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(54) Abstract Title: **Polymeric garment materials**

(57) Polymeric garment material is made by applying coagulant (34) to a substrate (32) which may be present on a mould (30), applying a foam (38) of a polymeric material to the substrate, allowing the coagulant to coagulate some of the foam and removing uncoagulated foam from the substrate to leave a layer of coagulated polymeric material on the substrate. The uncoagulated foam may be removed by spraying liquid such as water or directing a jet of gas such as air onto the substrate. After removing uncoagulated foam the substrate may be immersed in water to remove coagulant. The polymeric material may be one or more of nitrile latex, natural latex, polyurethane latex, polyvinyl chloride latex, neoprene and polyvinylacetate. The coagulant may be an aqueous or alcoholic solution of an electrolyte such as formic acid, acetic acid, calcium nitrate and calcium chloride. The garment may be a coat, an apron, a boot, a shoe, a sock, an item of underwear, a glove or a corset. The garment material allows perspiration to escape and reduces heat build up. It may have a water vapour permeability of 3.5 to 6.5 mg.cm⁻².h⁻¹ and when subjected to a temperature of 20 ± 2°C and a relative humidity of 65 ± 2% for 265 minutes holds between 1.0 and 8.5 mg of water per cm².

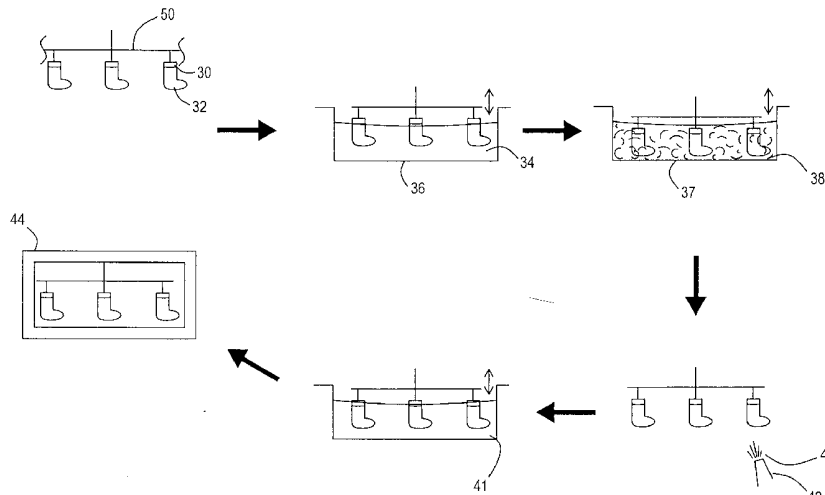


Fig. 4

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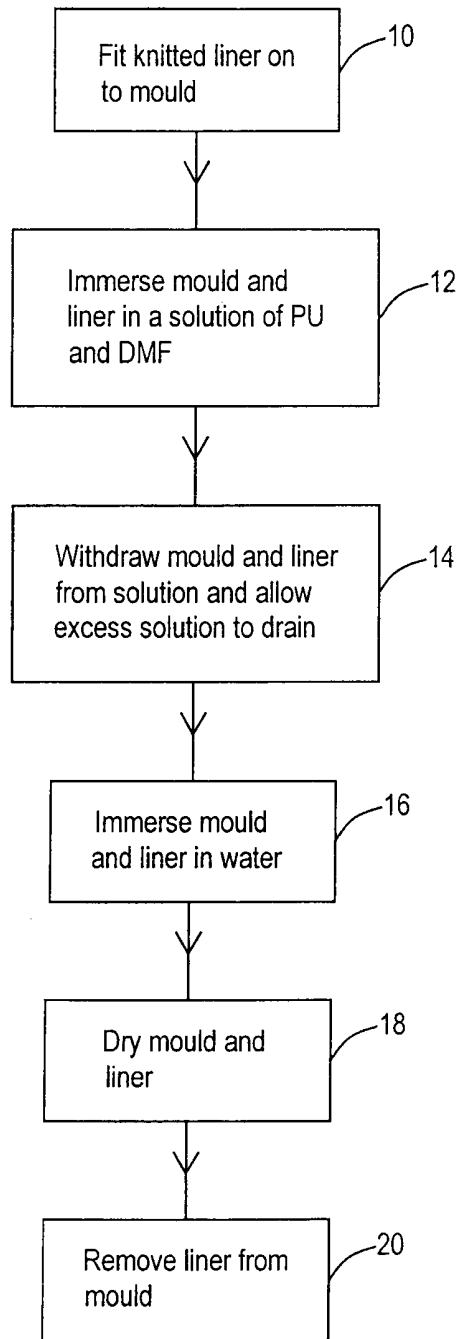


Fig.1

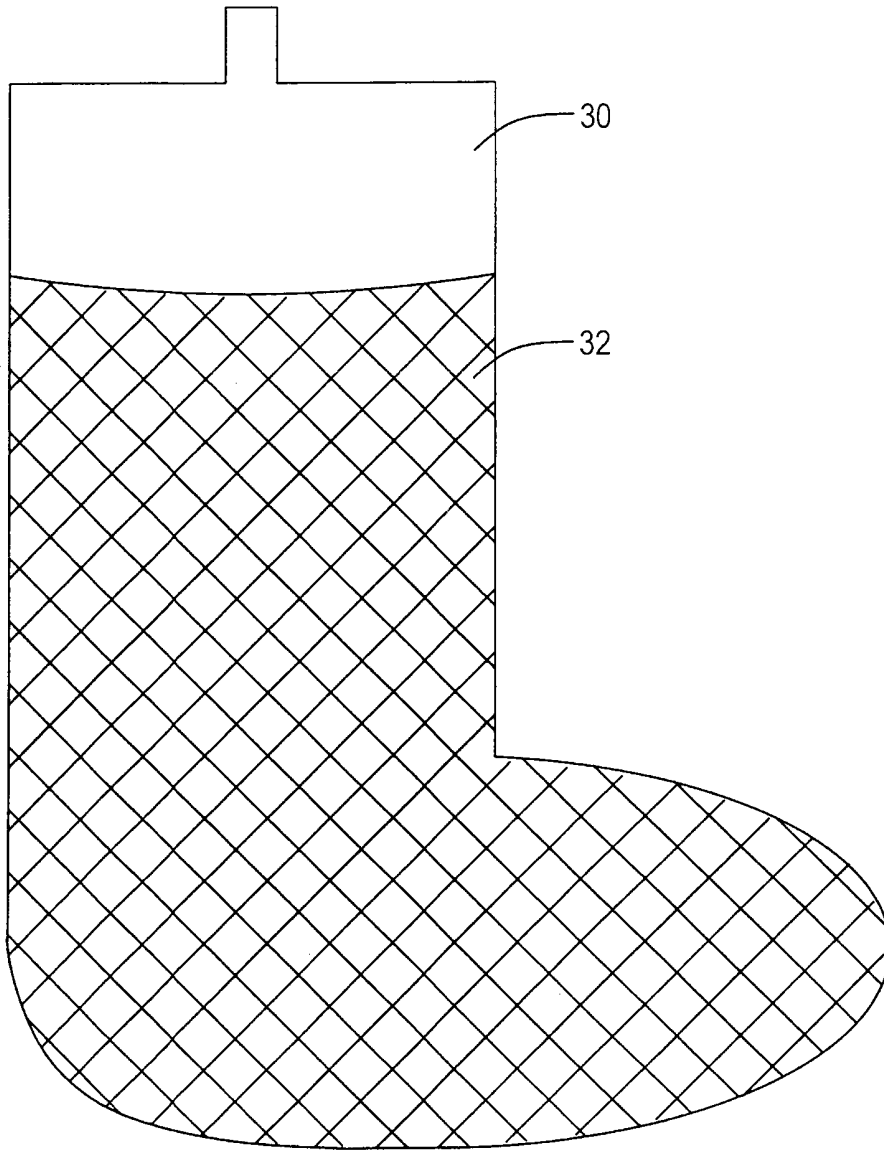


Fig. 2

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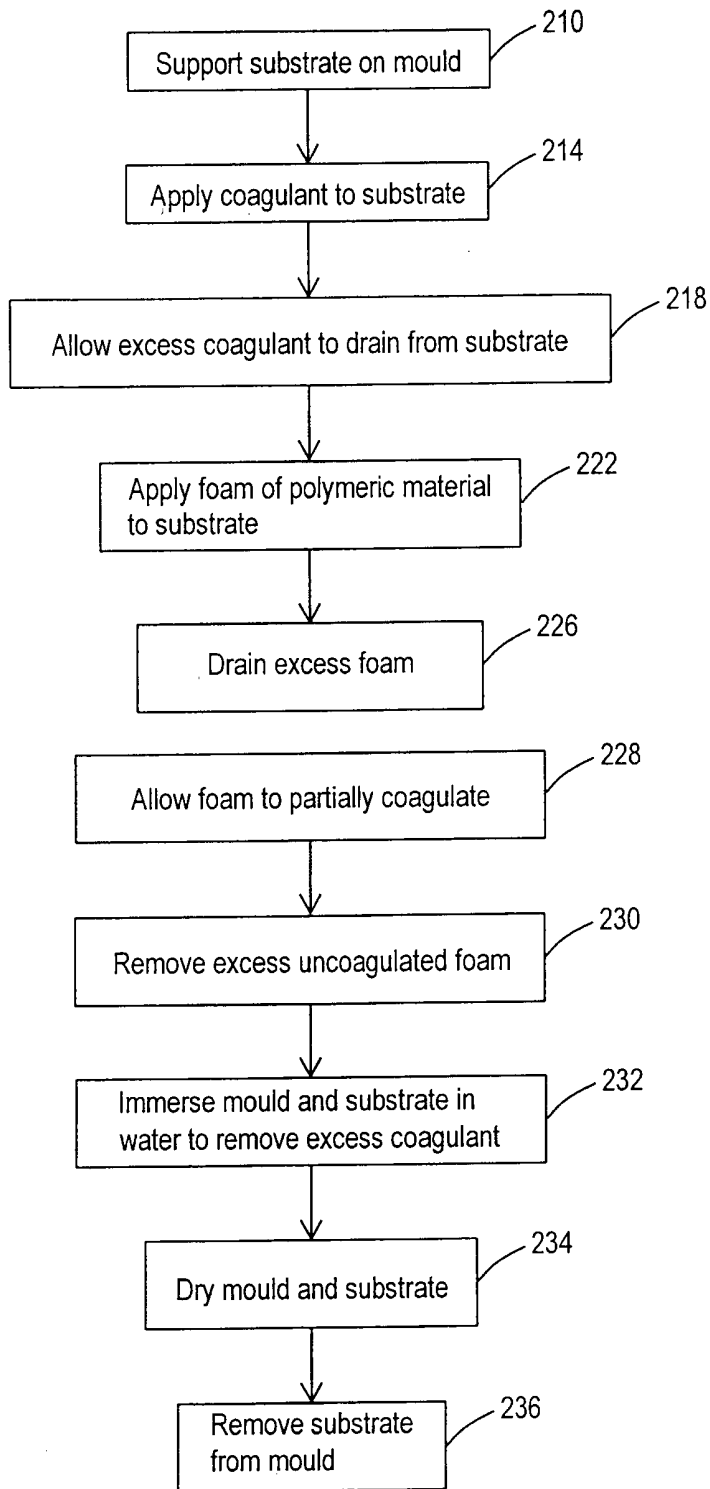


Fig.3

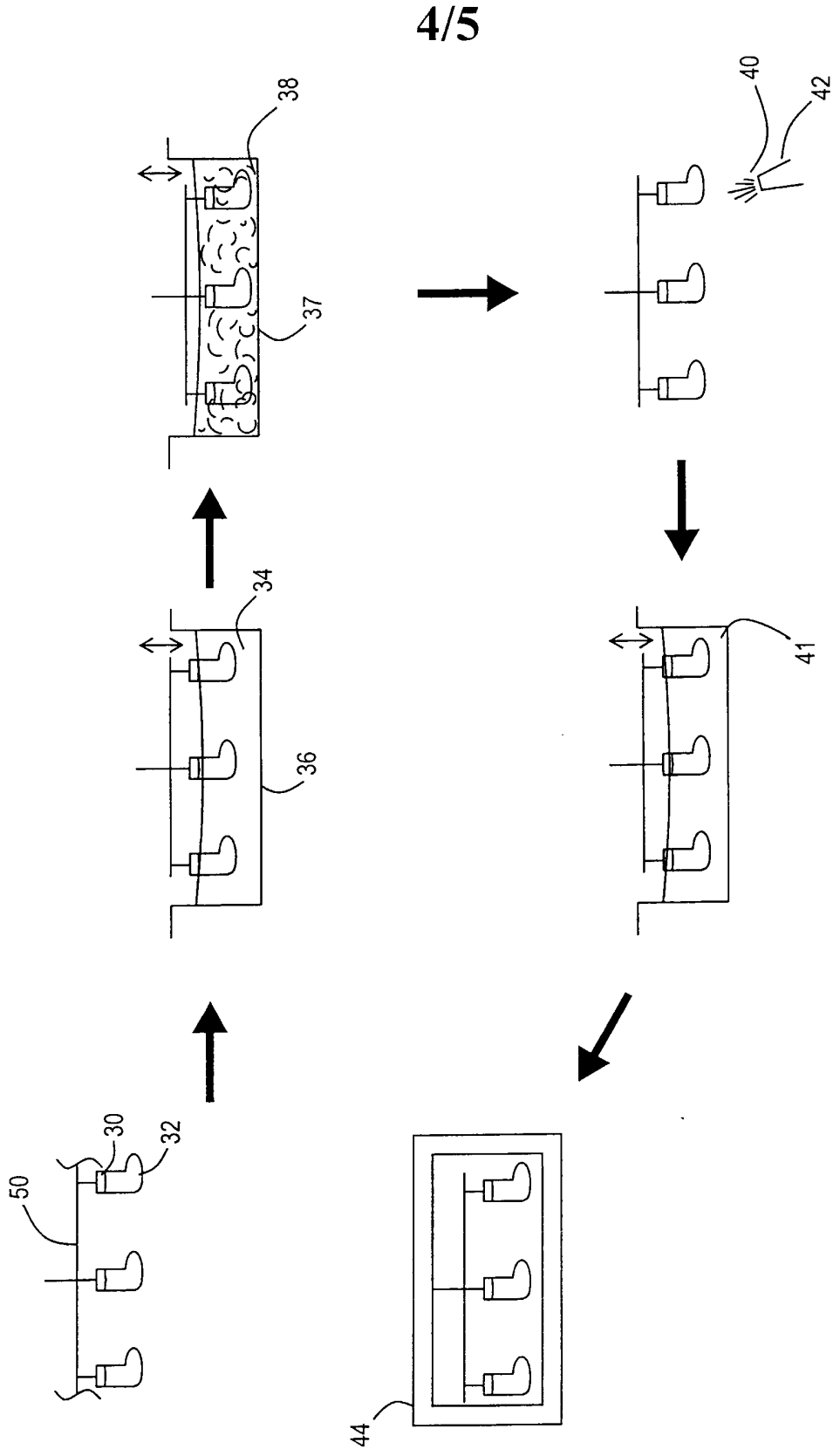


Fig. 4

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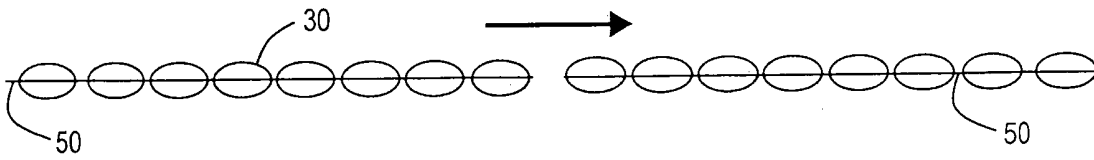


Fig. 5

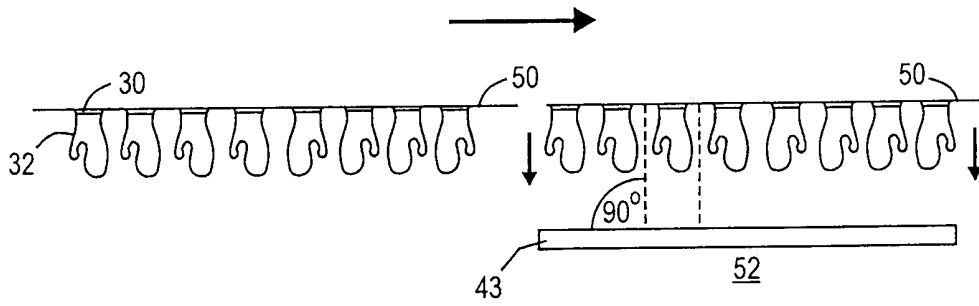


Fig. 6

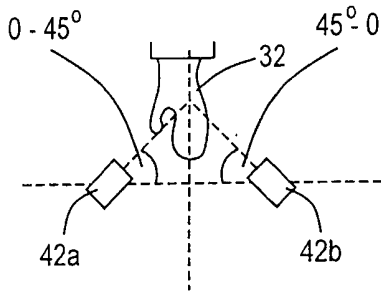


Fig. 7

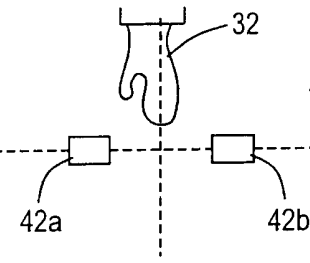


Fig. 8

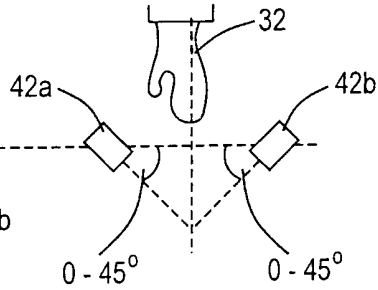


Fig. 9

POLYMERIC GARMENT MATERIAL

This invention relates to polymeric garment material, garments and methods of making polymeric garment material.

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Polymeric materials are currently used for a wide range of garments, some of these garments (for example, raincoats and aprons) make use of the protective properties of the material, other garments (for example, footwear, underwear and fashion garments) use polymeric materials because of appearance and/or feel of the material.

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Figure 1 illustrates the steps of a known method of producing a knitted nylon garment that has a polyurethane (PU) coating. At step 10 a knitted nylon lining is fitted on to a mould. The nylon lining acts as a substrate to which the PU coating is applied. Figure 2 illustrates a sock lining fitted to a mould 30 that supports the lining 32 so that the lining 32 takes the desired shape for the finished garment. In the case illustrated the garment is a sock, however, the method is applicable to other garments. At step 12 the mould 30 (fitted with the sock lining 32) is immersed into a solution of PU and dimethylformamide (DMF). At step 14 the mould 30 is withdrawn from the solution of PU and DMF and excess solution is allowed to drain leaving a coating of the PU/DMF solution on the lining 32. At step 16 the mould is immersed in water. The immersion causes the PU coating on the lining 32 to coagulate, that is the PU coating sets. The mould 30 remains in the water for a period of 90 to 120 minutes so that the DMF solvent is leached out of the lining into the water. At step 18 the mould is removed from the water and placed in an oven to dry the PU coated nylon liner. Finally at step 20 the PU coated nylon liner is removed from the mould 30 and a PU coated nylon sock is obtained.

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A major disadvantage with this process is that it uses DMF. DMF is a solvent that is known to be very toxic, and one that is easily absorbed through the skin. Therefore great care has to be taken when handling the solution of PU/DMF. In order that a safe working environment is provided the atmosphere in which the process is carried out needs to be well ventilated and provided with extraction fans.

At step 16, when the DMF is leached into water, the water will become saturated with DMF. Therefore, the water will need to be repeatedly changed - this is both time consuming and expensive. Additionally, since the DMF saturated water solution is toxic, care must be taken when disposing of the DMF saturated water so as to minimise environmental damage that may occur from the disposal. There is also a health hazard to the wearer of a garment made by this process since not all the DMF may have been removed during the leaching step 16. The health hazard is increased if the garment is to be worn next to the skin.

A further disadvantage of the process is that the PU coating penetrates the interstices of the nylon liner. Therefore, the PU coating will come into contact with the skin of a wearer of a garment made by this process if such a garment is worn next to the skin. This can cause irritation and build up of perspiration next to the skin, and, in particular, some wearers may be allergic to PU.

According to a first aspect of the invention there is provided a method of making garment material, the method having the steps: applying coagulant to a substrate; applying a foam of the polymeric material to the substrate; allowing the coagulant to coagulate some of the foam; and removing uncoagulated foam from the substrate to leave a layer of coagulated polymeric material on the substrate.

The use of foamed (aerated) polymeric material removes the need for the polymeric material to be dissolved in DMF or, indeed, any other solvent. Therefore, the method is less hazardous and more environmentally friendly. The garment material produced by the method will not contain
5 potentially harmful traces of solvent.

A wide range of polymeric materials are suitable for production of the foam, these include nitrile latex, natural latex, polyvinylchloride (PVC), polyvinylacetate (PVA) neoprene (polychloroprene) and rubber as well as
10 PU latex. The foam may be produced from a mixture of two or more of these polymeric materials. Hence, the method provided by the invention is more widely applicable than the known method (illustrated in Figure 1), which is restricted to the use of PU.

15 The substrate may be, for example, knitted nylon but a wide range of materials may be used as the substrate, for example, the substrate may be one of, or a blend of two or more of: cotton, spandex, lycra, polyester, aramid, dyneema, acrylic, carbon conductive fibre, copper conductive fibre, thunderon conductive fibre, multifilament yarn spun from liquid
20 crystal polymer (available under the brand name Vectran™), tactel, CoolMax™, ThermaStat™ and Thermax™.

Preferably, the step of removing the uncoagulated foam comprises directing a fluid at the substrate. For example a spray of liquid such as
25 water may be directed at the substrate.

Surprisingly, this method of removing the excess, uncoagulated foam leaves behind a cohesive, porous and breathable layer of polymeric material on the substrate. A garment made from the garment material
30 produced in this way allows perspiration to escape from wearer of the garment and reduces heat build up within the garment.

The garment material is more flexible and lightweight and garments made from the garment material are more comfortable to wear than garments produced by the prior art method illustrated in Figure 1.

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The penetration of the foam into the substrate may be controlled so that the foam does not fully penetrate the substrate. In this way, the garment material produced has an inner surface that does not have exposed polymeric material. This is advantageous since many people have an allergic reaction to polymeric materials (especially latex) worn next to the skin and the non penetrated portion of the substrate forms a barrier between the wearer of the garment and the coating of the polymeric material.

10 According to a second aspect of the invention there is provided garment material produced by the method of the first aspect of the invention.

According to a third aspect of the invention there is provided a garment produced by the method of the first aspect of the invention.

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According to a fourth aspect of the invention there is provided a garment or garment material having a substrate and a layer of coagulated polymeric material penetrating at least partially the substrate, the garment or garment material having a water vapour permeability in the range 3.5 to 6.5 mg.cm⁻².h⁻¹.

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According to a fifth aspect of the invention there is provided a garment or garment material having a substrate and a layer of coagulated polymeric material penetrating the substrate, wherein the polymeric material does not fully penetrate the substrate.

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According to a sixth aspect of the invention there is provided a garment or garment material having a substrate and a layer of coagulated polymeric material penetrating at least partially the substrate, wherein the garment or garment material has a water vapour permeability in the range
5 3.5 to 6.5 mg.cm⁻².h⁻¹.

Preferably the garment or garment material has a water vapour permeability in the range 5.0 to 6.5 mg.cm⁻².h⁻¹.

10 According to a seventh aspect of the invention there is provided a garment or garment material which, when subjected to a temperature of 20 ± 2 °C and a relative humidity of 65 ± 2% for 265 minutes, will hold between 1.0 mg and 8.5 mg of water per cm² of the garment or garment material.

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Preferably the garment or garment material, when subjected to a temperature of 20 ± 2 °C and a relative humidity of 65 ± 2% for 265 minutes, will hold between 1.0 mg and 5.5 mg of water per cm² of the garment or garment material.

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Preferred embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

25 **Figure 1** schematically illustrates a prior art method of making polyurethane coated garments;

Figure 2 schematically illustrates a substrate that has been placed on a mould;

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Figure 3 schematically illustrates a method of making garment material according to an embodiment of the invention;

Figure 4 schematically illustrates a system for making garment material
5 according to an embodiment of the invention;

Figure 5 schematically illustrates a plan view of a flight bar to which several moulds are mounted;

10 **Figure 6** schematically illustrates a side view of the flight bar of Figure 5, the flight bar being translated into a spraying station;

Figure 7 schematically illustrates a side view of a garment substrate in a section of the spraying station of Figure 7 in which nozzles are pointing
15 upwards;

Figure 8 schematically illustrates a side view of a garment substrate in a section of the spraying station of Figure 7, in which nozzles are pointing horizontally; and

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Figure 9 schematically illustrates a side view of a garment substrate in a section of the spraying station of Figure 7, in which nozzles are pointing downwards.

25 Referring to Figures 3 and 4, to make a garment according to an embodiment of the invention, at step 210 a lining or substrate 32 is fitted to a mould 30. The mould 30 supports the substrate 32 during the various process steps that are applied to the substrate 32 to produce the garment material. After the garment material has been made it is removed from
30 the mould 30.

The substrate 32 may take the form of a complete garment, for example, a sock (as is illustrated in Figure 2) or in a form that is a section of a garment, for example a pocket for a coat. In such cases the mould 32 provides the correct shape for the finished garment or garment section.

5 When the mould takes the shape of a finished garment it is preferable that the substrate 32 fitted on to the mould 30 is seamless so that the finished garment is also seamless. Alternatively, the mould 32 need not take any particular form and sheets of garment material are formed by the process. For example, the substrate may be stretched out between two clamps or

10 rollers, and for the purpose of this specification the term "mould" covers arrangements of clamps, rollers and the like that support the substrate 32 by applying tension to the substrate 32. In this case, garment or garment sections are produced by further processing of the sheets of garment material for example by pieces being cut from the sheet of garment

15 material and then the pieces being used to make a garment.

The mould 30 may be made from, for example, metal, porcelain, fibreglass or plastic.

20 Suitable materials for the substrate 32 include one of, or a blend of two or more of: nylon, cotton, spandex, lycra, polyester, aramid, dyneema, acrylic, carbon conductive fibre, copper conductive fibre, thunderon conductive fibre, multifilament yarn spun from liquid crystal polymer (available under the brand name Vectran™), tactel, CoolMax™,

25 ThermaStat™ and Thermax™. The substrate 32 has a lattice structure and may be formed by knitting, weaving or some other known process.

The process may be applied to batches of substrates ('batch-processing) such that the process steps are applied to a group of moulds 30, each

30 mould 30 supporting a substrate 32. Alternatively, the process may be applied continuously such that the moulds 30 are continuously translated

through the system 100. Of course, the moulds 30 may be continuously translated through some parts of the system 100 and stationary for periods of time at other parts of the system 100 according to what particular process step is occurring at those positions. Referring to Figure 5, the moulds 30, bearing the substrates 32 are mounted in a row on a bar 50, termed a "flight bar". In the example illustrated, four pairs of moulds 30 (bearing four pairs of gloves respectively) are mounted on a flight bar 50. The flight bar 50 moves in a linear direction from one process station to another at a set speed. There may be several flight bars 50, each flight bar 50 being at a different stage of the process, and the movement of a flight bar 50 from one station to the next is at set intervals.

At step 214 coagulant 34 is applied to the substrate 32. This may be achieved by immersing the substrate 32 (supported on the mould 30) into a bath or trough 36 containing the coagulant 34 or by spraying the coagulant 34 onto the substrate 32. The coagulant 34 is an aqueous or alcoholic solution of electrolytes. Suitable electrolytes include formic acid, acetic acid, calcium nitrate, calcium chloride or a mixture of two or more of these. Ethanol may be used to provide the alcoholic solution of electrolytes but other alcohols are also suitable, for example, iso-propyl alcohol and methanol may also be used.

At step 218 excess coagulant 34, i.e. coagulant that is not absorbed by the substrate 32 is allowed to drain from the substrate 32. If the coagulant 34 was applied by immersion in a bath/trough 36 of coagulant 34 then step 218 involves withdrawal of the mould 30 from the bath/trough 36.

At step 222 a foam 38 of polymeric material is applied to the substrate 32, for example by immersing the mould 30 supporting the substrate 32 into a bath/trough 37 of the foam 38. The production of a foam 38 of polymeric material is well known to a skilled person. The foam 38 may

be formed from one of, or combination of, several polymeric materials. Suitable polymeric materials include PU latex, nitrile latex, natural latex, polyvinylchloride (PVC), polyvinylacetate (PVA), neoprene (polychloroprene) and rubber. The foam 38 has a density in the range 15-5 35%, i.e. there is 15-35 % air by volume in the foam and a viscosity in the range 80-180 poise (8-18 Ns/m²). The foam 38 contains thickeners so that the foam 38 is of the required viscosity. The thickeners are usually added to the polymeric material when the polymeric material is in liquid form, i.e. before it is aerated. Examples of thickeners include polyvinyl 10 alcohol (0.2 - 0.6 parts per 100 parts polymeric material by volume) methyl cellulose (0.2 - 0.8 parts per 100 parts polymeric material by volume) and polyacrylate (0.2 - 0.6 parts per 100 parts polymeric material by volume). The foam also contains stabilisers so that the foam 38 is stable (i.e. does not degrade to a liquid) and curatives that provide 15 the polymeric coating obtained from the foam with mechanical strength so that the coating is resistant to, for example, abrasion, punctures and tearing. The stabilisers and curatives are usually added to the polymeric material when the polymeric material is in liquid form. Examples of 20 stabilisers include diphenyl guanidine alcohol (with a concentration of about 0.5 parts per 100 parts polymeric material by volume) and alkali casein (0.3 - 0.8 parts per 100 parts polymeric material by volume). Although the thickeners, stabilisers and curatives are normally added to the liquid polymeric material before it is aerated, they can also be added after aeration, for example if modification of the foam properties is 25 required (for example by adding more thickener to increase the viscosity of the foam).

At step 226 the substrate 32 is removed from the foam 38 and excess foam is allowed to drain from the substrate 32 to leave a layer of foam 38 30 on the substrate 32. The foam is arranged, as described in more detail below, not to pass through the substrate 32, but to remain on the outer

surface or pass part way through the substrate. The foam therefore forms a layer on the outside of the substrate 32.

At step 228 the foam 38 reacts with the coagulant 34 that has been
5 absorbed by the substrate 32 causing coagulation of the foam 38.

Only partial coagulation of the foam 38 is required, therefore, the foam 38 is allowed to react with the coagulant 34 for a limited period of time. After this period of time the coagulant closest to the substrate 32 will be
10 coagulated but the degree of coagulation progressively decreases with distance from the substrate 32 so that the outer surface of the foam will not be coagulated (i.e., the outer surface will be wet). Typically the foam 38 is allowed to react with the coagulant 34 for a period in the range of 60-180 seconds before the excess (uncoagulated) foam 38 is removed.
15 This period is controlled so that the underside of the foam layer that is in contact with the substrate 32 coagulates, but the outer part of the foam layer does not coagulate. Therefore, a film skin is not formed on the outer surface of the foam layer. The foam layer has a thickness in the range 0.5 - 1.5 mm.

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At step 230 the outer layer of excess, uncoagulated foam 38 is removed from substantially the whole area of the foam layer on the substrate 32. This may be done by directing one or more sprays of water 40 at the substrate 32. The water is directed at the substrate 32 via one or more
25 nozzles 42. Each spray of water 40 has a pressure in the range 1 - 4 bar ($1 \times 10^5 - 4 \times 10^5 \text{ N/m}^2$). The spraying process lasts for about 5 - 20 seconds.

The nozzles 42 may be stationary with a set orientation relative to the
30 substrate 32. Alternatively, the nozzles 42 may be moveable so that the orientation of the nozzle 42 relative to the substrate 32 can be varied

during the spraying process. The nozzles 42 may also be translatable relative to substrate 32 during the spraying process to provide good coverage of the substrate 32 with the spray 40. It is also possible to use a continuous jet instead of a spray, however, a spray is preferred since this
5 makes more economical use of water.

Referring to Figures 6 to 9, according to an embodiment of the invention the moulds 30, bearing the substrates 32, are translated on a flight bar 50 to a spraying station 52. Figures 6 to 9 illustrate the substrate 32 in the
10 form of a glove lining with the fingers of the glove lining pointing downwards (of course the invention is applicable to sock linings and other garment substrates). The spraying station 52 comprises a number of spray nozzles 42. The nozzles form two rows 43 that are orientated so that the nozzles of one row sprays the front of the substrate 32 (e.g. the palm side
15 of the glove linings 32) whilst the nozzles of the other row spray the back of the substrate 32 (e.g. the backhand side of the glove linings 32). The nozzles 42 are in a fixed position with a pre-set spraying angle and the nozzles 42 do not move during the spraying process. The spraying angle of each nozzle 42 is in the range 0 to 45° to the horizontal (the horizontal
20 being the normal to the surface of the substrate 32) and the spraying angle may be adjusted before the spraying process. The nozzles 42 may be arranged as pairs with a nozzle 42a on one row facing a nozzle 42b of the other row. The nozzles 42a, 42b may be set at different angles: for example the pair of nozzles 42a, 42b may point upwards at about 45° to
25 the horizontal as illustrated in Figure 7; the nozzles 42a, 42b may point horizontally as illustrated in Figure 8; or the nozzles 42a, 42b may point downwards at 45° to the horizontal illustrated in Figure 9. It is not necessary for the nozzles 42a, 42b in each pair to be orientated at the same angle to the horizontal.

As water is pumped through the nozzles 42 the flight bar 50 is translated vertically through the spray produced by the nozzles 42. For example, the moulds 30 are first moved downwardly through the sprays and then upwardly through the spray as the moulds are moved through the spraying station on the flight bar 50.

Other fluids could be used to remove the foam 38, for example a jet of compressed air could be directed at the substrate 32. The foam 38 could also be removed by immersing the substrate 32 in a bath/trough of an aqueous medium. The aqueous medium may comprise an anti-foam agent such as an emulsion of organo-modified polysiloxanes in the concentration range 0.01 - 0.1% by volume or a blend of petroleum and amorphous silica in the concentration range 0.2 - 0.8% by volume.

The removal of the excess foam 38, by directing fluid at the substrate 32, leaves behind a cohesive, porous and breathable layer of polymeric material on the substrate 32. At this stage of the process the layer of polymeric material has a thickness in the range 0.34 - 1.0 mm.

At step 232 excess coagulant 34 is removed from the substrate 32. This may be done by immersing the substrate 32 into a bath/trough of water 41; typically the immersion is for a period of about 15 minutes.

At step 234 the substrate 32 with its layer of polymeric material is dried. The drying may be done in an oven 44 which may be fitted with one or more fans that distribute the heat evenly throughout the oven 44. The drying could also be achieved by directing air over the substrate 32. The air may be dried and/or heated before it is directed over the substrate 32.

After being dried, the layer of polymeric material has a thickness in the range 0.26 - 0.80 mm.

At step 236, the garment material, comprising the substrate 32 with the polymeric coating, is removed from the mould 30.

- 5 The garment material produced by the above process has a uniform porosity.

The penetration of the foam 38 into the substrate 32 can be controlled so that the foam does not fully penetrate the substrate 32. In this way, the garment material produced has an inner surface that no, or very little, 10 exposed polymeric material. This is advantageous since many people are have an allergic reaction to polymeric materials (especially latex) worn next to the skin and the non penetrated portion of the substrate 32 would form a barrier between the wearer of the garment and the coating of the 15 polymeric material.

The penetration of the foam into the substrate (and the porosity of the finished garment material) can be controlled by varying a number of parameters including:

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- i. the formulation of the polymeric material;
- ii. the formulation of the coagulant;
- iii. the time between applying the coagulant and applying the foam;
- iv. the time between applying the foam and removing excess 25 (uncoagulated) foam;
- v. foam density;
- vi. foam viscosity; and
- vii. the weight and construction of the substrate.

30 The parameter values disclosed in the description provide fabric material that has the desired properties, however, the skilled person may achieve

the advantages of the invention using a method having parameters that vary from those given.

The garment material produced by the invention is particularly suitable
5 for gloves, for example gardening gloves and gloves used for light
assembly (for example the assembly of electronic components). Such
gloves (particularly gloves for light assembly) need to provide the wearer
with a high degree of dexterity and, when the gloves are worn for a long
period of time, the hands need to be kept cool, dry and comfortable.
10 Gloves made by the process of the invention allow perspiration to escape
from the glove/be absorbed by the glove and the hands of the wearer are
not irritated by the glove (either by heat build up, sweat, solvent residue
or polymeric material present on the lining of the glove). The increased
flexibility of the polymeric coating, compared to the coatings of prior art
15 garment material, allows for better dexterity and usability of the gloves.

Gloves made according to the invention were tested for water vapour
permeability and absorption of water. The tests were performed on
samples taken from four different gloves at a temperature of 20 ± 2 °C
20 and a relative humidity of $65 \pm 2\%$. The thickness of all these samples was
1.08mm. The results of these tests are given in table 1.

For comparison, samples from four prior art gloves were also tested
under the same conditions. The prior art gloves were made by using a
25 solution of polyurethane (PU) dissolved in DMF according to the method
illustrated in Figure 1. The thickness of each of these samples was 1.03
mm with an area of 18 cm². The results for these tests are given in Table
2.

30 The water vapour permeability figures are given in units of milligrams of
water that pass through a square centimetre of the sample in one hour

($\text{mg}\cdot\text{cm}^{-2}\cdot\text{h}^{-1}$). The absorption figures are given in milligrams of water absorbed by the whole sample as measured, with equivalents per square centimetre of the samples in brackets, after set periods of time at a temperature of 20 ± 2 °C and a relative humidity of $65 \pm 2\%$.

5

Table 1 Test results for samples taken from gloves according to an embodiment of the invention

	Sample 1	Sample 2	Sample 3	Sample 4
Permeability ($\text{mg}\cdot\text{cm}^{-2}\cdot\text{h}^{-1}$)	5.77	3.94	6.16	5.38
Absorption (mg.) after 265 minutes	45 (2.5 cm^{-2})	111 (6.2 cm^{-2})	32 (1.8 cm^{-2})	67 (3.7 cm^{-2})
Absorption (mg.) after 400 minutes	44 (2.4 cm^{-2})	143 (7.9 cm^{-2})	28 (1.6 cm^{-2})	69 (3.8 cm^{-2})

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Table 2 Test results for samples taken from prior art gloves made using a solution of PU in DMF

	Sample 1	Sample 2	Sample 3	Sample 4
Permeability ($\text{mg}\cdot\text{cm}^{-2}\cdot\text{h}^{-1}$)	10.47	10.39	10.47	10.33
Absorption (mg.) after 265 minutes	1 (0.06 cm^{-2})	2 (0.11 cm^{-2})	3 (0.17 cm^{-2})	1 (0.06 cm^{-2})
Absorption (mg.) after 400 minutes	3 (0.17 cm^{-2})	1 (0.06 cm^{-2})	2 (0.11 cm^{-2})	0 (0 cm^{-2})

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The average permeability of the samples taken from the gloves according to embodiment of the invention was $5.3 \text{ mg.cm}^{-2}.\text{h}^{-1}$ whereas for the samples taken from the prior art gloves the average permeability was $10.4 \text{ mg.cm}^{-2}.\text{h}^{-1}$.

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The tests were performed by an independent test organisation (SATRA Technology Centre, Kettering, Northamptonshire, UK). This organisation uses the following classification for water vapour permeability:

- | | | |
|----|------------------------|--|
| 10 | Very High permeability | - over $5.0 \text{ mg.cm}^{-2}.\text{h}^{-1}$ |
| | High permeability | - between 2.6 and $5.0 \text{ mg.cm}^{-2}.\text{h}^{-1}$ |
| | Moderate permeability | - between 1.0 and $2.5 \text{ mg.cm}^{-2}.\text{h}^{-1}$ |
| | Low permeability | - under $1.0 \text{ mg.cm}^{-2}.\text{h}^{-1}$ |

- 15 Therefore, both sets of samples can be considered to have very high permeability (with the exception of sample 2 of Table 1). It can be seen that the permeability of the prior art gloves is much higher than the gloves made according to the method of this invention. However, when the gloves of the current invention are worn there is significantly less
- 20 build of perspiration than when the prior art gloves are worn. This can be explained by considering the absorption figures: the gloves embodying the invention absorb far more water than the prior art gloves. Therefore, for the gloves embodying the invention, when worn, some of the perspiration is taken from the hand of the wearer and held in the glove and some of
- 25 the perspiration permeates (i.e. escapes from) the glove, hence there is less perspiration build on the inner surface of the glove. It is believed that the gloves embodying the invention absorb more water because the polymer layer has larger interstitial spaces compared to the prior art due
- 30 to the method of manufacture of the gloves (i.e., the method of the invention uses foamed polymer which is then washed off, for example with a water spray, before fully coagulating, whereas, for the prior art

method the glove liner/substrate is dipped in a solution of polymer and then immersed in water to coagulate the polymer solution). The interstitial spaces give the gloves a 'wicking action', that is water is pulled into the gloves by capillary action.

CLAIMS

1. A method of making garment material, the method having the steps:
applying coagulant to a substrate;
5 applying a foam of a polymeric material to the substrate;
allowing for the coagulant to coagulate some of the foam; and
removing uncoagulated foam from the substrate to leave a layer of
coagulated polymeric material on the substrate.
- 10 2. The method according to claim 1, wherein the step of removing
uncoagulated foam comprises removing an outer layer of the foam to
leave an inner layer of coagulated polymeric material on the substrate.
3. The method according to claim 2, wherein the outer layer is removed
15 before a skin has formed on the outer surface of the foam layer.
4. The method of any one of claims 1 to 3, wherein the step of removing
the uncoagulated foam comprises directing a fluid at the substrate.
- 20 5. The method of claim 4, wherein the fluid is a liquid.
6. The method of claim 5, wherein the liquid comprises water.
7. The method of claim 5 or 6, wherein liquid is directed as a spray.
25
8. The method of claim 7, wherein the spray has a pressure in the range 1
to 10 bar.
9. The method of claim 8, wherein the spray has a pressure in the range 1
30 to 4 bar.

10. The method of claim 4, wherein the fluid is a gas.

11. The method of claim 10, wherein the gas is at least predominantly air.

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12. The method of claim 10 or 11, wherein gas is directed as a jet.

13. The method of claim 12, wherein the jet has a pressure in the range 1 to 10 bar.

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14. The method of claim 13, wherein the jet has a pressure in the range 1 to 4 bar.

15. The method of any one of claims 4 to 14 wherein the fluid is directed at angle in the range 0° to 45° to the normal to the surface of the substrate.

16. The method of claim 1, wherein the step of removing uncoagulated foam from the substrate comprises immersing the substrate in liquid.

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17. The method of claim 16 wherein the liquid comprises water.

18. The method of any previous claim wherein the substrate comprises knitted nylon.

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19. The method of any previous claim comprising the step of immersing the substrate in water to remove coagulant after the step of removing the uncoagulated foam from the substrate.

30 20. The method of claim 19 comprising the step of drying the substrate after the step of immersing the substrate in water.

21. The method of claim 20 wherein the drying comprising placing the substrate in an oven.
- 5 22. The method of any previous claim, wherein the step of allowing the coagulant to coagulate some of the foam lasts for a period in the range 60 to 180 seconds.
23. The method of any previous claim, wherein the coagulant is an
10 aqueous solution of one or more electrolytes.
24. The method of any one of claims 1 to 22, wherein the coagulant is an alcoholic solution of one or more electrolytes.
- 15 25. The method of claim 23 or 24, wherein the one or more electrolytes comprise one or more of the following substances: formic acid, acetic acid, calcium nitrate and calcium chloride.
26. The method of any previous claim, wherein the polymeric material
20 comprises one of: nitrile latex, natural latex, polyurethane latex, polyvinyl chloride latex, neoprene and polyvinylacetate.
27. The method of claim 26, wherein the polymeric material comprises a
blend of two or more of: nitrile latex, natural latex, polyurethane latex,
25 polyvinylchloride latex, neoprene and polyvinylacetate.
28. The method of any previous claim, wherein the substrate is placed on a mould before the coagulant is applied to the substrate.
- 30 29. The method of claim 28 wherein the mould is composed of one or more of the following materials: metal, ceramic, fibre glass and plastic.

30. The method of claim 28 or 29, wherein the mould takes the form a portion of a garment.
- 5 31. The method of claim 28 or 29, wherein the mould takes the form of a complete garment.
32. The method of any previous claim, wherein the garment is a garment chosen from one of the following: a coat, an apron, a boot, a shoe, a
10 sock, an item of underwear, a glove, and a corset.
33. A garment material produced by the method of any preceding claim.
34. The garment material of claim 33 having a water vapour permeability
15 in the range 3.5 to 6.5 mg.cm⁻².h⁻¹.
35. The garment material of claim 33 or claim 34, when subjected to a temperature of 20 ± 2 °C and a relative humidity of 65 ± 2% for 265 minutes, holding between 1.0 mg and 8.5 mg of water per cm² of the
20 garment material.
36. A garment produced by the method of any one of claims 1 to 32.
37. The garment of claim 36 having a water vapour permeability in the
25 range 3.5 to 6.5 mg.cm⁻².h⁻¹.
38. The garment of claim 36 or claim 37, when subjected to a temperature of 20 ± 2 °C and a relative humidity of 65 ± 2% for 265 minutes, holding between 1.0 mg and 8.5 mg of water per cm² of the
30 garment.

39. The garment of any one of claims 36 or 38, wherein the garment is a glove.

40. A garment or garment material having a substrate and a layer of
5 coagulated polymeric material penetrating at least partially the substrate, wherein the garment or garment material has a water vapour permeability in the range 3.5 to $6.5 \text{ mg.cm}^{-2}.\text{h}^{-1}$.

41. The garment or garment material of claim 40, when subjected to a
10 temperature of $20 \pm 2 \text{ }^\circ\text{C}$ and a relative humidity of $65 \pm 2\%$ for 265 minutes, holding between 1.0 mg and 8.5 mg of water per cm^2 of the garment or garment material

42. A garment or garment material having a substrate and a layer of
15 coagulated polymeric material penetrating the substrate, wherein the polymeric material does not fully penetrate the substrate.

43. The garment or garment material of any one of claims 40 to 42, wherein the garment is a glove.

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44. Apparatus for producing garment material comprising a mould arranged to support a substrate, foam application means arranged to apply foam of a polymeric material to the substrate, and foam removing means arranged to remove uncoagulated foam from the substrate to leave a layer
25 of coagulated polymeric material on the substrate.

45. A method as hereinbefore described with reference to Figures 3 and 4.

30 46. An apparatus as hereinbefore described with reference to Figure 4.

47. A garment as manufactured according to the method as hereinbefore described with reference to Figures 3 and 4.

Amendments to the claims have been filed as follows**CLAIMS**

1. A method of making a garment or garment material, the method having the steps:
 - 5 applying coagulant to a substrate; then
 applying a foam of a polymeric material to the substrate;
 allowing for the coagulant to coagulate some of the foam; and
 removing uncoagulated foam from the substrate to leave a layer of
 coagulated polymeric material on the substrate.
- 10 2. The method according to claim 1, wherein the step of removing uncoagulated foam comprises removing an outer layer of the foam to leave an inner layer of coagulated polymeric material on the substrate.
- 15 3. The method according to claim 2, wherein the outer layer is removed before a skin has formed on the outer surface of the foam layer.
4. The method of any one of claims 1 to 3, wherein the step of removing the uncoagulated foam comprises directing a fluid at the substrate.
- 20 5. The method of claim 4, wherein the fluid is a liquid.
6. The method of claim 5, wherein the liquid comprises water.
- 25 7. The method of claim 5 or 6, wherein liquid is directed as a spray.
8. The method of claim 7, wherein the spray has a pressure in the range 1 to 10 bar.
- 30 9. The method of claim 8, wherein the spray has a pressure in the range 1 to 4 bar.

10. The method of claim 4, wherein the fluid is a gas.
11. The method of claim 10, wherein the gas is at least predominantly
5 air.
12. The method of claim 10 or 11, wherein gas is directed as a jet.
13. The method of claim 12, wherein the jet has a pressure in the range 1
10 to 10 bar.
14. The method of claim 13, wherein the jet has a pressure in the range 1
to 4 bar.
- 15 15. The method of any one of claims 4 to 14 wherein the fluid is directed
at angle in the range 0° to 45° to the normal to the surface of the
substrate.
16. The method of claim 1, wherein the step of removing uncoagulated
20 foam from the substrate comprises immersing the substrate in liquid.
17. The method of claim 16 wherein the liquid comprises water.
18. The method of any previous claim wherein the substrate comprises
25 knitted nylon.
19. The method of any previous claim comprising the step of immersing
the substrate in water to remove coagulant after the step of removing the
uncoagulated foam from the substrate.

20. The method of claim 19 comprising the step of drying the substrate after the step of immersing the substrate in water.
- 5 21. The method of claim 20 wherein the drying comprising placing the substrate in an oven.
22. The method of any previous claim, wherein the step of allowing the coagulant to coagulate some of the foam lasts for a period in the range 60 to 180 seconds.
- 10 23. The method of any previous claim, wherein the coagulant is an aqueous solution of one or more electrolytes.
24. The method of any one of claims 1 to 22, wherein the coagulant is an alcoholic solution of one or more electrolytes.
- 15 25. The method of claim 23 or 24, wherein the one or more electrolytes comprise one or more of the following substances: formic acid, acetic acid, calcium nitrate and calcium chloride.
- 20 26. The method of any previous claim, wherein the polymeric material comprises one of: nitrile latex, natural latex, polyurethane latex, polyvinyl chloride latex, neoprene and polyvinylacetate.
- 25 27. The method of claim 26, wherein the polymeric material comprises a blend of two or more of: nitrile latex, natural latex, polyurethane latex, polyvinylchloride latex, neoprene and polyvinylacetate.
- 30 28. The method of any previous claim, wherein the substrate is placed on a mould before the coagulant is applied to the substrate.

29. The method of claim 28 wherein the mould is composed of one or more of the following materials: metal, ceramic, fibre glass and plastic.

5 30. The method of claim 28 or 29, wherein the mould takes the form of a portion of a garment.

31. The method of claim 28 or 29, wherein the mould takes the form of a complete garment.

10 32. The method of any previous claim, wherein the garment is a garment chosen from one of the following: a coat, an apron, an item of footwear, a sock, an item of underwear, a glove, and a corset.

15 33. A garment material produced by the method of any preceding claim.

34. The garment material of claim 33 having a water vapour permeability in the range 3.5 to 6.5 mg.cm².h⁻¹.

20 35. The garment material of claim 33 or claim 34, when subjected to a temperature of 20 ± 2 °C and a relative humidity of 65 ± 2% for 265 minutes, holding between 1.0 mg and 8.5 mg of water per cm² of the garment material.

25 36. A garment produced by the method of any one of claims 1 to 32.

37. The garment of claim 36 having a water vapour permeability in the range 3.5 to 6.5 mg.cm².h⁻¹.

30 38. The garment of claim 36 or claim 37, when subjected to a temperature of 20 ± 2 °C and a relative humidity of 65 ± 2% for 265

minutes, holding between 1.0 mg and 8.5 mg of water per cm² of the garment.

39. The garment of any one of claims 36 or 38, wherein the garment is a
5 glove.

40. Apparatus for producing garment material comprising a mould
arranged to support a substrate to which coagulant has been applied, foam
application means arranged to apply foam of a polymeric material to the
10 substrate, and foam removing means arranged to remove uncoagulated
foam from the substrate to leave a layer of coagulated polymeric material
on the substrate.

41. Apparatus according to claim 40 further comprising coagulant
15 application means for applying the coagulant to the substrate.

42. A method as hereinbefore described with reference to Figures 3 and
4.

20 43. An apparatus as hereinbefore described with reference to Figure 4.

44. A garment as manufactured according to the method as hereinbefore
described with reference to Figures 3 and 4.



Application No: GB0407210.4
Claims searched: 42 and 43 in part

Examiner: Dr Richard Gregson
Date of search: 12 August 2004

Patents Act 1977
Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	42	US 3846156 A (SEIBERT) - see abstract and example 2 in particular
X	42	US6599849 A (VOGT et al.) - see abstract and column 4, lines 38-54

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^w :

B2E

Worldwide search of patent documents classified in the following areas of the IPC⁰⁷

A41D; B32B; D06N

The following online and other databases have been used in the preparation of this search report

EPODOC, WPI, JAPIO



INVESTOR IN PEOPLE

Application No: GB0407210.4
Claims searched: 40,41 and 43 in part

Examiner: Dr Richard Gregson
Date of search: 12 August 2004

Patents Act 1977 Further Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
X	40 and 43	US 3665157 A (HARADA) - see abstract, column 3, lines 33-40 and examples in particular.
X	40 at least	US 3846156 A (SIEBERT) - see abstract and examples 2 and 3 in particular.
X	40 at least	US 4743470 A (NACHTKAMP et al) - see abstract and example 5g in particular.
X	40 at least	US 4707400 A (TOWERY) - see abstract and example 2 in particular
A	n/a	US 4059659 A (HILTERHAUS) - see abstract and column 3, lines 27-43 in particular.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

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EPODOC, WPI, JAPIO



Application No: GB0407210.4
 Claims searched: 1 to 39 and 44 to 47

Examiner: Robert Mirams
 Date of search: 21 June 2004

Patents Act 1977: Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular reference
A	1	WO01/58656 A1 (ANSELL HEALTHCARE) whole document
A	1	GB1365734 A (FELDMUHLE) whole document
A	1	WO99/48393 A1 (HUTCHINSON) whole document
A	1	GB0717103 A (METALLGESELLSCHAFT)

Categories:

X Document indicating lack of novelty or inventive step	A Document indicating technological background and/or state of the art.
Y Document indicating lack of inventive step if combined with one or more other documents of same category.	P Document published on or after the declared priority date but before the filing date of this invention.
& Member of the same patent family	E Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC^w :

B2E

Worldwide search of patent documents classified in the following areas of the IPC⁰⁷

A41D; B32B; D06N

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