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MESH STRUCTURE AND LAMINATE MADE THEREWITHBackground to the Invention

GB 2 035 191A and GB 2 073 090A should be referred to
for background details on stretching and orientating plastics
materials.

Definitions

The term "rectangular" includes square.

The term "orientated" means molecularly orientated.

The term "thickness" refers to the dimension normal to
the plane of the starting material or mesh structure,
the term "width" refers to the appropriate dimension in
the plane of the starting material or mesh structure (normally
at right angles to the direction of the strand in question),
and the term "w:d ratio" is the ratio of the width to
the thickness.

The "calculated stretch ratio on the interconnecting strands"
is the ratio of the distance apart of the mid-points of
the main zones after drawing to that before drawing (though

(13)

normally the actual stretch ratio is less due to the main strands necking down slightly between connection points with the interconnecting strands).

5 The width of a main zone is generally the distance between the two lines which are tangent to the line of holes or depressions on either side of the main zone, the same being the case mutatis mutandis for main strands and mesh openings. A somewhat different definition applies to a ribbed structure (see below).

10 The depressions are not necessarily formed by the application of pressure.

The Invention

The invention provides a method as set forth in Claim 1, ^{31 32 33 34 or 39} ~~18, 19, 23, 25 or 26~~, mesh structures as set forth ^{25, 33, 34 or 35} ~~in Claim 12, 20, 21 or 22~~, and laminates as set forth ^{40, 42 or 43} ~~in Claim 27, 29 or 30~~. The remaining Claims set forth preferred features of the invention.

In the method of the invention, the main, parallel zones narrow down to form the main strands and thus stretch
20 out the subsidiary intermediate or transverse zones into

orientated interconnecting strands whose orientation is preferably at right angles to the direction of drawing, and calculated stretch ratios of 5:1 or more can be applied to the interconnecting strands (though the interconnecting strands are preferably not stretched so much that they fibrillate even if this is possible with the particular plastics material used). The orientation of the main strands extends from end to end thereof although they are interconnected by the interconnecting strands at a plurality of positions spaced along the main strands.

It has thus been discovered that a mesh structure which has substantial orientation in two directions at right angles can be produced by stretching a substantially unorientated starting material in a single direction. Nonetheless, as explained below, the invention is not restricted to using a single, unidirectional draw.

Substantial contraction of the web of material as a whole in the "transverse" direction can be prevented for instance by using tenter-type chains (with no overfeed) or by having a short distance between the nips of drawing rolls: in the latter case, some contraction may occur, particularly adjacent the margins of the material but the effect of the invention can still be obtained. To facilitate the stretching of the "transverse" zones, these zones should not be too wide (i.e. should not have too great a dimension in the direction in which the main zones are stretched) - they are preferably substantially narrower than the

(15)

main zones, i.e. the distance between the holes or depression of one line and those of the adjacent line is substantially greater than the distance apart of the holes or depressions in any one line. The main strands can have a uniform thickness along their centre line (or another line parallel to their axes) and their width can also be fairly uniform. These main strands run right through the mesh structure and give the mesh structure its strength. Particularly if the mesh structure is being used for a cross-laid laminate (main strands of one mesh structure layer generally at right angles to the main strands of the other mesh structure layer), the transverse strength of the mesh structure is not of importance and need only be sufficient for machine handling in an automatic process; the interconnecting strands need only to keep the main strands roughly parallel prior to laminating.

It is believed that if the main zones or strands are to exhibit sufficient strength to orientate the intermediate zones, the interconnecting strands should be of smaller cross-sectional area than the main strands, and those cross-sectional areas are conveniently measured at the mid-points. The main strands can predominate in weight

per square unit area of the mesh structure, for instance forming 85, 90, 95% or even more of the weight of the product, thus ensuring economic use of the plastics material.

- In order to achieve this, and in order to achieve good cross-orientation, the distance between the main zones can be small (i.e. the main zones being close together), the holes or depressions (if present) being correspondingly small and forming a very low percentage of the surface area of the starting material. Apart from the foregoing, a small distance between the main zones (when the main zones are close together) can give good cross-orientation. A small percentage width reduction of the main zones can give a large stretch ratio on the intermediate or transverse zones. The main zones in the starting material are preferably at least ~~two or~~ four times as wide as the distance between ^{the main} ~~such~~ zones, if appreciable stretch is to be achieved in the interconnecting strands. There would be a large number of the side-by-side main zones, e.g. at least ten and preferably at least fifty or a hundred. Mesh structures can be produced with from fifty to four hundred main strands to the meter and one would expect mesh structure widths of one to four meters. The main strands will usually be of substantially rectangular section, i.e. two sides of the rectangle being the faces of the mesh structure.
- If the starting material is to be drawn solely in the transverse direction (TD), a stenter can be used. In

(17)

general, the holes or depressions in each line should be close together to achieve the cross orientation of the intermediate zones - the intermediate zones would thus be small, as measured in the direction in which the starting material is drawn.

Though one can use a single, unidirectional draw, it may be possible or advantageous to draw the starting material biaxially. Thus the starting material can be drawn, e.g. to a small stretch ratio, in the direction at right angles to the main zones. This drawing will orientate the intermediate zones to a certain extent, though the orientation need not penetrate into the sides of the main zones (i.e. pass beyond notional lines on either side of a respective main zone and tangent to the holes or depressions). The stretch ratio on the interconnecting strands so formed may be for instance 2:1. Subsequently (or even possibly simultaneously), the material is drawn parallel to the main zones, stretching out the main zones but also further stretching out the interconnecting strands in a direction parallel to their axes. The whole operation could be performed by giving a small machine direction (MD) draw using draw rolls and then giving a large TD draw in a stenter.

As a further possibility, once the main strands have been formed, it is possible to draw in the direction at right angles to the main strands, further to stretch out the

interconnecting strands, possibly reducing or eliminating the thicker small zones referred to below.

In general, in the mesh structures of the invention, the ratio of main strand width: transverse pitch of main strands, as measured at mid-points (which are usually the narrowest points) of the main strands, is preferably below 1:5, say from 1:4.5 or 1:4.25 or 1:4 down to 1:2, though larger relative transverse pitches are possible with suitable dimensioning of the starting material - the main strands at their narrowest points may be separated by a distance of not more than three times their width at their narrowest points.

The production of the correct mesh structure depends upon a combination of various parameters, such as pitching of the holes or depressions (i.e. transverse dimension of the individual intermediate zones and width of main zones) and draw ratio applied to the main zones. The main zones in the starting material and the main strands in the mesh structure are preferably much wider than they are thick and hence tape-like, preferred w:d ratios for both the main zones and the main strands being at least about 10:1, 20:1, or more. If the main zones are not very close together, high w:d ratios are required. The actual thickness, if uniform, may not be of great importance, though this has not been _____

assessed experimentally. It is found easier to obtain more uniform thickness strands with very thin starting materials, the thickness normally becoming less uniform as the average thickness increases (i.e. less thickness difference between main strands and the interconnecting strands, and between different zones in the structure); it is found that starting materials of thickness of 0.5mm and less are preferred, the most useful being those of 0.2mm and less. However, in principle, the starting material can be of any suitable thickness.

The preferred starting material is strictly uniplanar, by which is meant that, ignoring any membrane (which may not lie on the median plane), all parts of the starting material are symmetrical about the median plane of the starting material; in this manner, in the mesh structure, all parts will be symmetrical about the median plane, ignoring any membrane, film or fibrils (which may not lie on the median plane) produced from the starting membrane. It is further preferred that the starting material should have planar faces apart from the holes or depressions. However insubstantial departures from uniplanarity or from planarity are not excluded - for instance, in an alternative to having starting material with planar faces, it would be possible to provide the starting material with parallel ribs, which could be formed by direct extrusion or embossing, the ribs forming the main zones (in this

case, the width of a main zone is the width of the rib).

The holes (or depressions if applicable) can be formed e.g. by punching, slitting, embossing or burning in (on a water-cooled roller), or by forming them as the starting material itself is formed (for instance obturating a slit die e.g. generally as in French Patent Specification No. 368 393 or by integral extrusion of a square mesh as in U.S. Patent Specification No. 3 325 181). Slitting is a useful way of forming the holes as there is no substantial material removal and as it enables the main zones to be very close together. A useful process is that in which a plastics sheet is formed with longitudinal slits, and is then heated whilst its longitudinal margins are restrained, forming roughly elliptical holes. In general, it is preferred to avoid any substantial protuberance around the periphery of the holes or depressions. If depressions are formed, the membrane closing the depressions can be ruptured during stretching and the residual film-like material removed; alternatively, an orientated film can remain in the mesh openings.

The starting material is preferably not substantially orientated, though melt-flow orientation can be present.

The starting material can be any suitable thermoplastics

(21)

material, such as for instance high density polyethylene (HDPE), low density polyethylene, polypropylene, copolymers of HDPE and polypropylene, polyesters, and polyamide. Tape-like filaments tend to crack or split when produced from some plastics such as HDPE and polypropylene, but these may be acceptable for certain uses - the use of polyesters can reduce the tendency to crack or split. The starting material can have a skin on one or both faces containing an ultra-violet stabiliser; if a laminate is formed and the skin is on one face, it would be on the outside face.

The intermediate zones are stretched (and hence one would expect the axes and direction of orientation of the interconnecting strands to extend) ^{generally} at right angles to the direction of drawing the starting material; ~~this angle is preferably roughly 90°, but the angle could be substantially less than 90° though it is preferably more than 75°.~~ Though ^{generally} the interconnecting strands may extend substantially at right angles to the main strands, ~~this need not be so.~~

The interconnecting strands need not have any specific geometrical shape nor be aligned with any interconnecting strand on the other side of the respective main strand - for instance, the interconnecting strands could form the "verticals" in a "brick wall" pattern with the main strands forming the "horizontal".

The mesh structure can be very flat and thus easily laminated to provide good cross-laid laminates. Although there may be small zones of thicker material where the interconnecting strands join the main strands, there need be no large-sized nodules which could interfere with bonding. The structure may be cross-laminated with a similar or identical structure, but this is not necessarily so. The structures can be bonded directly face to face or can be separated by at least one further layer. More generally, the mesh structure of the invention may be bonded to a layer (such as an orientated plastics material film with a preferred direction of orientation) which has a marked maximum strength in one direction, the main strands of the mesh structure of the invention being generally at right angles to the direction of maximum strength of said layer.

The mesh structure of this invention can have a high strength in the direction of the main strands and thus the cross-laid laminate will have good strength characteristics in two directions at right angles. As the mesh structure of the invention can be formed and laminated at much greater speeds than fabrics can be woven or knitted, the invention renders possible the fabrication at relatively high speeds of a material which can be substituted for woven fabrics for some purposes.

The mesh structure of this invention can be used without lamination, i.e. as an unlaminated material.

Description of Preferred Embodiments

The invention will be further described, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a plan view of a plastics starting material
5 for forming a mesh structure in accordance with the invention;

Figure 2 is a plan view of the mesh structure formed therefrom;

Figures 3 and 4 are plan views of two further mesh structures in accordance with the invention;

Figure 5 is a perspective view of the mesh structure of
10 Figure 4;

Figure 6 is a section along the plane VI-VI in Figure 5:

Figure 7 shows various shapes of holes or depressions that can be used in the starting material;

15 Figure 8 is a schematic perspective view of a laminate in accordance with the invention; and

Figures 9 to 14 are schematic sections through six other laminates in accordance with the invention.

In the drawings, the hatchings run up and down the slope; only sample contoured zones are indicated with hatchings.

Figures 1 to 5

- 5 Looking at Figure 1, the starting material is a strictly uniplanar sheet of plastics material 1 having planar faces and in which is formed a regular pattern of holes or depressions 2; the holes or depressions 2 are in lines, the holes or depressions 2 in each line dividing
- 10 the starting material 1 into a large number of parallel main zones 3 which are close together and on either side of or separated by the lines of holes or depressions 2; the holes or depressions 2 also define small transverse or intermediate zones 5 between the main zones 3 and
- 15 between the holes or depressions 2; each of the intermediate zones 5 is symmetrical about a respective line at right angles to the line of holes or depressions 2, and the interconnecting strands 6 are at right angles to the main strands 4; as the starting material is
- 20 uniplanar with planar faces, the thickness of each intermediate zone 5 is the same as that of the main zones 3, i.e the intermediate zones 5 are defined between the planes defined by the outer faces of the main zones; the holes or depressions 2 are close
- 25 together and the distance between the holes or depressions 2 of one line and those of the adjacent line is substantially greater than the distance apart of the

holes or depressions 2 in each line; the holes or depressions 2 preferably have their centres on a notional rectangular grid and the area of the holes or depressions 2 is preferably less than 20% of the plan view of the starting material 1. For the purposes of illustration and for most of the following Examples, the holes or depressions 2 are shown as circular, but Figure 7 shows various shapes for the holes or depressions 2, including simple piercings and slits. Although circular holes or depressions are easier for tooling, it is suggested that square holes on the square, with radiussed corners (Figure 7, middle of top row) give better control during stretching and a better, more regular product - "on the square" means that the sides of the square are parallel to and at right angles to the stretching direction. If elongated, the direction in which the major axis of the hole or depression 2 extends can be either parallel to the lines of holes or depressions 2 or at right angles thereto.

The starting material 1 is drawn only in the direction indicated by the double arrow in Figure 1, while preventing any substantial contraction of the web of material as a whole in the direction at right angles to the drawing direction, i.e while preventing any substantial reduction of the (transverse) pitch of the main zones 3, though permitting reduction in width of each individual main zone 3. As illustrated in Figure 2, the material forms a geometrically regular product. The main zones 3 in the starting material 1 are

14a

stretched out into continuous, uniaxially-orientated, rectangular section main strands 4 which are like tapes or filaments running right through the structure, their orientation extending longitudinally thereof, i.e. generally parallel to the drawing direction, and from end to end thereof, and their centre lines have substantially uniform thickness. At the same time, the width of the main zones 3 substantially decreases, whereby the force of contraction of each main strand 4 as the main strand 4 reduces in width causes the intermediate zones 5 to stretch at right angles to the drawing direction, to form discontinuous, smaller cross-sectional area, uniaxially-orientated, transverse, interconnecting strands 6 which extend at right angles to the main strands 4 and interconnect the main strands 4 at a plurality or large number of positions spaced along the main strands 4, with the orientation extending longitudinally of the interconnecting strands 6, i.e. at right angles to the drawing direction. The mesh structure is biaxially-orientated. In the generally rectangular mesh openings formed, the largest dimension parallel to the main strands 4 is substantially greater than that at right angles to the main strands 4. The width of the interconnecting strands 6 is substantially less than that of the main strands 4 and the cross-sectional area of the mid-points of the interconnecting strands 6 is less than the minimum cross-sectional area of the main strands 4; the orientation of (or stretch ratio applied to) the interconnecting strands 6 may be



substantially more than that applied to the main strands 4, though this is not essential. The stretch ratio of the interconnecting strands 6 is determined by the diameter or width of the holes or depressions 2 and the reduction in width of the main zones 3 when forming the main strands 4. The main zones 3 should decrease in width by at least 50%, as measured at their narrowest parts. According to the stretch ratio applied, small, thicker unorientated or less orientated zones 7 (small blobs and/or unstretched shoulders) may remain adjacent each end of each interconnecting strand 6. The zones 7 may be thicker than both the main and interconnecting strands 4,6, or just thicker than the main strands 4. The zones 7 need not necessarily be present; for instance with polyester, the corresponding zones may be flat or have slight depressions, indicating that biaxial orientation has occurred in such zones (this possibly occurs even if there are blobs or shoulders). No account is taken herein of the small zones 7, or of the depressions, when giving the stretch ratios on the interconnecting strands 6, i.e. it is assumed that the whole of each interconnecting strand 6 stretched out uniformly, although this may not be the case.

The stretching is carried out at a temperature above the second order transition temperature of the plastics material but substantially below the softening point so that melt flow orientation is avoided during the stretching; for example for HDPE, the preferred temperature range is 75°

28

to 102°C. After stretching, the structures can be annealed in a well known manner.

Figure 7

5 As indicated above, Figure 7 shows various shapes of holes or depressions 2 that can be used in the starting material.

Examples

To provide typical examples, a parallel-faced starting material was formed with holes on a notional rectangular grid. The square holes of Example 4 were "on the square".

10 The starting material was stretched at an elevated temperature. The following Table gives details of four Examples. All dimensions are in mm, unless otherwise specified. The starting material was planar and effectively parallel sided, though differences in thickness were noted in one
15 starting material (used for Examples 1 and 2), the maximum and minimum thickness of the starting material being recorded as 0.28 and 0.21 mm (nominal 0.25 mm). In each Example, the maximum thickness of the product was at zone 7. Due to thickness variations in the starting materials (small
20 in the case of Examples 3 and 4), there were variations in the dimensions observed in the products, but average values have been recorded for Examples 1 and 2 and

29

typical values for Examples 3 and 4. In commercial production, closer thickness tolerances would be required of the starting material than those indicated for Examples 1 and 2.

5 It will be noted from the Table that the widths of the interconnecting strands are much less than the widths of the main strands (the widths being measured at the narrowest parts of the interconnecting strands and of the main strands, respectively). It will also be noted from the Table that the distance apart of the holes in
10 the starting material, as measured in the stretch direction, is much less than the distance apart of the holes, as measured in the transverse direction.

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Table

Example	1	2	3	4
Figure in which illustrated	2	3	4	4**
Material	80/20 HDPE/LDPE *		HDPE	HDPE
Thickness	0.25		0.5	4.5
Hole shape	circular	circular	circular	square, radiused corners
Hole size	1.6	3.175	1.6	6.35 0.75 radius corners
Hole pitch (stretch direction)	2.4	4.7	2.4	8
Hole pitch (transverse)	6.35	12.7	12.7	25.4
w : d ratio main zones	19 : 1	38:1	22:1	4.2:1
Temperature of Stretching (°C)	75-85	75-85	90	96
Stretch ratio on longitudinal strands	7:1	3.5:1	9:1	5.6:1
Longitudinal strand width reduction (measured at mid-point)	66%	38%	44%	53%
Maximum opening size, measured in transverse direction	4.9	7.2	6.5	15.5
Calculated stretch ratio on interconnecting strands	3.03:1	2.26:1	4.06:1	2.58:1
Longitudinal strand thickness (mid-point= thinnest point)	0.08	0.07	0.16	1.78
Longitudinal strand width (mid-point=narrowest part)	1.5	5.5	6.2	9.0
w:d ratio longitudinal strand	19:1	79:1	39:1	5:1
Interconnecting strand thickness (mid-point)	0.08	0.07	0.20	2.5
Interconnecting strand width (mid-point)	0.3	0.3	0.5	1.0
Thickness of thickest point of structure	0.18	0.18	0.45	3.3

* Co-extrusion (one-sided) ** Closest Figure

Figure 8

A cross-laid laminate is shown in Figure 8, and can be considered as having been made in a machine whose machine direction (MD) is indicated by the arrow. The laminate is formed of two layers 21, 22, each of which can be generally in accordance with any of Figures 2, 3, or 4. The top layer 22 has been stretched in the MD and the bottom layer 21 has been stretched in the transverse direction (TD).

The bonding is preferably effected by providing a multi-component starting material, having on at least one face a bonding material which bonds at a temperature which does not destroy the physical properties of the mesh structure, the two mesh structure layers being heated to bond them - thus the bonding material can be a skin which melts or becomes tacky at a temperature (or temperature and pressure) at which the main component of the mesh structure would not de-orientate. The bonding material may be for instance ethylene vinyl acetate or low density polyethylene (LDPE); the starting material can for instance be unorientated

0.15mm thick polypropylene with a thin layer of LDPE on at least one face. The bonding material can be provided in any suitable way, for instance by extrusion coating or co-extrusion. Alternatively, a bonding material or adhesive can be applied immediately prior to laminating.

Figures 9 to 14

In Figures 9 to 14 MD stretched layers are indicated as 21 and TD stretched layers are indicated as 22, although in the alternative these could be reversed. Figures 9 and 10 illustrate three-layer and four-layer laminates respectively. Figures 11 to 13 show the incorporation of one or more layers 23 of another material, e.g. polyethylene film. Figure 14 shows the lamination of a layer which can be generally in accordance with Figure 2, 3 or 4, with a film 23 of plastics material, e.g. polyethylene film, which has a preferred or single direction of orientation (direction of maximum strength) at right angles to the main strands 4.

Uses

The single layer mesh structure of the invention can be used for: Sunshade cloth, wind-breaks, sand barriers (small thicknesses), civil engineering such as ground stabilisation

22

or reinforcement (large thicknesses), general construction, such as concrete reinforcement, plaster reinforcement for ceiling panels or as a false ceiling, and asphalt reinforcement with the main strands extending transversely of the traffic direction (in this case, polyester is a preferred material).

The laminate of the invention can be used for:

Textile fabrics for industrial application, wind-breaks, shade cloths, bases for needle felt, olive harvesting nets, packaging, tarpaulin, bale wraps, carpet backings, or sacks or bags e.g. for wool, cement (laminated with paper or film) or fertilizers.



34

22.

Claims

1. A method of making a plastics material mesh structure, comprising:

providing a plastics starting material which has a
5 regular pattern of holes or depressions, the holes or depressions being in parallel notional lines, the distance between the holes or depressions of one line and those of the adjacent line being substantially greater than the distance between the holes or
10 depressions in each line, the holes or depressions defining elongate, side-by-side main zones between the lines of holes or depressions and intermediate zones between the holes or depressions in each line, each of which intermediate zones is generally symmetrical about
15 a respective notional line at right angles to the line of holes or depressions, the major part of the thickness of each intermediate zone being between planes defined by the outer faces of the main zones; and

drawing the starting material only in a direction
20 substantially parallel to the main zones while preventing substantial reduction of the pitch of the main zones though permitting reduction in width of each

35



23

individual main zone, thereby stretching the main zones out into continuous, substantially uniaxially-orientated main strands with the orientation therein extending substantially uniformly from end to end and generally parallel to the drawing direction, substantially decreasing the width of the main zones when forming the main strands whereby the force of contraction of each main strand as the main strand reduces in width causes said intermediate zones to stretch in a direction generally at right angles to the drawing direction to form discontinuous, substantial uniaxially-orientated interconnecting strands which interconnect the main strands, whereby a biaxially-orientated mesh structure is produced comprising said orientated main strands and said orientated interconnecting strands with the orientation in the interconnecting strands extending generally at right angles to the main strands and the cross-sectional area of the mid-points of the interconnecting strands being less than the minimum cross-sectional area of the main strands.

2. The method of Claim 1, wherein the starting material is substantially unorientated.

3. The method of Claim 1, wherein a substantially unorientated starting material is subjected to a small stretch in a direction at right angles to the drawing



35

24

direction of Claim 1, prior to drawing the starting material as set forth in Claim 1.

4. The method of any preceding Claim, after drawing the starting material as set forth in Claim 1, the mesh
5 structure is drawn in a direction at right angles to the drawing direction of Claim 1.

5. The method of any of the preceding Claims, wherein the starting material has planar faces, apart from the holes or depressions.

10 6. The method of any of the preceding Claims, wherein, ignoring any membrane forming the base of a said depression, all zones of the starting material are symmetrical about the median plane of the starting material.

15 7. The method of any of the preceding Claims, wherein the main zones are substantially wider than they are thick.

8. The method of any of the preceding Claims, wherein the main zones are generally rectangular in shape, as
20 seen in section normal to said drawing direction, being substantially wider than they are thick.

(37)

25



9. The method of any of the preceding Claims, wherein the ratio of the width to thickness of the main zones is about 5:1 or more.
10. The method of any of Claims 1 to 8, wherein the
5 ratio of the width to thickness of the main zones is about 20:1 or more.
11. The method of any of the preceding Claims, wherein the pitch of the main strands in the direction at right angles to said drawing direction is less than about five
10 times the width of the main strand at its narrowest part.
12. The method of any of Claims 1 to 10, wherein the main zones are at least about 2.975 times as wide as the distance between the main zones.
13. The method of any of Claims 1 to 10, wherein the
15 main zones are at least four times as wide as the distance between the main zones.
14. The method of any of the preceding Claims, wherein the starting material is drawn until the main zones have decreased in width by at least 50%, as measured at the
20 narrowest parts of the main zones.
15. The method of any of the preceding Claims, wherein



said holes or depressions are on a notional rectangular grid.

16. The method of any of the preceding Claims, wherein,
in the mesh structure formed, there is adjacent each end
5 of each interconnecting strand a zone of plastics
material which is thicker than the material of the
remainder of the interconnecting strand.

17. The method of Claim 16 when read as appendant to any
of Claims 1 to 9, wherein said thicker zones are at
10 least about 1.32 times as thick as the thickness of the
mid-point of the interconnecting strands.

18. The method of Claim 16 when read as appendant to any
of Claims 1 to 9, wherein said thicker zones are at
least about 1.85 times as thick as the thinnest part of
15 the main strands.

19. The method of any of the preceding Claims, wherein
the thickness of the starting material is about 0.5 mm
or less.

20. The method of any of Claims 1 to 5, wherein the
20 product of the distance between the holes or depressions
of one line and those of the adjacent line and the
overall stretch ratio applied, divided by the

39



27.

width of the holes or depressions as measured in the direction at right angles to said drawing direction, is at least about 10.5.

21. The method of any of the preceding Claims, wherein
5 the main strands and the interconnecting strands define substantially rectangular mesh openings whose dimension parallel to the main strands is substantially greater than their dimension parallel to the interconnecting strands.

10 22. The method of any of the preceding Claims, wherein in each said mesh structure the main strands contain at least 85% of said plastics material of said mesh structure.

23. The method of any of the preceding Claims, wherein
15 the main strands have substantially uniform thickness, as seen in section along their centre lines.

24. The method of any of the preceding Claims, and carried out on continuous machinery, said lines of holes or depressions being substantially aligned with the
20 machine direction.

25. A mesh structure, comprising:



23

substantially parallel, continuous, substantially uniaxially-orientated main strands whose orientation extends substantially uniformly from end to end thereof and generally parallel thereto; and

- 5 discontinuous, substantially uniaxially-orientated, interconnecting strands interconnecting the main strands, the interconnecting strands extending generally at right angles to the main strands at a plurality of positions spaced along the main strands, having
- 10 orientation which is directed generally parallel to the interconnecting strands, the cross-sectional area of the interconnecting strands being less than the cross-sectional area of the main strands and the width of the interconnecting strands being much less than the
- 15 widths of the main strands, which cross-sectional areas and widths are measured at the narrowest parts of the interconnecting strands and of the main strands, respectively;

there being adjacent each end of each interconnecting strand a zone of plastics material which is thicker than

20 the material of the remainder of the interconnecting strand.

26. The mesh structure of Claim 25, wherein all parts are symmetrical about the median plane of the mesh

43



31

one mesh structure layer extend generally at right angles to the main strands of the other mesh structure layer.

37. The method of Claim 36, wherein both of the mesh
5 structure layers are as claimed in any of Claims 25 to 30 and 33 to 35.

38. A method of producing a laminate, comprising bonding
the mesh structure of any of Claims 25 to 30 and 33 to 35 to a layer of film material.

10 39. A method of producing a laminate, substantially as herein described.

40. A laminate comprising at least two mesh structure layers each of which is integral and has mesh openings formed between respective substantially parallel,
15 orientated main strands which are interconnected by interconnecting strands and at least one of which layers is as claimed in any of Claims 25 to 30 and 33 to 35, the two mesh structure layers being bonded to form, or form part of, the laminate with the main strands of one
20 mesh structure layer generally at right angles to the main strands of the other mesh structure layer.

41. The laminate of Claim 40, wherein both mesh



32.

49

structure layers are as claimed in any of Claims 25 to 30 and 33 to 35.

42. A laminate produced by the method of any ~~one~~ of Claims 36 to 38.

- 5 43. A laminate substantially as herein described with reference to, and as shown in, any of Figures 8 to 14 of the accompanying drawings.
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