the glove prior to failure. In various embodiments, a near-end of service life indication (NESLI) is provided for a smart protective glove. The smart protective glove may indicate a remaining operation time of the glove by means of colorimetric principle based on the use of embedded pH indicators in a stack of layers forming the glove. After a certain period of time of use in harsh chemicals, the harsh chemicals will penetrate an outer protective layer of the glove and contact the pH indicators, changing the color of the pH indicator. The pH indicator diffuses back to the outer surface of the glove and result in the glove showing a color change with respect to its background color. Such an event may signify for example that the remaining lifetime left for operation is equal to about 10% of its entire life. An existing process for making gloves may be minimally adjusted to provide the colorimetric indication.

[0011] FIG. 1 illustrates layers of a glove generally at 100. A first layer 110 is a protective layer, and may be formed of latex or other protective material, like nitrile, chloroprene (e.g. Neoprene, butyl, polyvinyl chloride (PVC), PU, CSM, Fluoro elastomer (e.g. Viton). In one embodiment, the first protective layer 110 comprises about 90% of the total of two or more protective layers of the glove. A second embedded pH indicator layer 115 may be formed of Bromophenol blue in one embodiment. The second layer 115 may be thin, in the thickness range of 30-60 μm , but provide enough pH indicator material to provide color change to a visible portion of the first protective layer as the glove reaches 90% of its useful life. A third layer 120 comprises a second protective layer with thickness equal to (the remaining) 10% of the total protective layer thickness, which is then optionally followed by a fourth layer 125 which may be a glue layer, and fifth layer 130 which may be a liner. Note that the fourth and fifth layers may be optional.

[0012] In a standard process for NESLI gloves fabrication a dip coating process can be used for making the two protective layers, the color change layer and the glue layer. In order to obtain a smart NESLI protective glove with color indication when about 10% of the lifetime of the glove is left due to its previous immersion in a solution containing harsh chemicals like acid, base, solvents, the second layer is an embedded solid state layer containing

a universal pH indicator like bromophenol blue that may be included in the fabrication process of protective gloves. Bromophenol blue provides color changes over a broad range of pH, from basic to acidic. Other pH indicators may also be used in further embodiments, but may have color changes that occur when exposed to solutions over a narrow range of pH, such as only acidic or only basic solutions. When such pH indicators are used, the gloves should be labeled for use in the corresponding solutions.

[0013] In further embodiments, a direct printing process may be used for selectively printing the color change indicator layer 115. Direct printing, such as by inkjet printer allows the color changing layer to be masklessly deposited so that alphanumeric characters to be printed with a text like "10% LEFT" as indicated in FIG. 2 on a glove 200 at 210. Note that the second protective layer 120 may be thicker than that described to provide a longer service life than that specified by the characters in some embodiments. The thickness may depend on how conservative a manufacture desires to be in providing indications of remaining useful life of a glove.

[0014] To obtain a smart glove with color service life indication (SLI) at more different remaining lifetimes (75%, 50%, 25%, 10% for example) direct printing may be performed at different depths as indicated in block form in FIG. 3 at 300 (25%, 50%, 75%, 90%) as a protective layer 310 is formed. Each indicator layer represented at 315, 320, 325, 330 respectively can be patterned or shaped to display its own alphanumeric characters as indicated in FIG. 3 as (75%, 50%, 25%, 10%) "LIFETIME LEFT" corresponding to the depth in the protective layer 310 in which they are printed. The patterned indication layers in one embodiment should be non-overlapping such that as each layer becomes visible, it does not overlap and potentially be obscured by indications provided from a previously layer. Such indications may be sized and located to be easily read by the user. One location is on the glove corresponding to a back of the hand. Fingers may also be exposed to solutions longer, and may also contain indicators. In further embodiments, the last indicator layer may be a full layer that colors most of the surface of the glove indicating little life remaining.

[0015] The activation mechanism causing the indicator layer to produce a visible indication at an external surface of the glove occurs by exposure of the smart glove to vapors and liquid state of the chemicals mentioned, referred to as a solution. In the body of the protective layers of the gloves there are always nanopores which are filled with air, and these nanopores are at the origin of the liquid permeation process. This means that the liquid molecules can diffuse inside the protective layer via those pores and after a certain time they can penetrate the entire thickness of the protective layer. This time is called the breakdown time of the protective layer in a certain solution. The breakdown time of a protective layer will depend on its thickness, the magnitude of the permeating

liquid molecule and the size of the nanopores. Exposure of the glove to the solution results in nanopores filling with liquid molecules, and thus the liquid is gradually penetrating in the first protective layer. After the nanopores are filled with the solution along the entire thickness of the first protective layer, the solution from the nanopores will start to dissolve the color changing indicator layer containing bromophenol blue in one embodiment, acting as a pH indicator or dye. This dye will start diffusing back along the nanopores via concentration gradient and capillary forces, through the first protective layer to the outer surface of the glove.

[0016] When the dye arrives at the outer surface of glove through a multitude of nanopores, a change in the background color of glove will be easily visible to a user. A background color of white for the glove may provide for maximum contrast of the indication color. The color will be changed according to the overall pH of the liquid in the pores after glove exposure to both acids and bases, and solvents, i.e., the solution.

[0017] According to the color change of the bromophenol blue exposed to the solution from the nanopores, yellow color is obtained for $\text{pH} < 3$, multiple colors for pH between 3 and 4.6 (real pH indicator in this pH range) and blue color for $\text{pH} > 4.6$. For a solution having pH of between $3 < \text{pH} < 4.6$ a multitude of colors can appear depending the value of the pH in that range. For example, in a solution of pH 3.6 (near the middle of the transition range of this pH indicator) obtained by dissolution in water without any pH adjustment, bromophenol blue has a characteristic green red color. For an NESLI glove immersed in different solutions with different pH values, the pH of the final solution from pores will dictate the color appearing on the outer surface of the glove. One advantage of bromophenol blue is that it has the largest change in color hue when the concentration of the observed sample increases or decreases. The change occurs over all ranges of pH.

[0018] This concept of smart colorimetric NESLI/SLI glove can be applied to all types of chemically protective gloves.

[0019] Generic technology for the dip coating fabrication process of the protective glove consists of full immersion of a previously cleaned hand-shaped former (HSF) in multiple baths where the liquid state of the future layers are present. After each dip coating, a thermal treatment may be made for the solid state consolidation of the film. Such processes are well known for the formation of a protective layer such as a latex protective layer as described below. Similar processes may be used for formation of protective layers comprised of other materials. At the end of the process, the gloves may be peeled off from the HSF, and thus the last deposited layer on the glove will be the layer in contact with the skin. Three alternative methods for forming protective gloves are now described.

I. An example of a "standard" all-dip-coating fabrica-

tion process of a smart latex glove containing a single color change layer indicating 10% lifetime left before removal (NESLI indicator) could be as follows:

1. Dip coating of the previously cleaned hand-shape former (HSF) into the "latex" mix (containing a vulcanization system: sulfur, ZnO and accelerators) for getting a latex film of thickness equal to 90% from the total desired thickness of latex film.
2. Thermal treatment of the dip-coated HSF for obtaining a solid state of the first latex film (vulcanization at temperatures in the range 120-140°C).
3. Dip-coating of the HSF from operation 2 into a bath containing bromophenol blue slurry at the right viscosity (10-30 mPa).
4. Thermal treatment at about 120-140°C for about 8-10 min of the HSF from the operation 3.
5. Dip coating of the HSF from operation 4 into the "latex" bath for getting a latex film of thickness equal to 10% of thickness of the total desired thickness of latex film. Note that 90% and 10% are just example thicknesses. Other thicknesses may be used. For gloves intended for mildly acidic or basic solutions, 5% for the second latex layer may suffice. A higher percentage than 10% may be desired for gloves intended for harsher solutions.
6. Thermal treatment of the hand-shape former from operation 5.
7. Dip coating of the HSF from operation 6 into a glue bath.
8. Glue drying at a mild thermal treatment of the HSF from operation 7.
9. Adding the liner to the HSF from operation 8.
10. Final treatment of HSF from operation 9 for robust gluing the liner to the HSF.
11. Removing the glove from the HSF such that the liner is on an inside of the glove.

II. An example of the original hybrid fabrication process of NESLI gloves based on direct printing and dip-coating may be as follows:

1. Dip coating of the hand-shape former (HSF) into the "latex" bath for getting a latex film of thickness equal to 90% from the total desired thickness of latex film.
2. Thermal treatment of the dip-coated HSF from operation 1 for obtaining a solid state of the first latex film.
3. Direct printing on selective areas of the HSF from operation 2 of the color changing layer creating the text "10% LEFT"
4. Thermal treatment of the HSF from operation 3 which was direct printed for getting a solid color changing layer.

- 5. Dip coating of the HSF from operation 4 into the "latex" bath for getting a latex film of thickness equal to 10% of thickness of the total desired thickness of latex film.
- 6. Thermal treatment of the HSF from operation 5.
- 7. Dip coating of the HSF from operation 6 into the glue bath.
- 8. Glue drying at a mild thermal treatment of the HSF from operation 7.
- 9. Adding the liner to the HSF from operation 8.
- 10. Final treatment of HSF from operation 9 for robust gluing the liner to the HSF.

III. Finally, an example of original all-printed NESLI glove can be also envisioned, where all the dip-coating processes from above were replaced by direct printing.

[0020] The fabrication process of the smart gloves with multiple colorimetric service life indicators SLI (75%, 50%, 25%, 10%) may be made utilizing a hybrid or printed technologies from above. The process for getting these multiple service life indications derives from the examples from above. The multiple service life indications may avoid overlapping such that indications showing a longer service life remaining do not obscure indications of less service life remaining. Note that the last indicator layer may be dip coated causing the entire glove to change color with a selected percentage of the protective life of the glove remaining.

[0021] An example of process for making the viscous bromophenol blue slurry that can be used for dip coating or inkjet printing can be as shown below:

- 1. Dissolve the bromophenol blue powder in a mixture of water and small amount of alcohol.
- 2. Add surfactants like dimethyl sulfonamide, dimethylsulfoxide, polyhydric alcohol.
- 3. Add viscosity intensifying agent resin (for example: shellac, guaiac gum methyl cellulose and ethyl cellulose). The viscosity of the final solution may be in the range 10-30 mPa, while the final thickness may be in the range 30-60 μm.
- 4. Obtain a homogeneous and viscous solution of the color changing agent based on bromophenol blue.

[0022] An automated factory for fabrication of printed NESLI/SLI protective gloves may involve moving the HSF on a line from one location to another for receiving the right process. The same or separate dip coating vats of latex may be utilized.

Examples:

[0023]

- 1. A protective glove formed of multiple layers com-

prising:

- a first protective layer having a top surface and a bottom surface;
- an indicator layer embedded in the glove at the bottom surface of the first protective layer and formed of a material that changes color of a solution when exposed to the solution penetrating the first protective layer, wherein the change in color of the solution becomes visible from the top surface of the first protective layer; and
- a second protective layer formed such that the indicator layer is between the second protective layer and the first protective layer.

2. The protective glove of example 1 wherein the first protective layer provides approximately 90% of the protective life of the glove.

3. The protective glove of any of examples 1-2 wherein the indicator layer is patterned in a shape indicating the percentage of a protective lifetime of the glove remaining.

4. The protective glove of any of examples 1-3 wherein the indicator layer comprises a pH indicator generating a color corresponding to a pH of the solution.

5. The protective glove of example 4 wherein the pH indicator comprises bromophenol blue.

6. The protective glove of any of examples 1-5 wherein the protective layers comprise natural or synthetic lattices.

7. The protective glove of any of examples 1-6 wherein the indicator layer is a continuous layer.

8. The protective glove of any of examples 1-7 and further comprising multiple patterned indicator layers embedded at different depths of the first protective layer, the patterned indicator layers patterned to provide an indication at the top surface of the first protective layer representative of the remaining useful life of the protective glove.

9. The protective glove of any of examples 1-8 wherein the first protective layer comprises latex and the indicator layer comprises bromophenol blue.

10. A protective glove formed of multiple layers comprising:

- a first protective layer formed in the shape of a protective glove and having a top surface and a bottom surface;

- a bromophenol blue pH indicator layer embedded in the glove at the bottom surface of the first protective layer that changes color when exposed to a solution penetrating the first protective layer, wherein the change in color becomes visible from the top surface of the first protective latex layer; and

- a second protective layer formed such that the indicator layer is between the second protective

layer and the first protective layer.

11. The protective glove of example 10 wherein the first protective layer provides approximately 90% of the protective life of the glove.

12. The protective glove of any of examples 10-11 wherein the indicator layer is patterned in a shape indicating the percentage of a protective lifetime of the glove remaining.

13. The protective glove of any of examples 10-12 and further comprising multiple patterned indicator layers embedded at different depths of the first protective layer, the patterned indicator layers patterned to provide an indication at the top surface of the first protective layer representative of the remaining useful life of the protective glove.

14. A method of forming a protective glove, the method comprising:

dip coating a hand shaped former into a bath to form a first protective layer having a first thickness;

forming an indicator layer on the first protective layer; and

dip coating the hand shaped former into a bath to form a second protective layer having a second thickness.

15. The method of example 14 wherein forming an indicator layer on the first protective layer comprises dip coating the hand shaped former having the first protective layer into a bath containing a bromophenol blue slurry to form the indicator layer comprising bromophenol blue.

16. The method of example 15 wherein the bromophenol blue slurry comprises bromophenol blue powder, alcohol, a surfactant, and a viscosity intensifying agent resin.

17. The method of any of examples 14-16 wherein forming an indicator layer on the first protective layer comprises printing the indicator layer in a pattern.

18. The method of example 17 wherein the pattern comprises text indicating a remaining protective lifetime of the protective glove.

19. The method of any of examples 17-18 wherein the text comprises a percentage proportional to the thickness of the second protective layer relative to the thickness of the first protective layer.

20. The method of any of examples 14-19 and further comprising:

dip coating the hand shaped former with the second protective layer into a glue bath to form a layer of glue; and

adding a liner to the layer of glue.

[0024] Although a few embodiments have been described in detail above, other modifications are possible.

For example, the logic flows depicted in the figures do not require the particular order shown, or sequential order, to achieve desirable results. Other steps may be provided, or steps may be eliminated, from the described flows, and other components may be added to, or removed from, the described systems. Other embodiments may be within the scope of the following claims.

10 Claims

1. A protective glove (100, 200, 300) formed of multiple layers comprising:

a first protective layer (110, 310) having a top surface and a bottom surface;

an indicator layer (115, 315, 320, 325, 330) embedded in the glove at the bottom surface of the first protective layer (110, 310) and formed of a material that changes color of a solution when exposed to the solution penetrating the first protective layer (110, 310), wherein the change in color of the solution becomes visible from the top surface of the first protective layer (110, 310); and

a second protective layer (120, 310) formed such that the indicator layer (115, 315, 320, 325, 330) is between the second protective layer (120, 310) and the first protective layer (110, 310).

2. The protective glove (100, 200, 300) of claim 1 wherein the first protective layer (110, 310) provides approximately 90% of the protective life of the glove.

3. The protective glove (100, 200, 300) of claim 1 wherein the indicator layer (115, 315, 320, 325, 330) is patterned in a shape indicating the percentage of a protective lifetime of the glove remaining.

4. The protective glove (100, 200, 300) of claim 1 wherein the indicator layer (115, 315, 320, 325, 330) comprises a pH indicator generating a color corresponding to a pH of the solution.

5. The protective glove (100, 200, 300) of claim 4 wherein the pH indicator comprises bromophenol blue.

6. The protective glove (100, 200, 300) of claim 1 wherein the protective layers (110, 310, 120) comprise natural or synthetic lattices.

7. The protective glove (100, 200, 300) of claim 1 wherein the indicator layer (115, 315, 320, 325, 330) is a continuous layer.

8. The protective glove (100, 200, 300) of claim 1 and

further comprising multiple patterned indicator layers (315, 320, 325, 330) embedded at different depths of the first protective layer (110, 310), the patterned indicator layers patterned to provide an indication at the top surface of the first protective layer (110, 310) representative of the remaining useful life of the protective glove.

9. The protective glove (100, 200, 300) of claim 1 wherein the first protective layer (110, 310) comprises latex and the indicator layer (115, 315, 320, 325, 330) comprises bromophenol blue.

10. A method of forming a protective glove (100, 200, 300), the method comprising:

dip coating a hand shaped former into a bath to form a first protective layer (110, 310) having a first thickness;

forming an indicator layer (115, 315, 320, 325, 330) on the first protective layer (110, 310); and dip coating the hand shaped former into a bath to form a second protective layer (120, 310) having a second thickness.

11. The method of claim 10 wherein forming an indicator layer (115, 315, 320, 325, 330) on the first protective layer (110, 310) comprises dip coating the hand shaped former having the first protective layer into a bath containing a bromophenol blue slurry to form the indicator layer (115, 315, 320, 325, 330) comprising bromophenol blue.

12. The method of claim 11 wherein the bromophenol blue slurry comprises bromophenol blue powder, alcohol, a surfactant, and a viscosity intensifying agent resin.

13. The method of any one of claims 10-12 wherein forming an indicator layer (115, 315, 320, 325, 330) on the first protective layer (110, 310) comprises printing the indicator layer (115, 315, 320, 325, 330) in a pattern.

14. The method of claim 13 wherein the pattern comprises text (315, 320, 325, 330) indicating a remaining protective lifetime of the protective glove.

15. The method of any one of claims 10-12 and further comprising:

dip coating the hand shaped former with the second protective layer (120, 310) into a glue bath to form a layer of glue (125); and adding a liner (130) to the layer of glue (125).

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

1. A protective glove (100, 200, 300) formed of multiple layers to protect a wearer against harsh chemicals, the protective glove comprising:

a first protective layer (110, 310) having a top surface and a bottom surface and having nanopores;

an indicator layer (115, 315, 320, 325, 330) embedded in the glove at the bottom surface of the first protective layer (110, 310) and formed of an indicator material that changes color of a harsh chemical solution when exposed to the harsh chemical solution penetrating through the nanopores of the first protective layer (110, 310), wherein the nanopores in the first protective layer and the indicator material are adapted to allow the change in color of the harsh chemical solution to become visible from the top surface of the first protective layer (110, 310) by the diffusion of the indicator material through the nanopores to the top surface of the first protective layers; and

a second protective layer (120, 310) formed such that the indicator layer (115, 315, 320, 325, 330) is between the second protective layer (120, 310) and the first protective layer (110, 310).

2. The protective glove (100, 200, 300) of claim 1, wherein the first protective layer (110, 310) provides approximately 90% of the total of the first and second protective layers of the glove.

3. The protective glove (100, 200, 300) of claim 1, wherein the indicator layer (115, 315, 320, 325, 330) comprises a pH indicator generating a color corresponding to a pH of the solution.

4. The protective glove (100, 200, 300) of claim 3, wherein the pH indicator comprises bromophenol blue.

5. The protective glove (100, 200, 300) of claim 1, wherein the protective layers (110, 310, 120) comprise natural or synthetic lattices.

6. The protective glove (100, 200, 300) of claim 1, wherein the indicator layer (115, 315, 320, 325, 330) is a continuous layer.

7. The protective glove (100, 200, 300) of claim 1, and further comprising multiple patterned indicator layers (315, 320, 325, 330) embedded at different depths of the first protective layer (110, 310).

8. The protective glove (100, 200, 300) of claim 1, wherein the first protective layer (110, 310) comprises latex and the indicator layer (115, 315, 320, 325, 330) comprises bromophenol blue. 5
9. A method of forming the protective glove (100, 200, 300) of claim 1, the method comprising:
- dip coating a hand shaped former into a bath to form the first protective layer (110, 310) having a first thickness; 10
- forming the indicator layer (115, 315, 320, 325, 330) on the first protective layer (110, 310); and 15
- dip coating the hand shaped former into a bath to form the second protective layer (120, 310) having a second thickness.
10. The method of claim 9, wherein forming the indicator layer (115, 315, 320, 325, 330) on the first protective layer (110, 310) comprises dip coating the hand shaped former having the first protective layer into a bath containing a bromophenol blue slurry to form the indicator layer (115, 315, 320, 325, 330) comprising bromophenol blue. 20
- 25
11. The method of claim 10, wherein the bromophenol blue slurry comprises bromophenol blue powder, alcohol, a surfactant, and a viscosity intensifying agent resin. 30
12. The method of any one of claims 9-11 wherein forming the indicator layer (115, 315, 320, 325, 330) on the first protective layer (110, 310) comprises printing the indicator layer (115, 315, 320, 325, 330) in a pattern. 35
13. The method of any one of claims 9-12 and further comprising:
- dip coating the hand shaped former with the second protective layer (120, 310) into a glue bath to form a layer of glue (125); and 40
- adding a liner (130) to the layer of glue (125). 45

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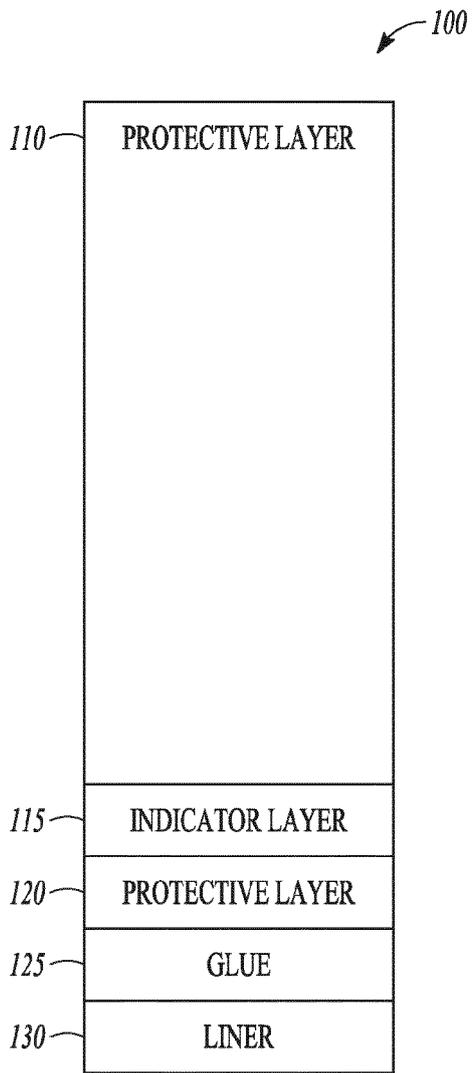


FIG. 1

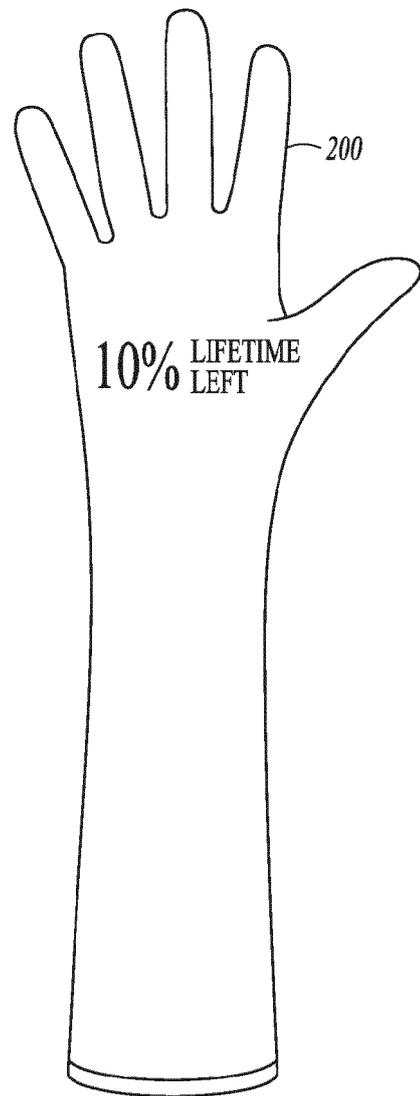


FIG. 2

300 →

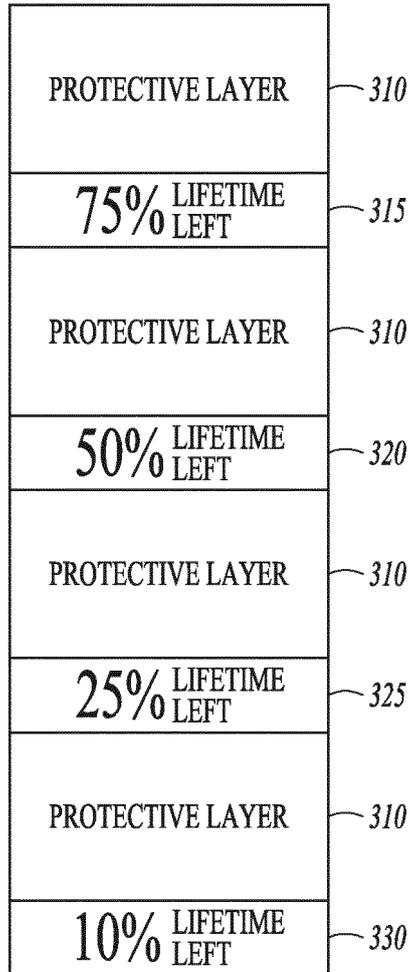


FIG. 3



EUROPEAN SEARCH REPORT

Application Number
EP 15 19 3529

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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	US 5 133 087 A (MACHIDA MORIHISA [JP] ET AL) 28 July 1992 (1992-07-28) * the whole document *	1-15	INV. A41D19/00
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