

METHOD OF AND APPARATUS FOR MANUFACTURING A
FLEXIBLE LAMINATED MATERIAL

This invention relates to a method of manufacturing a flexible laminated composite body of material containing a web of material, preferably a non-woven fabric, bonded together with a net structure, in this method a web containing perforations and made of a shrinkable, at least monoaxially orientated, thermoplastic material is heated in a heating zone to its thermoplastic condition so that, as the thermoplastic material shrinks, a network or lattice structure is formed by the opening up of the perforations, and then the net structure is bonded to the web of material in a pressure zone, making use of the heat still present from the shrinking step; the invention also relates to apparatus for carrying out the method and to the product of the method.

In the known methods of the above-mentioned type (e.g. as shown in Swiss. Patent Specification No. 515 109 or US Patent Specifications Nos. 3 616 152, 3 769 120 or 3 885 074), in which the net structure is formed from a slit film, laminates made up of three layers of material are formed by adhesively bonding together two webs of material by means of the net structure, i.e. without the difficulties of, for example, handling steps and the measuring out of a liquid or pasty adhesive. However it is found that there is a marked inward shrinking of the peripheral zones of the perforated web. With a working width of the webs of material of, for example, 50cm, in the known methods there is a transverse shrinkage of the perforated web of, for example, 6-8cm.

This leads to bunching up of the material at the edges of the net structure, causing a noticeable thick-

ening of the edges, amounting to 0.01 to 1.5mm. The webs of material are accordingly, looked at over their working width, more strongly bonded together at the edge zones than in the middle zone, and in many cases this results in an inadequate adhesion of the webs of material in the regions between the edges. The presence of the poorly bonded regions results, for example, in the formation of folds in the webs of material so that the composite body not only has an unsatisfactory appearance and insufficient quality but also has insufficient strength. For example in the event of the peripheral zones being torn, the insufficient bonding of the webs of material can make itself disturbingly noticeable.

A further drawback of the marked or strong shrinkage of the edges of the perforated web consists in the formation of more or less outwardly projecting edge strips of the webs of material, which lack adhesion as a consequence of failure of the net structure. The resulting need for the unbonded peripheral zones to be cut off not only represents a loss of material but also requires a greater width of the webs of material, corresponding to the edge zones that are cut off, than is necessary for the final product. Moreover, in the known methods, folds arise, for example, during manufacture, transverse to the direction of travel of the perforated web, especially when one or both of the material webs for example themselves tend to shrink, i.e. are unstable at the softening or plastifying temperature of the material. Especially as a consequence of the peripheral shrinkage caused by perforated webs of poorer quality, these cannot be processed to produce laminated composite bodies in the desired manner with the known methods without damage, in particular without the above-mentioned problems and unwanted side effects.

It is accordingly the object of the invention to provide a process of the kind mentioned in the introduction but without the drawbacks of the previously known methods, for manufacturing a web-shaped flexible laminated body, in which a uniform adhesive bonding of at least one web of material to a net structure is achieved over the entire working width of the web.

For achieving this object the method as defined in the introduction above is characterised in that the perforated web is conveyed through the heating zone along a guide path which is continuously curved in one direction and it is brought into contact with the web of material as a carrier web, made of a material which is substantially stable at the plastifying temperature of the perforated web, and, with the perforated web still in a thermoplastic condition, the perforated web and carrier web are fed together to the pressure zone.

By virtue of the curved guiding path, i.e. the curved guiding or travelling of the perforated web in the method according to the invention, there is an auxiliary clamping effect in the heating zone, by which, as the perforated web shrinks, its side edges are held in their predetermined positions. Inward shrinking in the peripheral zones, e.g. as a consequence of sliding with respect to the carrier web in a direction transverse to the direction of travel of the perforated web, is thereby substantially reduced, if not altogether prevented, so that the net structure which is formed has substantially the same width as that of the perforated web from which it is formed. The method according to the invention makes it possible for the net structure

which is formed to extend, directly after the bonding, substantially right up to the edge of the web of material at least at its one side. On account of the lack of the bunching up of material at the edges consequent on the prevention of inward shrinkage of the net, the net structure is bonded to the web of material over its entire width to substantially the same degree. The flexible laminated composite body, which can be described as a web-shaped flat entity, accordingly has uniformly strong adhesion over the whole working width of the web of material, right up to the edges. The danger of folds being formed is substantially reduced if not indeed entirely overcome. Also the need for removal of a significant portion of unbonded material at the edges is eliminated. On the contrary, the web of material fed in can have the same width as the perforated web and the same as the desired final width of the body to be produced.

By the expression "net structure" used here there is to be understood in the following any structure which has a discontinuous surface, formed through at least some kind of opening up or widening of perforations, and for example it can be a net itself, and it results in adhesive bonding to the web of material which is not over a completely continuous surface.

As a consequence of the curved guide path the perforated web can be fed through the heating zone under tension so that a condition of biaxial stretching can be achieved, resulting for example in clinging of the edge regions of the perforated web on shrinkage as a consequence of friction for example, on the carrier web. Accordingly in an advantageous manner the net structure can be of full and undisturbed form in the regions directly adjacent to the, for example, unperforated edge

zones, because the edge zones are held in their predetermined positions by the curvature of the guide path and cannot become shifted inwards. Accordingly the discontinuous e.g. also dot by dot, bonding or welding of the web of material to the net structure by a heat sealing action, achieved as a consequence of the use of the net structure can take place uniformly over the whole surface of the net structure. On account of the auxiliary clamping, another web of material to be bonded can be applied to the as yet free face of the perforated web after the thermoplastic condition is reached, so that the heating of the perforated web to the thermoplastic condition, e.g. by the other web of material, is not adversely affected and can be fully effective on the still uncoated face of the perforated web. In this way overheating and consequent damage by heat, e.g. also of the carrier web, is avoided. The choice of material of the carrier web, as one which is substantially stable at the plastifying temperature of the perforated web, and itself preferably shows little shrinkage, leads to the fact that in one embodiment of the invention the perforated web can be guided through the heating zone already in contact with carrier web. The presence of the curved guide path prevents the formation of unwanted longitudinal folds in the carrier web.

In one embodiment of the invention the perforated web is guided through the heating zone e.g. with constant curvature so that constant tension of the perforated web can be achieved. With reference to the tangent drawn at the vertex of the guide path, the perforated web can be fed through the heating zone in a direction towards the tangent or away from it, preferably at an angle with respect to the tangent, the magnitude of which is selected for example according to

the required degree of curvature for producing the auxiliary clamping. The size of the angle of for example at least 2° can be helpful, according to the material used, in preventing the formation of longitudinal folds in the perforated web and maybe also in the carrier web. The guide path can have a constant curvature or a succession of different curvatures. If the perforated web is fed into the heating zone for example in a direction towards the tangent and is withdrawn from the heating zone in a direction away from the tangent, the perforated web can be fed with a tension which increases in the heating zone up to a maximum and then decreases again, or for example it can be guided to point a minimum distance from a heating element and then guided away again. According to the material used for the perforated web and/or the carrier web the tension and/or also the heating of the perforated web can be influenced or controlled in this way.

The perforated web, which can also be described as a perforated layer, can comprise or contain a plastics material, such as for example polyethylene (PE), ethylene vinyl acetate (EVA) or EVA copolymer, polypropylene (PP), polyamide (PA) polyurethane (PU), polyester (PEST) or another suitable thermoplastic material which can be bonded to the web of material in the thermoplastic condition i.e. at its softening or plastifying temperature by heat sealing. It can be used in the form of a film or foil or ^{sheet} ~~plate~~. The perforated web can, however, also be a perforated non-woven fabric, e.g. a fibre web or the like, which can contain shrinkable fibres, as described for example in Swiss Patent Specification 515 109. The perforated web can have holes punched in it, for example, round holes. Preferably a slit film is used as a bonding film, for example comprising a plastics foil with slits, for example mutually offset, in substantially parallel

rows, and arranged substantially transverse to the direction of shrinkage, corresponding to the direction of stretching, of the plastics foil. This embodiment has the advantage that the slit film cannot shrink inwards, in the direction of shrinking, over unslit bridge regions but on the contrary the shrinkage is used up substantially wholly in opening up of the slits. Accordingly from the slit film with mutually offset slits there is conveniently formed a net having a high degree of uniformity of its structure, this uniformity being important for uniform adhesion to the carrier web. However the slits could also be arranged in another manner, as already known from the Swiss Patent Specification 515 109, mentioned above. By being formed from a slit film the net structure can, in an advantageous manner, be formed with intersection points and net webs of small dimensions; this can be advantageous for complete adhesion.

The carrier web and/or the other web of material can comprise a foil, e.g. of a plastics material, a woven fabric a knitted fabric, a non-woven fabric, a layer of threads or the like. Two webs could be bonded together, a woven fabric or non-woven fabric, and e.g. a foam material or a foil or two foils, and laminated flexible composite bodies of any desired kind can be obtained by means of a net structure, employing the adhesive bonding, as described already for example in Swiss Patent Specification No. 515 109. Mats, floor coverings, for example decorative materials, clothing fabrics, for example uppers for shoes, furnishing materials, insulating materials or the like can be produced, provided on one side or on both sides with a fabric or textile.

According to the material employed the perforated web (together with the carrier web), is fed to the pressure zone immediately following the heating zone, or, after leaving the heating zone and before reaching the pressure zone, it can be conducted through an unheated zone which is of minimum length so as to maintain the perforated web in its thermoplastic condition.

The method according to the invention is preferably carried out with the carrier web, the perforated web and the web of, for example, another material, all being fed continuously.

The invention is further explained in the following in conjunction with embodiments by way of example and in conjunction with the drawings, in which:-

Figure 1 is a diagrammatic section showing apparatus for manufacturing by the method according to the invention a web-shaped flexible laminated composite body;

Figure 2 shows part of the apparatus of figure 1 to a larger scale;

Figure 3 is a diagrammatic section of another embodiment of part of the apparatus;

Figure 4 is a diagrammatic illustration in section of another form of apparatus for manufacturing a web-shaped composite body;

Figure 5 shows a diagrammatic illustration in section of part of a flexible laminate directly after bonding and

Figure 6 shows a diagrammatic illustration of another flexible laminate directly after bonding.

Referring to Figure 1 a perforated web 2 of shrinkable, at least mono-axially orientated, thermoplastic material, e.g. a slit film such as described in Swiss Patent Specification 515 109, passes from a reel 1 to a cylinder or roller 3 on which the perforated web 2 is brought into contact with a carrier web 4 coming from a reel 5 and fed to the roller 3. The perforated web 2 and the carrier web 4 pass together over a guiding and feeding roller 6 and a delivery roller or cylinder 7 which can be driven (by means not shown) and, as also shown in Figure 2, the two webs are drawn over a grid of bars 8, 9 and 10 into a nip plane A by a pair of pressure rolls 11 and 12, forming a pressure zone characterised by a length D lying in the nip plane. Freely rotatable or rotatable driven rollers could be used instead of the bars 8, 9 and 10.

Facing the side of the grid of bars 8, 9 and 10 over which the slit film 2 and the carrier web 4 pass is an electrically operated heating device 13 having terminals 14 and radiating heat in the direction of the arrow B. A web of material 16 is fed from a further reel 15 over guiding and feeding rollers 17 and 18 and passing under the pressure roller 11, likewise to the nip plane A.

The slit film 2 which lies on the side of the carrier web 4 which faces towards the heating device, is heated by the device 13 to its thermoplastic condition over a heating zone of length H, so that it shrinks and the slits in it open up, to form a net structure. After it has left the heating zone H, the

web 16 of material is brought into engagement with the still uncoated i.e. free, surface of the net and then the net is adhesively bonded and heat sealed in the pressure zone D on the one hand to the carrier web 4 and on the other hand to the web 16 of material, i.e. on both faces, making use of the heat retained in it from the shrinkage step. The carrier web 4 and the web 16 of material are accordingly bonded together in the pressure zone D by means of the net to form a web-shaped flexible laminated composite body 19 of non-woven fabric which, after leaving the pressure zone D is withdrawn over a guide roller or cylinder 20 through a pair of draw-off rollers 21 and is finally wound up on a reel 22.

As shown in particular in Figure 2, the bars 8, 9 and 10 are arranged with their longitudinal axes $8a$, $9a$ and $10a$ on an arc E of a circle, so as to lie at the corners of a convex regular polygon (not shown). The film 2 thus follows a guide path F which is continuously curved in one direction, formed by the array of the bars 8, 9 and 10, this path F being convexly curved with respect to the heating device 13 so that the film 2 is heated on the convexly curved side of the guide path F. The film 2 is guided through the heating zone H onto each bar 8, 9 and 10 with uniform curvature and at an angle α of at least 2° with respect to the tangent T drawn at the vertex S of the latter. By virtue of the curvature of the guide path F the film 2 and also the carrier web 4 are deflected with respect to a path L illustrated by a dotted line in the drawing, which leads directly from the feed roller 7 to the nip plane A and thereby into the pressure zone D, so that an auxiliary clamping effect is achieved and both the film 2 and the carrier web 4 are under tension on the guide path F and thereby in the heating zone H. The film 2 is led into the

heating zone H in a direction towards the tangent T, on the bars 8 and 9 and is withdrawn from the heating zone H in a direction away from the tangent T, on the bars 9 and 10, so that at the vertex S over the grid bar 9, the tension is at a maximum. If each angle α at the bars 8 and 9 amounts to 3° then from the feed-in side of the slit film 2 to the highest vertex point S at the grid bar 9 there is a total angle of deflection of 6° . The same angles apply at the delivery side from the bar 9 in a direction towards the pressure zone D. As a result of the tension the film 2 adheres to the carrier web 4 so that its edges are prevented from shifting laterally inwards by shrinkage transverse to the direction of travel.

The components of the apparatus described so far are arranged in a frame 23; the guiding and feed rollers 3, 6, 7, 17, 18 and 20 and the reels 1, 5, 15 and 22 are freely rotatable or are driven in the directions indicated by arrows. In the same way, the pairs of rollers 11, 12 and 21 are mounted in the frame 23 to be driven in the direction of the arrows indicated.

To allow it to be set at a desired spacing in relation to the bars 8, 9 and 10 and thereby to the slit film 2, the heating device is mounted to slide by means of a securing screw 24 working in a slot-shaped guide 25 in the frame 23 in a direction towards and away from the bars 8, 9 and 10, and is also able to pivot about the screw 24.

Instead of the bars 8, 9 and 10 being arranged on an arc E, they could also be arranged at the corners of an irregular polygon, so that a guide path of varying radius of curvature (but always in one sense) can be achieved, according to requirements.

Similarly also the highest vertex of the curvature can be at another point in the heating zone H. Whilst maintaining the tension until bonding in the pressure zone D, the film 2 and the carrier web 4 pass together, between the heating zone H and the pressure zone D, through an unheated zone U of which the length, for example according to the kind of material and the delivery speed of the slit film or the intensity of heating, is that which is necessary to maintain the thermoplastic condition of the material of the film 2 until it reaches the pressure zone D and it can be less than 50cm, e.g. 25 to 30cm. According to the kind of material and/or for example the thickness of the carrier web 4, the guide roller 6 the feed roller 7, the bars 8, 9 and 10, the pressure rollers 11, 12, the feed roller 18 and/or guide roller 20 can be kept by heating or cooling at a desired temperature, at which the film is kept in a thermoplastic condition without damage to the carrier web 4 and/or the web 16 of material, and thereby the desired bonding is achieved to form the laminate 19. In this way the thermoplastic condition can be maintained until bonding takes place in the pressure zone, and it is possible to avoid overheating of the slit film, the carrier web 4, the web 16 of material and/or the above-mentioned rollers and bars. It is also possible to envisage, in place of the bars 8, 9 and 10, the provision of a corresponding curved plate which can be provided with perforations or cooled or heated.

Using a slit film 2 made, for example, of EVA copolymer having a width of, for example, 160cm and a thickness, for example, 50 to 200 microns, the process is performed with a heating temperature of, for example, 150 to 200°C at the surface of the slit film and a travel velocity of, for example, 6m/min.

Referring to Figure 3, which also illustrates components already illustrated in Figures 1 and 2, a perforated web 30 is guided on the curved path F through the heating zone H and a carrier web 31 is fed in on that side of the perforated web 30 which faces towards the bars 8, 9 and 10, i.e. on the underside of the latter at the bar 10 at which the perforated web 30 is in a thermoplastic condition. The web 30 can have any kind of perforations that open up on heating to form a net structure and for example can be a slit film as described earlier in connection with Figures 1 and 2. The perforated web 30 is heated in the heating zone H by a gas-fired infra-red element 32 of a heating device 34. To protect the pressure rollers 11, and thereby the web 16, from overheating, a cooling device 35 is mounted on the frame 23 in the unheated zone U and shields the rollers 11 from heat radiated by the heating device 34.

The manufacture of the flexible laminate 19 takes place as described with reference to the embodiment of Figures 1 and 2.

As shown in Figure 4, a carrier web 37 delivered in the direction of the arrow G over a guide roller 36 is brought into engagement with a perforated web 39 on a feed roller 38 driven in the direction of the arrow K, the web 39 being fed in along the direction of the arrow M and being present, after engagement, on that side of the carrier web 37 which faces towards the feed roller 38. From the feed roller 38 the carrier web 37 and the perforated web 39 are transferred together to a heated drum 40, driven in the direction of the arrow N (by means not shown), on which drum the carrier web 37 lies as an inner layer, with the perforated web 39 forming an outer layer. In passing around through an angle β the perforated web 39 and the carrier web 37 are

guided together through the heating zone along a curved guide path formed by the surface 41, this path being curved always in one direction and of constant radius of curvature, and, the length of the path being defined by the size of the angle β . On the drum 40 the perforated web 30 is heated to a thermoplastic condition from the concave side of the guide path 41 through the carrier web 37, so that again, a net is formed by opening up of the perforations as a consequence of shrinkage of the material of the perforated web 39. The net, which is in a thermoplastic condition, is drawn off together with the carrier web 37 by a pair of pressure rollers 42 arranged directly following the heating zone. At the feed-in side of the pair of the pressure rollers 42 the uncoated side of the net is brought into engagement with a web 43 of material delivered in the direction of the arrow P, this web being caused to bond to the carrier web 37 through the net, still in a thermoplastic condition, in the pressure zone formed by the pair of rollers 42, to form a web-shaped laminated composite body 44 of non-woven fabric which is drawn off in the direction of the arrow R. The drum 40 has an opening 40a in its end face for the supply of hot steam for heating purposes.

Figure 5 shows a flexible laminate 45 directly after bonding of the webs of material 46 and 47 through a net 48 of thermoplastic material, shrunk in the direction of the arrow V and placed between them, as can be achieved by the process according to the invention, for example by heat sealing in the pressure zone in Figure 1. The net 48 shows no significant inward shrinkage at its edges 49 in the direction of the arrows V, i.e. transverse to its longitudinal direction W, in which it was fed through the heating zone over the curved guide path. Accordingly the net 48 extends substantially right up to the side edges 50 and 51 of

the webs 46 and 47 which are transverse to the direction of shrinkage V. As a consequence of uniform thickness Z of the net 48 over its whole width C, i.e. both at the edges 49 of the net and also in the remaining regions 52 of the net, it is bonded to the webs 46 and 47 on both sides with substantial uniformity over the entire width C.

Referring to Figure 6, in which parts already shown in Figure 5 are given the same reference numerals, the process according to the invention can be used to make a laminate 53 which can be manufactured without the web 16 of material of Figures 1 to 3 or the web 43 of Figure 4. The body 53 comprises a net 54 of which one face is bonded to a web 55 of material and has the same features as described already with reference to the embodiment of Figure 5. As a consequence of the one-sided adhesion of the net 54 to the web 55 the body 53 can be employed with the uncovered side of the net 54 for example for applying to, or heating, a web of cloth or the like.

Claims

1. A method of manufacturing a web-shaped flexible laminated composite body which contains at least one web of material bonded to a net structure, in which a perforated web made of a shrinkable, at least monoaxially orientated, thermoplastic material is heated to a thermoplastic condition in a heating zone so that the net structure is formed by shrinkage of the thermoplastic material and consequent opening of the perforations, this structure being brought into contact with the web of material and then bonded to the web of material in a pressure zone, employing the heat still present from the shrinkage step, characterised in that the perforated web is guided through the heating zone along the convex side of a guide path which is curved continuously in one direction and at least before reaching the pressure zone it is brought into contact with the web of material as a carrier web, made of a material which is substantially stable at the softening or plastifying temperature of the perforated web, and, with the perforated web still in its thermoplastic condition, both webs are fed together to the pressure zone.

2. A method according to claim 1 in which the perforated web is heated on the convex side of the curved guide path.

3. A method according to claim 1 in which the perforated web is heated on the concave side of the curved guide path.

4. A method according to claim 1 in which the guide path through the heating zone is of constant mean curvature.



5. A method according to claim 1 in which the perforated web is guided through the heating zone at a predetermined angle with respect to the tangent drawn at the vertex of the latter.
6. A method according to claim 5 in which the perforated web is guided through the heating zone in a direction towards the tangent.
7. A method according to claim 5 in which the perforated web is guided through the heating zone in a direction away from the tangent.
8. a method according to claim 5 in which the perforated web is guided into the heating zone in a direction towards the tangent and out of the heating zone in a direction away from the tangent.
9. A method according to claim 5 in which the perforated web is guided at an angle of at least 2° with respect to the tangent.
10. A method according to any one of claims 1 to 9 in which the perforated web and the carrier web are fed together through the heating zone, in a path continuously curved in the one direction.
11. A method according to any one of claims 1 to 10 in which, with the perforated web still in its thermoplastic condition, there is applied to its as yet uncoated side another web of material, which becomes bonded to the carrier web in the pressure zone by means of the net structure.
12. A method according to claim 11 in which the last-mentioned web of material is applied immediately ahead of the pressure zone.



13. A method according to any one of claims 1 to 12 in which the perforated web is guided onto the carrier web and into the pressure zone on the continuously curved path.

14. A method according to any one of claims 1 to 12 in which the pressure zone follows immediately on after the heating zone.

15. A method according to any one of claims 1 to 12 in which the perforated web and the carrier web pass through an unheated zone between the heated zone and the pressure zone.

16. A method according to any one of claims 1 to 15 in which the perforated web is guided along a path which departs from a straight-line path leading directly from a supply point to the pressure zone.

17. A method according to any one of claims 1 to 16 in which the perforated web is a slit film.

18. A method according to claim 17 in which the slit film comprises a plastics foil with substantially parallel rows of slits which are arranged substantially transverse to the direction of shrinkage of the plastics foil corresponding to the direction of stretch.

19. A method according to claim 18 in which the slits of adjacent rows are mutually offset.

20. A method according to claim 18 or Claim 19 in which the slit film is manufactured from thermoplastic synthetic resin.



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21. A method according to any one of claims 1 to 20 in which the carrier web and/or the other web of material comprise a textile material in the form of a non-woven fabric, a woven fabric, or a knitted fabric.

5 22. A method of manufacturing a web-shaped flexible laminated composite body substantially as described with reference to the accompanying drawings.

10 23. Apparatus for manufacturing a web-shaped flexible laminated composite body substantially as described with reference to the accompanying drawings.

24. A web-shaped flexible laminated composite body manufactured by the method of any of Claims 1 to 22 or 39.

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