SUMMARY OF THE INVENTION

To attain the aforementioned higher degree of stiffness and other desirable characteristics, the present invention employs a coextruded multilayer polymer sheet as the starting material for the fabrication of the integral geogrid.

The experiments described herein support the inventors' theory that by virtue of the inventive construction, the coextruded multilayer sheet components provide a crystalline synergistic effect during extrusion and orientation, resulting in enhanced material properties that provide performance benefits to use of the integral geogrid in soil geosynthetic reinforcement.

According to a first aspect, there is provided an integral geogrid comprising a plurality of interconnected, oriented strands having an array of openings therein, the integral geogrid being produced from a multilayer polymer starting sheet having an initial thickness of at least about 2 mm and layers of polymeric materials in which at least two of the layers are different from one another, and being formed in a single coextrusion, and the plurality of interconnected, oriented strands being oriented by post-extrusion stretching.

According to a second aspect, there is provided a starting material for making an integral geogrid comprising a

multilayer polymer starting sheet having layers of different materials and formed in a single coextrusion, and having holes or depressions therein that provide openings when the starting sheet is uniaxially or biaxially stretched.

According to a third aspect, there is provided a method of making an integral geogrid, comprising: providing a multilayer polymer starting sheet having an initial thickness of at least about 2 mm and adjacent layers of polymeric materials that are different from one another, with the multilayer polymer starting sheet being formed in a single coextrusion; providing a patterned plurality of holes or depressions in the coextruded multilayer polymer starting sheet; and orienting the coextruded multilayer polymer starting sheet having the patterned plurality of holes or depressions therein by stretching, to provide a plurality of interconnected, oriented strands and to configure the holes or depressions as grid openings.

According to a fourth aspect, there is provided a method of providing an integral geogrid construction, comprising: uniaxially or biaxially stretching a starting material that is a multilayer polymer starting sheet having layers of different materials and formed in a single coextrusion, and having a patterned plurality of holes or depressions therein, to provide an integral geogrid having a

plurality of oriented strands and a plurality of grid openings; and embedding the integral geogrid in a mass of particulate material.

According to a fifth aspect, there is provided an integral geogrid comprising a plurality of interconnected, oriented strands having an array of openings therein, the integral geogrid being produced from a multilayer polymer starting sheet having layers of polymeric materials in which at least two of the layers are different from one another, and being formed in a single coextrusion, and the oriented strands having an aspect ratio of greater than 1.0.

According to one embodiment of the present invention, a starting material for making an integral geogrid includes a coextruded multilayer polymer sheet having holes or depressions therein that provide openings when the starting material is uniaxially or biaxially stretched.

According to another embodiment of the present invention, an integral geogrid includes a plurality of highly oriented strands interconnected by partially oriented junctions and having an array of openings therein that is produced from a coextruded multilayer polymer sheet. According to one embodiment of the invention, the integral geogrid is a triaxial integral geogrid.

material 100 has been stretched and oriented into the upper layer 230 of the strands 205 and junctions 235. Similarly, the third or lower layer 110 of the starting material 100 has been stretched and oriented into the lower or underneath layer 210 of the strands 205 and junctions 235. As the first layer 130 and third layer 110 are being stretched and oriented, the second or middle layer 120 is also being stretched and oriented into middle layer 220 of both the strands 205 and junctions 235.

As indicated above, Figure 7 is a side cross-sectional view of the section of the triaxial integral geogrid shown in Figure 4. And, as is evident from Figure 7, the strand 205 has what is known to one skilled in the art as a high aspect ratio, i.e., a ratio of the thickness or height of the strand cross section to the width of the strand cross section that is greater than 1.0. Such a high aspect ratio structure is disclosed in U.S. Patent No. 9,556,580 to Walsh and in U.S. Patent No. 10,024,002 to Walsh, both of which are assigned to Tensar Technologies Limited, another associated company of the assignee of the instant application for patent. The subject matter of the foregoing patent Nos. 9,556,580 and 10,024,002 is expressly incorporated into this specification by reference as if the disclosures were set forth herein in their entireties.

The invention also relates to a method of making the above-described triaxial integral geogrid 200. The method includes: providing the coextruded multilayer polymer sheet 100; forming a plurality of holes or depressions in the coextruded multilayer polymer sheet 100 in a selected pattern, such as in accordance with the disclosure of the Walsh ’112 patent; and biaxially stretching and orienting the coextruded multilayer polymer sheet having the patterned plurality of holes or depressions therein to form an integral geogrid having a plurality of interconnected, oriented strands between partially oriented junctions and to configure the holes or depressions as grid openings.

In general, once the coextruded multilayer polymer sheet 100 has been prepared with holes or depressions, the triaxial integral geogrid 200 can be produced from the sheet

WHAT IS CLAIMED IS:

1. An integral geogrid comprising:

a plurality of interconnected, oriented strands having an array of openings therein,

the integral geogrid being produced from a multilayer polymer starting sheet having an initial thickness of at least about 2 mm and layers of polymeric materials in which at least two of the layers are different from one another, and being formed in a single coextrusion, and

the plurality of interconnected, oriented strands being oriented by post-extrusion stretching.

2. The integral geogrid according to claim 1, wherein the oriented strands have been uniaxially or biaxially stretched.

3. The integral geogrid according to claim 1, wherein the coextruded multilayer polymer starting sheet includes a first layer, a second layer, and a third layer, with the first layer and the third layer being arranged on opposite planar surfaces of the second layer.

4. The integral geogrid according to claim 1, wherein the coextruded multilayer polymer starting sheet has a thickness of from about 2 mm to about 12 mm.

5. The integral geogrid according to claim 3, wherein the first layer has a thickness of from about 0.5 mm to about 4.5 mm, the second layer has a thickness of from about 1 mm to about 9 mm, and the third layer has a thickness of from about 0.5 mm to about 4.5 mm.

6. The integral geogrid according to claim 3, wherein the first layer has a material of construction of a high molecular weight polyolefin, the second layer has a material of construction of a broad specification polymer, and the third layer has a material of construction of a high molecular weight polyolefin.

7. The integral geogrid according to claim 6, wherein the high molecular weight polyolefin of the first layer is a polypropylene, the broad specification polymer of the second layer is a post-industrial polypropylene, and the high molecular weight polyolefin of the third layer is a polypropylene.

8. The integral geogrid according to claim 1, wherein the plurality of interconnected, oriented strands includes transverse strands interconnected by substantially longitudinally oriented strands.

9. The integral geogrid according to claim 1, wherein the integral geogrid is configured for structural or construction reinforcement purposes.

10. A starting material for making an integral geogrid comprising a multilayer polymer starting sheet having layers of different materials and formed in a single coextrusion, and having holes or depressions therein that provide openings when the starting sheet is uniaxially or biaxially stretched.

11. The starting material according to claim 10, wherein the coextruded multilayer polymer starting sheet includes a first layer, a second layer, and a third layer, with the first layer and the third layer being arranged on opposite planar surfaces of the second layer.

12. The starting material according to claim 10, wherein the coextruded multilayer polymer starting sheet has an initial thickness of at least 2 mm.

13. The starting material according to claim 10, wherein the coextruded multilayer polymer starting sheet has a stretched thickness of from about 0.2 mm to about 9 mm.

14. The starting material according to claim 10, wherein the coextruded multilayer polymer starting sheet once stretched exhibits an increased flexural stiffness and torsional rigidity relative to the flexural stiffness and torsional rigidity of a non-coextruded sheet having a substantially same starting thickness.

15. A soil construction comprising a mass of particulate material strengthened by embedding therein an integral geogrid as claimed in claim 1.

16. A method of strengthening a mass of particulate material, comprising embedding in the mass of particulate material the integral geogrid as claimed in claim 1.

17. A method of making an integral geogrid, comprising:

providing a multilayer polymer starting sheet having an initial thickness of at least about 2 mm and adjacent layers of polymeric materials that are different from one another, with the multilayer polymer starting sheet being formed in a single coextrusion;

providing a patterned plurality of holes or depressions in the coextruded multilayer polymer starting sheet; and

orienting the coextruded multilayer polymer starting sheet having the patterned plurality of holes or depressions therein by stretching,

to provide a plurality of interconnected, oriented strands and to configure the holes or depressions as grid openings.

18. The method according to claim 17, wherein the coextruded multilayer polymer starting sheet having the patterned plurality of holes or depressions therein is oriented by uniaxial or biaxial stretching.

19. The method according to claim 17, wherein the coextruded multilayer polymer starting sheet includes a first layer, a second layer, and a third layer, with the first layer and the third layer being arranged on opposite planar surfaces of the second layer.

20. The method according to claim 17, wherein the coextruded multilayer polymer starting sheet has an initial thickness of at least 2 mm.

21. The method according to claim 19, wherein the first layer has a thickness of from about 0.5 mm to about 4.5 mm, the second layer has a thickness of from about 1 mm to about 9 mm, and the third layer has a thickness of from about 0.5 mm to about 4.5 mm.

22. The method according to claim 19, wherein the first layer has a material of construction of a high molecular weight polyolefin, the second layer has a material of construction of a broad specification polymer, and the third layer has a material of construction of a high molecular weight polyolefin.

23. A method of providing an integral geogrid construction, comprising:

uniaxially or biaxially stretching a starting material that is a multilayer polymer starting sheet having layers of different materials and formed in a single coextrusion, and having a patterned plurality of holes or depressions therein, to provide an integral geogrid having a plurality of oriented strands and a plurality of grid openings; and

embedding the integral geogrid in a mass of particulate material.

24. The integral geogrid according to claim 1, wherein the integral geogrid is a triaxial integral geogrid.

25. The method according to claim 17, wherein the integral geogrid is a triaxial integral geogrid.

26. The method according to claim 17, wherein the integral geogrid is a uniaxial integral geogrid.

27. The method according to claim 17, wherein the integral geogrid is a biaxial integral geogrid.

28. The method according to claim 17, wherein the integral geogrid includes a color identification layer.

29. An integral geogrid comprising:

a plurality of interconnected, oriented strands having an array of openings therein,

the integral geogrid being produced from a multilayer polymer starting sheet having layers of polymeric materials in which at least two of the layers are different from one another, and being formed in a single coextrusion, and

the oriented strands having an aspect ratio of greater than 1.0.