

SPECIFICATION

Plastics Material Mesh Structure

Background of the Invention

The invention relates to integral plastics material diamond mesh structures comprising mesh openings defined between orientated strands and junctions interconnecting the strands, and to methods of producing them by stretching special starting materials. British Patent Specification No. 769 205 (Monosilio) shows a final product which has orientated strands and flat orientated junctions. The centres of the junctions can split relatively easily under shock loads.

Definitions

The term "rectangular" or "rectangle" includes square.

The term "orientated" means molecularly orientated.

The terms "thick", "thickness", "deep" and "depth" refer to the dimension normal to the plane of the starting material or mesh structure and the term "width" refers to the appropriate dimension in the plane of the starting material or mesh structure.

The thickness or depth of a strand is the thickness of the strand cross-section, but ignoring raised edges. Particularly if the original holes or depressions have no radiussing where they issue at the faces of the starting material, the strands will have a "pin-cushion" cross-section, with raised edges and lower centres; the thickness will be as measured inwardly of the raised edges.

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

The Invention

The invention provides a method as set forth in Claim 1 and structures as set forth in Claims 9, 10 and 13. Claims 2 to 8, 11, 12, 14 and 15 set forth preferred features of the invention.

The continuous lines of orientated plastics material running through the structure provide good strength in the structure in one direction, enabling the net to be used for instance for packaging or agricultural or horticultural use, and as explained hereafter, there may also be continuous lines of orientated plastics material running through the structure in the direction at right angles to the first direction, providing structures which can be used for instance fishing nets. The method gives good control of the exact position of orientation and enables good sized thicker zones to be left in the junctions, which are more resistant to shock loads.

Description of Preferred Embodiments

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

Figures 1a and 1b show a starting material and finished structure using the invention;

Figures 2a to 2c show the junctions in Figure 1b on a larger scale, at three different stages of stretching (Figure 2c is on a larger scale than that

of Figures 2a and 2b).

Figure 3 shows various shapes for the holes or depressions in the starting material;

Figure 4 shows a way of punching the starting material;

Figure 5 shows a finished structure designed for a particular purpose;

Figures 6a to 6c show various edge shapes; and

Figure 7 shows a plant for producing a mesh structure in accordance with the invention.

In Figure 1a, the starting material is in the form of a plastics material sheet 1 having substantially planar, parallel faces and comprising a pattern of holes or depressions 2 whose centres are on a diamond or rhombus grid, in two sets of parallel lines which are at a substantial angle to each other. In effect, the holes or depressions 2 are staggered and in rows; although the holes or depressions 2 of adjacent rows preferably overlap, this is believed not to be essential.

The holes or depressions 2 are aligned in the vertical direction (looking at Figure 1a) with the respective holes or depressions 2 of the next row but one.

On stretching in the vertical direction (looking at Figure 1a), i.e. at right angles to the rows, the zones indicated by x will stretch first and form orientated strands 3 (Figure 1b) interconnected by junctions 4 formed from the zones indicated by the notional rectangles y, z. The strands 3 are stretched to such an extent that the orientation passes down each side of the junction 4, forming orientated lateral zones 5 (Figure 2a) which extend parallel to the direction of stretching and pass on either side of single central zones or masses 6 of unorientated or less orientated plastics material. The crotches at the sides of the junction 4, between respective adjacent strands 3, are thus orientated, the preferred direction of orientation extending around each crotch. The strands 3 must have sufficient strength to stretch out the lateral zones 5.

It is believed that the notional rectangle y.z. should not be stretched first or instantaneously with the zones x, and that the structure of the invention may not always be produced even when the notional rectangle y.z. is stretched after the zones x. As a general indication without being limited thereby, it is believed that the dimension y should be substantially greater than the dimension z, and the ratio y:z is preferably at least 1.5:1 and suitably as large as practicable.

Figure 2a shows the first type of junction 4 which is produced, namely having a generally hexagonal, thicker central zone or blob 6 which extends from the upper crotch to the lower crotch, and acts as a tear blocker in these crotches, resisting tearing if the structure is tensioned in use in the direction at right angles to the direction of stretching during production. There are continuous lines of orientated plastics material running through the structure generally in the direction of stretching; each line comprising in succession the strand 3 of one mesh opening 7,

the lateral zone 5 of a junction 4, the strand 3 of the next mesh opening, and so on.

In the junction 4 of Figure 2*b*, further stretch has been applied in the first direction of stretch so that the central mass 6 is somewhat narrower and the lateral zones 5 are somewhat wider. The central mass 6 can still contain some unorientated plastics material, or at least plastics material which is substantially less orientated than that of the lateral zones 5.

The stretching in the first direction must be terminated before the centre of the central mass 6 is pulled out—if the stretching is continued, the centre of the mass 6 can be pulled right out and fully orientated.

To improve the strength of the material in the direction at right angles to the first direction of stretching, the structure can be stretched at right angles to the first direction of stretching to orientate the top and bottom ends of the blob or mass 6 shown in Figure 2*a* or 2*b* and produce the junction 4 shown in Figure 2*c*. In Figure 2*c*, the mass 6 is shown as being of generally square shape with the corners of the square directed towards the crotches between adjacent strands 3, but it may alternatively have a rather more rounded shape. There are lateral zones 5 completely surrounding (as seen in plan) the mass 6, each of the crotches having orientated plastics material whose direction of orientation runs around the crotch. In effect, there are now also continuous lines of orientated plastics material running through the structure in the direction normal to the first direction of stretching. Such a structure can be used for instance for fishing nets.

In the junction of any of Figures 2*a* to 2*c*, the mass 6 can have substantially the same thickness as that of the starting material and be at least twice as thick as the lateral zones.

40 Example 1

3 mm polypropylene sheet was punched with 3.18 mm diameter circular holes at a transverse pitch of 9.78 mm and a longitudinal pitch of 5.54 mm. The holes had their centres on two sets of notional parallel lines each making an angle of 30° with the transverse direction. Distances *x*, *y* and *z* were 2.54 mm, 6.60 mm and 2.36 mm, respectively, the *y*:*z* ratio being 2.8:1. The sheet was given a 7.5:1 stretch (measured after relaxation) in the longitudinal direction at 97°C, with no constraint in the transverse direction. The stretch ratio was measured by comparing the longitudinal dimensions of the holes before and after stretching. The structure produced was similar to that of Figure 2*a*. The thickness of the mid-point of the strands 3 was 1.12 mm, the thickness of the mass 6 was 2.93 mm and the thickness of the lateral zones 5 was 1.12 mm.

60 Example 2

1.5 mm HDPE (high density polyethylene) sheet was punched with 1.5 mm diameter circular holes at a diagonal pitch of 3 mm and a transverse pitch of 5.3 mm, and was given at

97°C a 7:1 overall stretch (measured after relaxation) in the longitudinal direction, with no constraint in the transverse direction, to produce a structure similar to that of Figure 2*b*.

Example 3

The product of Example 1 was stretched at 97°C in the transverse direction with no constraint in the longitudinal direction until the thickness of all the lateral zones 5, all the way round the central mass 6, was uniform. The structure produced was similar to that of Figure 2*c*.

Figure 1*a* shows a preferred shape for the holes or depressions 2, namely long-shaped and more particularly elliptical—another preferred shape is the slot with radiussed ends shown in Figure 3, left-hand side of the second row; these shapes reduce the amount of starting material required. If a single stretching operation is being carried out in an in-line process, the stretching operation is preferably carried out in the machine direction and the major axes of the holes or depressions 2 preferably extend parallel to the first direction of stretching. This in effect enables a wider mesh structure to be produced from a starting material of a fixed width. If two sequential stretching operations are being carried out, the first one may be in the transverse direction, in which case the major axes of the holes or depressions 2 can extend normal to the first direction of stretching. Figure 3 shows many different shapes which can be used for the holes or recesses 2. The holes or depressions preferably occupy substantially less than 50% or 25% of the plan view area of the sheet 1.

For increased tear strength, each strand 3 should be sufficiently deep (in relation to its width), where it passes into a junction; it is preferred for this reason that, at its mid-point (normally its narrowest part) each strand 3 should have a width which is not more than 1.5 times its depth; the relatively deep strands so produced act as tear blockers at the junctions. For this purpose, the dimension *x* should be suitably chosen in relation to the thickness (*d*) of the sheet 1, and the *x*:*d* ratio is preferably 1.5:1 or less, e.g. 1:1 or 1:1.5.

It is believed that, in theory, it does not matter whether the first stretching operation is carried out in the transverse direction or in the machine direction in a continuous production plant.

The starting material may be of flat form or tubular, and may be a mesh structure or a ribbed structure.

The starting material can be of any suitable thickness though in general terms a range of 0.125 to 12.5 mm is preferred, narrower preferred limits being at least 0.5 mm and at most 5 mm; the starting material can be in sheet form or tubular. The preferred starting material is strictly uniplanar, by which is meant that, ignoring any membrane (which may not lie on the median plane), all zones of the starting material are symmetrical about the median plane of the

starting material. Inherently, the stretched mesh structure produced from such a starting material according to this invention, will also have all its zones symmetrical about its median plane, i.e. the plane in which the net will lie if laid out flat.

However, insubstantial departures from uniplanarity are not excluded. The holes (or depressions if suitable) can be formed by punching or by forming them as the starting material itself is formed, obturating a slit die for instance generally as in French Patent Specification No. 368 393. If the starting material is tubular, it can be punched in flat form as a "lay-flat" tube. As shown in Figure 4, the edge folds of the lay-flat tube 11 can be punched so that the pattern of holes around the whole periphery of the tube is substantially uniform.

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 depression can be ruptured during stretching and the residual film-like material removed.

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

The starting material can be any suitable thermoplastics material, such as for instance HDPE, low density polyethylene, polypropylene, copolymers of HDPE and polypropylene, and polyamides. The starting material can have a skin on each face containing an ultra-violet stabiliser. To enable the mesh structure to be used for laminating, whether to one or more like mesh structures or to one or more different materials such as fabric or film, the starting material may have a special layer on one or both faces. This layer may be of a substance such as low density polyethylene or ethylene vinyl acetate which melts or becomes tacky at a temperature at which the main component of the structure would not de-orientate. The layer or layers could be produced by extrusion coating or coextrusion.

After stretching, the structures can be annealed in a manner well known.

Figure 5 illustrates that the structure need not be uniform along its length, and that specific non-uniformities can be introduced for specific purposes, for instance to produce a carrier bag. In the case as shown in Figure 5, the structure 12 is of tubular form and at regular intervals has an unstretched piece of unperforated plastics material 13, and an unstretched piece of plastics material 14, which has holes 15 for a carrying handle. The tube is cut along the dot-dash lines 16, and can either be sealed across the piece 13 or across the piece 14, as desired, to produce a top-filled or bottom-filled, pre-packed carrier bag.

Figures 6a to 6c show that, for instance for a fishing net, a selvage 17 (see Figure 1b) can be provided by forming a wavy edge 18 on the starting material (Figure 6a shows an alternative in dashed lines). Thus, the starting material has a non-rectilinear edge 18, in effect being in the form

of loops, so that when the starting material is stretched, the edge zones stretch to an effective ratio which is less than the stretch ratio applied to the starting material as a whole and which is not substantially greater than that of the zones between immediately adjacent holes or depressions in each line. In this way, the selvage 17 is not over-stretched. The selvage 17 can be made wider and/or thicker than the strands 3 by suitably widening the wavy edge 17 and/or thickening it.

The finished structures of the invention will be packaged in the normal way, for instance in the form of a roll, for commercial sale.

Figure 7 shows a plant that can be used for the commercial production for the mesh structure. The plant is shown schematically, but the units themselves are conventional units.

There is a let-off unit 21 supporting a roll 22 of unperforated starting material which passes through the plant along the path indicated by the dashed lines and arrows. The starting material passes through a sheet flattening unit 23, a perforator 24, a transverse direction orientation (stretching) machine 25, a machine direction orientation (stretching) machine 26 and is wound up on a wind-up unit 27. In the second orientation machine 26, one should avoid too short a distance between the nips in order to allow some sideways contraction of the mesh structure. The first orientation machine will be omitted if the structure of Figure 2a or 2b is being produced.

Claims

1. A method of producing an integral plastics material diamond mesh structure comprising:

providing substantially uniplanar plastics starting material comprising a pattern of holes or depressions whose centres are on two sets of notional parallel lines which are at a substantial angle to each other; and

stretching the starting material in a direction at a substantial angle to each set of lines to draw out into orientated strands the zones between immediately adjacent holes or depressions in each line and form mesh openings, which strands are interconnected by junctions formed from the zones between pairs of holes or depressions which are adjacent in the direction of stretching, which junctions are orientated along their lateral zones which extend parallel to the direction of stretching, to provide continuous lines of orientated plastics material running through the structure generally in the direction of stretching, each line comprising in succession a strand, the lateral zone of a junction, another strand, the lateral zone of the next junction, and so on, each junction having between its lateral zones a single zone which is either unorientated or substantially less orientated than the lateral zones, which single zone extends as far as the two opposite crotches (between respective adjacent strands) which are generally aligned in the direction of stretching.

2. The method of Claim 1, wherein the



starting material. Inherently, the stretched mesh structure produced from such a starting material according to this invention, will also have all its zones symmetrical about its median plane, i.e. the plane in which the net will lie if laid out flat. However, insubstantial departures from uniplanarity are not excluded. The holes (or depressions if suitable) can be formed by punching or by forming them as the starting material itself is formed, obturating a slit die for instance generally as in French Patent Specification No. 368 393. If the starting material is tubular, it can be punched in flat form as a "lay-flat" tube. As shown in Figure 4, the edge folds of the lay-flat tube 11 can be punched so that the pattern of holes around the whole periphery of the tube is substantially uniform.

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 depression can be ruptured during stretching and the residual film-like material removed.

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

The starting material can be any suitable thermoplastics material, such as for instance HDPE, low density polyethylene, polypropylene, copolymers of HDPE and polypropylene, and polyamides. The starting material can have a skin on each face containing an ultra-violet stabiliser. To enable the mesh structure to be used for laminating, whether to one or more like mesh structures or to one or more different materials such as fabric or film, the starting material may have a special layer on one or both faces. This layer may be of a substance such as low density polyethylene or ethylene vinyl acetate which melts or becomes tacky at a temperature at which the main component of the structure would not de-orientate. The layer or layers could be produced by extrusion coating or coextrusion.

After stretching, the structures can be annealed in a manner well known.

Figure 5 illustrates that the structure need not be uniform along its length, and that specific non-uniformities can be introduced for specific purposes, for instance to produce a carrier bag. In the case as shown in Figure 5, the structure 12 is of tubular form and at regular intervals has an unstretched piece of unperforated plastics material 13, and an unstretched piece of plastics material 14, which has holes 15 for a carrying handle. The tube is cut along the dot-dash lines 16, and can either be sealed across the piece 13 or across the piece 14, as desired, to produce a top-filled or bottom-filled, pre-packed carrier bag.

Figures 6a to 6c show that, for instance for a fishing net, a selvage 17 (see Figure 1b) can be provided by forming a wavy edge 18 on the starting material (Figure 6a shows an alternative in dashed lines). Thus, the starting material has a non-rectilinear edge 18, in effect being in the form

of loops, so that when the starting material is stretched, the edge zones stretch to an effective ratio which is less than the stretch ratio applied to the starting material as a whole and which is not substantially greater than that of the zones between immediately adjacent holes or depressions in each line. In this way, the selvage 17 is not over-stretched. The selvage 17 can be made wider and/or thicker than the strands 3 by suitably widening the wavy edge 17 and/or thickening it.

The finished structures of the invention will be packaged in the normal way, for instance in the form of a roll, for commercial sale.

Figure 7 shows a plant that can be used for the commercial production of the mesh structure. The plant is shown schematically, but the units themselves are conventional units.

There is a let-off unit 21 supporting a roll 22 of unperforated starting material which passes through the plant along the path indicated by the dashed lines and arrows. The starting material passes through a sheet flattening unit 23, a perforator 24, a transverse direction orientation (stretching) machine 25, a machine direction orientation (stretching) machine 26 and is wound up on a wind-up unit 27. In the second orientation machine 26, one should avoid too short a distance between the nips in order to allow some sideways contraction of the mesh structure. The first orientation machine will be omitted if the structure of Figure 2a or 2b is being produced.

Claims

1. A method of producing an integral plastics material diamond mesh structure comprising: providing substantially uniplanar plastics starting material comprising a pattern of holes or depressions whose centres are on two sets of notional parallel lines which are at a substantial angle to each other; and stretching the starting material in a direction at a substantial angle to each set of lines to draw out into orientated strands the zones between immediately adjacent holes or depressions in each line and form mesh openings, which strands are interconnected by junctions formed from the zones between pairs of holes or depressions which are adjacent in the direction of stretching, which junctions are orientated along their lateral zones which extend parallel to the direction of stretching, to provide continuous lines of orientated plastics material running through the structure generally in the direction of stretching, each line comprising in succession a strand, the lateral zone of a junction, another strand, the lateral zone of the next junction, and so on, each junction having between its lateral zones a single zone which is either unorientated or substantially less orientated than the lateral zones, which single zone extends as far as the two opposite crotches (between respective adjacent strands) which are generally aligned in the direction of stretching.

2. The method of Claim 1, wherein the

structure is subsequently stretched in a direction substantially at right angles to the first direction of stretching, to further stretch the junctions and form from said single zone an orientated zone in and adjacent each of the remaining two crotches between pairs of adjacent strands with the preferred direction of orientation extending around the crotches, and a central zone comprising the residual unorientated or less orientated plastics material.

3. The method of Claim 1 or 2, wherein the holes or depressions are long-shaped with their major axes substantially parallel to the (first) direction or to the second direction of stretching.

4. The method of Claim 3, wherein the holes or depressions are elliptical.

5. The method of any one of the preceding Claims, wherein the holes or depressions are in rows extending generally at right angles to the (first) stretching direction, the holes or depressions being generally aligned, in the (first) stretching direction, with the holes or depressions of the next row but one, the holes or depressions of adjacent rows overlapping.

6. The method of any one of the preceding Claims, wherein the holes or depressions are in rows extending generally at right angles to the (first) stretching direction, the holes or depressions being generally aligned, in the (first) stretching direction, with the holes or depressions of the next row but one, the distance between the sides of two adjacent holes or depressions in the same row being substantially greater than the distance between the side of one hole or depression and the side of the generally aligned hole or depression in the next row but one.

7. The method of Claim 6, wherein the former distance is at least 1.5 times the latter distance.

8. The method of any one of the preceding Claims, wherein the starting material has a non-rectilinear edge so that when the starting material is stretched, the edge zones are stretched to a ratio which is not substantially greater than that of the zones between immediately adjacent holes or depressions in each line.

9. An integral plastics material mesh structure, produced by the method of any one of the preceding Claims.

10. An integral plastics material diamond mesh structure, comprising mesh openings defined between orientated strands and junctions interconnecting the strands, substantially each junction having orientated lateral zones which provide continuous lines of orientated plastics material running through the structure, each line comprising in succession a strand, the lateral zone of a junction, another strand, the lateral zone of the next junction, and so on, each junction having

between its lateral zones a single zone of plastics material which is thicker than the lateral zones and is either unorientated or substantially less orientated than the lateral zones, which single zone forms at least part of two opposite crotches between respective adjacent strands interconnected by the junction.

11. The method or structure of any one of the preceding Claims, wherein said single zone is of generally hexagonal shape with two opposite sides thereof in said crotches.

12. The method or structure of any one of Claims 1 to 10, wherein said single zone is of generally rectangular shape with two opposite sides thereof in said crotches.

13. An integral plastics material diamond mesh structure, comprising mesh openings defined between orientated strands and junctions interconnecting the strands, substantially each junction having all its lateral zones orientated, so providing continuous lines of orientated plastics material running through the structure, each line comprising in succession a strand, and lateral zone of a junction, another strand, the lateral zone of the next junction, and so on, substantially each junction having a central zone of plastics material which is thicker than the lateral zones and is either unorientated or substantially less orientated than the lateral zones, the central zone being completely surrounded (as seen in plan) by the orientated plastics material of the lateral zones.

14. The structure of Claim 13, wherein the central zone is of generally square shape with the corners of the square directed towards the crotches between adjacent strands interconnected by the junction.

15. The method or structure of any one of the preceding Claims, wherein, at its narrowest part, the width of each strand is not more than 1.5 times its depth.

16. The method of Claim 1 and substantially as herein described.

17. The method of producing an integral plastics material mesh structure substantially as herein described in any one of the Examples.

18. The method of producing an integral plastics material mesh structure, substantially as herein described with reference to any one of Figures 2a to 6c of the accompanying drawings.

19. The integral plastics material diamond mesh structure substantially as herein described in any one of the Examples.

20. The integral plastics material diamond mesh structure substantially as herein described with reference to, or as shown in, any one of Figures 2a to 6c of the accompanying drawings.



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ERRATUM

SPECIFICATION No. 2 034 240 B

Page 1, line 114, for y:2 read y:z

THE PATENT OFFICE

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