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(71) Applicant: **Autoliv Development AB**

447 83 Vårgårda (SE)

(72) Inventors:

• **Stow David**

41678 Gothenburg (SE)

• **Finn Hugh**

Culcheth, Warrington WA3 4LG (GB)

• **Prat Jean Francois**

76000 Rouen (FR)

(74) Representative: **Beattie, Alex Thomas Stewart**

Forresters

Skygarden

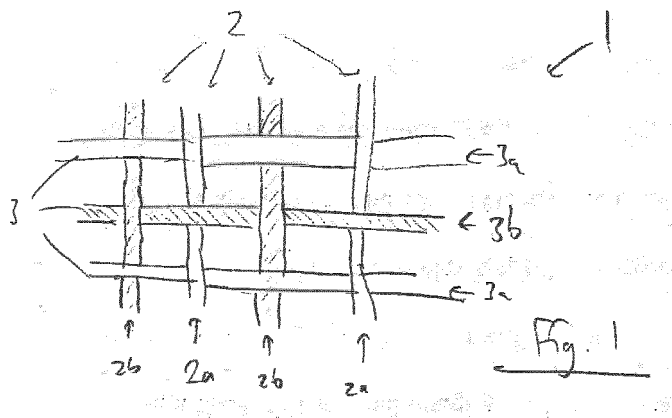
Erika-Mann-Strasse 11

80636 München (DE)

(54) **Improvements in or relating to air-bag material**

(57) A fabric for use in forming a vehicle air-bag, the fabric being formed from a plurality of yarns, at least some

of the yarns being formed partially or entirely from recycled polymer material.



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Description

Description of Invention

[0001] Almost all vehicle air-bags that are currently in production are principally formed from woven materials, which form the main flexible panels of the air-bag. Conventionally, these panels are woven from a nylon material, although other materials, such as polyester, are also in use.

[0002] Because of the potentially life-threatening consequences of vehicle air-bags failing to perform properly, air-bags are generally formed from polymer materials, such as nylon or polyester, which are manufactured directly from new, "virgin" sources. It is recognised that such materials will have the best mechanical characteristics and reliability. However, as those skilled in the art will know, these sources are invariably derived from oil. Manufacturers of such air-bags are therefore at the mercy of significant and unpredictable price fluctuations. At the same time, all industries are under pressure to reduce the quantity of oil that is consumed, since oil is a finite resource, and the search for, and extraction of, new sources of oil can cause many different types of harm to the Earth's environment.

[0003] It is an object of the present invention to seek to address this problem.

[0004] Accordingly, one aspect of the present invention provides a fabric for use in forming a vehicle air-bag, the fabric being formed from a plurality of yarns, at least some of the yarns being formed partially or entirely from recycled polymer material.

[0005] Conveniently, the yarns are elongate yarns.

[0006] Advantageously, some of the yarns are formed substantially from recycled polymer material.

[0007] Preferably, at least some of the yarns are formed from material which is a blend of new polymer material and recycled polymer material.

[0008] Conveniently, the fabric comprises a mixture of new yarns and blended yarns.

[0009] Advantageously, at least some of the yarns are formed substantially entirely from material derived from new polymer material.

[0010] Preferably, the fabric comprises a mixture of first yarns formed substantially entirely from new polymer sources, and second yarns formed substantially entirely from recycled polymer sources.

[0011] Conveniently, the proportion of new and recycled yarns is around 50/50.

[0012] Advantageously, the proportion of new and recycled yarns is between 50/50 and 20/80

[0013] Alternatively, the proportion of new and recycled yarns is between 50/50 and 80/20.

[0014] Preferably, the fabric comprises a mixture of blended yarns and recycled yarns.

[0015] Conveniently, the fabric comprises a mixture of first blended yarns, having a first mix of new and recycled material, and second blended yarns, having a separate

second different mix of new and recycled material. Advantageously, the fabric comprises first and second sets of yarns arranged substantially at right angles to one another, wherein the proportion of recycled material in the first set of yarns is greater than that in the second set of yarns.

[0016] Another aspect of the present invention provides an air-bag formed from a fabric according to any preceding claim.

[0017] Preferably, the air-bag comprises first yarns and second yarns, and wherein the first yarns are expected to be exposed, during deployment of the air-bag, to greater forces than the second fibres, and wherein the proportion of recycled material in the second yarns is greater than the proportion of recycled material in the first yarns.

[0018] A further aspect of the present invention provides a method of manufacturing an air-bag, comprising the steps of: providing first and second yarns, the proportion of recycled material in the second yarns being greater than the proportion of recycled material in the first yarns; selecting a first region or yarn direction of the air-bag, and a second region or yarn direction of the air-bag, wherein the first region or yarn direction is expected to be exposed, during deployment of the air-bag, to greater forces than the second region or yarn direction; and forming the air-bag so that the second yarns comprise the second region or yarn direction of the air-bag and the first yarns comprise the first region or yarn direction of the air-bag.

[0019] In order that the present invention may be more readily understood embodiments thereof will now be described, by way of example, with reference to the accompanying drawings, in which figure 1 shows a schematic view of a fabric embodying the present invention.

[0020] It is an object of this invention to incorporate recycled polymer material into air-bag fabrics. However, those of skill in the art will appreciate that the mechanical and other properties of recycled polymers are generally inferior to materials manufactured directly from new or "virgin" polymer sources, e.g. oil. The manufacture of air-bag fabrics has generally been a trade-off between the provision of materials that are light and flexible, so that the size, weight and cost of the air-bag module can be minimised, and providing materials of a very high strength, so that the air-bags perform reliably under the very high forces encountered during vehicle impacts. Unlike the use of recycled polymer material to manufacture, for instance, plastic bottles and park benches, there has been considerable resistance in the air-bag industry to the introduction of recycled material. Even a relatively small increase in the weight of air-bag fabric (typically expressed in kg/m²), or decrease in the tensile strength of the fabrics used to form the air-bag (generally measured in Cn/tex) has been perceived as certain to make the resulting air-bag unwieldy, expensive, unsafe and/or commercially uncompetitive.

[0021] A further additional difficulty is that, while recy-

cled polymer material may perform reasonably well in injection moulding, recycled polymer materials generally perform less well in extrusion procedures, such as those used to form the yarns from which air-bag fabrics are woven.

[0022] These factors have contributed to a significant prejudice against the use of recycled materials by workers in this technical field.

[0023] Referring to figure 1, a region of a first fabric 1 embodying the present invention is shown. As is known in the art, the fabric 1 includes a plurality of warp fibres or yarns 2, which are substantially parallel with one another and are interwoven with a plurality of weft fibres or yarns 3. In preferred embodiments the fibres 2,3 are interwoven so that, as each warp fibre 2 is followed along its length, it passes alternately over and under successive weft fibres 3 that are encountered. Similarly, as each weft fibre 3 is followed along its length, it passes alternately under and over successive warp fibres 2 that are encountered.

[0024] The warp fibres 2 comprise substantially equal numbers of first warp fibres 2a, which are formed from a polymer material derived from a new or "virgin" polymer source (hereafter referred to as "new polymer materials"), and second warp fibres 2b, which are formed substantially entirely from recycled polymer material.

[0025] In preferred embodiments the weft fibres 3 also comprise a substantially even mix of first weft fibres 3a, which are formed substantially entirely from new polymer material, and second weft fibres 3b, which are formed substantially entirely from recycled polymer material.

[0026] In one embodiment, the fabric 1 is formed generally from a nylon material. In this case, the second warp fibres 2b and the second weft fibres 3b may be formed from pellets of recycled nylon, for instance obtained from recycled items such as mechanical machine parts, bearings and so on.

[0027] In another embodiment, the fabric 1 may be formed substantially from a polyester material. In this case, the second fibres 2b and the second weft fibres 3b may be formed from, for example, material recovered from recycling PET bottles and the like.

[0028] The skilled person will be aware of other sources of recycled or recovered polymer material, depending on the polymeric material from which the air-bag 1 is to be made.

[0029] It has, surprisingly, been found by the inventors that the introduction of around 50% of yarns made from recycled polymer material, with the remainder of the fibres being formed from new polymer material, does not adversely affect the mechanical properties of the fabric 1 as much as expected. It has, in particular, been found that the strength of the fabric formed in this way may retain a tenacity above 40Cn/tex, both before and after aging, without a significant increase in the weight of the air-bag fabric. For certain designs of air-bag, this tenacity is sufficient to allow the air-bag to perform acceptably.

[0030] It has been found that, for fabrics that are to be

used under more demanding conditions, the proportion of fibres derived from new polymer material may need be as high as 80%, with the remaining 20% of fibres being formed substantially entirely from recycled polymer materials.

[0031] Conversely, for less demanding applications, it has been found that fabrics comprising 80% of fibres formed substantially entirely from recycled polymer sources may be used, together with as little as 20% of fibres formed substantially entirely from new polymer sources.

[0032] In other embodiments of the invention, yarns may be formed from a polymer material which comprises a blend of new material and recycled material. The new and recycled polymer material can be mixed and melted so that the materials are combined and blended together, and the resulting material can then be extruded to form yarns that can be used to weave fabric.

[0033] In some embodiments, fabric may be formed from warp and weft yarns, all of which are formed from blended new and recycled polymeric material. Preferably, the proportions of the blend are substantially the same in all of the fibres.

[0034] In further embodiments, however, a fabric may be woven from a mixture of blended fibres and fibres formed substantially entirely from new polymer material. In some embodiments, the proportion of new fibres to blended fibres may be around 50%. However, depending upon the proportions of the blend used, and the purpose for which the air-bag is required, the proportion of blended fibres may be as great as 80%, or as little as 20%.

[0035] In still further embodiments, a fabric may be woven from a combination of blended fibres and fibres which are formed substantially entirely from recycled polymer sources. The strength of such a fabric may be reduced compared to other fabrics disclosed herein, depending on the proportions of the blend that is used to make the blended fibres. However, it has again been found that fabrics formed in this way may perform acceptably for certain applications.

[0036] Once again the proportion of blended fibres may be as high as 80%, or as low as 20%.

[0037] In yet further embodiments, a fabric may be formed from a combination of new fibres, blended fibres and recycled fibres.

[0038] The proportion of each type of fibre that is used will depend upon the required strength of the fabric, and the proportions of the blend. It is anticipated that the proportion of each type of fibre may be between 10% and 50%. For instance, an example fabric may comprise 10% new fibres, 50% blended fibres and 40% recycled fibres.

[0039] It is envisaged that, when weaving air-bag fabrics, manufacturers may be provided with three types of fibre, i.e. new fibres, blended fibres having a standard blending proportion and recycled fibres. When a fabric of a particular strength is required, these yarns can be mixed in the required proportions to achieve the necessary strength, whilst maximising the amount of recycled

material used in the fabric, and also balancing the use of the three types of yarn, so that stocks of any particular type of yarn are not depleted disproportionately quickly.

[0040] In further embodiments of the invention, a fabric may be formed from at least two different types of blended yarn, with the proportion of blending in each type of yarn being different. For instance, a fabric may be formed from a mix of relatively strong blended fibres, comprising 80% of material from new polymer sources and 20% of material from recycled polymer sources, and relatively weak blended fibres, comprising 80% of material from recycled polymer sources and only 20% from new polymer sources.

[0041] The proportion of strong blended fibres in the mix may be as high as 80%, or as low as 20%.

[0042] Indeed, it is envisaged that fabrics may be formed from a combination of new fibres, at least two different types of blended fibres, and recycled fibres. The skilled person will, from the discussion set out in this document, be able to establish how to compose a fabric of this type effectively.

[0043] In certain designs of air-bag, the mechanical properties of the air-bag in a first region, or in a first direction, are of particular importance. For instance, in the case of an inflatable curtain (IC)-type side air-bag, the air-bag generally unrolls downwardly from the ceiling line of the vehicle, to form an inflated curtain between the interior of the vehicle wall and a vehicle occupant. This type of air-bag is particularly useful in protecting occupants during a side collision or roll-over event.

[0044] In use of an IC-type air-bag, the strength (i.e. tenacity) of the fibres which extend in the forwards-backwards direction of the vehicle is of greater importance than the strength of the fibres which run in the vertical direction.

[0045] In certain embodiments of the invention, the fibres used to form the weft fibres may be different to those used to form the warp fibres. For instance, the proportion of different types of fibres may be different, or the blended materials used in some or all of the fibres may be different.

[0046] Returning to the example of an IC air-bag, the warp fibres of a fabric may be those which substantially lie in the forward-backward direction of the vehicle, when the air-bag is deployed, and the weft fibres are those that are arranged substantially in the vertical direction. It will be understood that, in this arrangement, the strength of the warp fibres is of greater importance than the that of the weft fibres.

[0047] In this embodiment, the warp fibres may all, or substantially all, be formed from new polymer material, while the weft fibres may comprise a mix of new and recycled fibres, for instance a 50/50 mix.

[0048] In another embodiment, some or all of the warp fibres may be formed from a material which comprises a blend of around 80% of material from new polymer sources, with around 20% of polymer from recycled polymer sources. The weft fibres, on the other hand, may comprise a blend which is around 80% of polymer from re-

cycled polymer sources, and only 20% from new polymer sources.

[0049] The skilled person will appreciate from the discussion above that the proportion of blended fibres to new fibres and/or the proportion of recycled material that comprises the fibres, can influence the mechanical properties of the resulting fabric. In embodiments of the invention, the overall proportion of recycled material, per unit weight of the yarns, is greater in the warp or weft fibres than in the other of the warp/weft fibres.

[0050] It will be understood that embodiments of the present invention may provide fabrics which are practical and appropriate for use in forming vehicle air-bags, while helping to reduce costs and/or minimise the unpredictability of costs, and also reducing environmental damage and depletion of fossil resources.

[0051] In this specification the terms "yarn" and "fibre" are generally used interchangeably, except where the context may require a different interpretation.

[0052] When used in this specification and claims, the terms "comprises" and "comprising" and variations thereof mean that the specified features, steps or integers are included. The terms are not to be interpreted to exclude the presence of other features, steps or components.

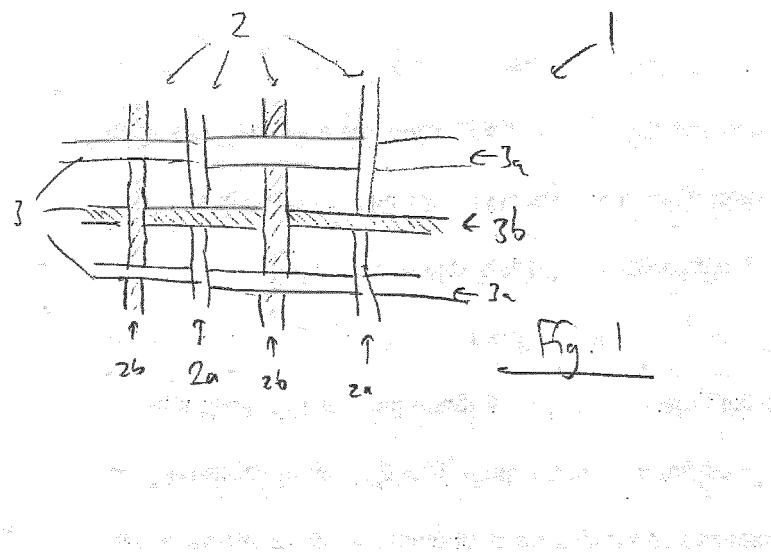
[0053] The features disclosed in the foregoing description, or the following claims, or the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately, or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

Claims

1. A fabric for use in forming a vehicle air-bag, the fabric being formed from a plurality of yarns, at least some of the yarns being formed partially or entirely from recycled polymer material.
2. A fabric according to claim 1, wherein some of the yarns are formed substantially from recycled polymer material.
3. A fabric according to claim 1 or 2, wherein at least some of the yarns are formed from material which is a blend of new polymer material and recycled polymer material.
4. A fabric according to claim 3, comprising a mixture of new yarns and blended yarns.
5. A fabric according to any preceding claim, wherein at least some of the yarns are formed substantially entirely from material derived from new polymer material.

6. A fabric according to any preceding claim, comprising a mixture of first yarns formed substantially entirely from new polymer sources, and second yarns formed substantially entirely from recycled polymer sources. 5
7. A fabric according to claim 6, wherein the proportion of new and recycled yarns is around 50/50.
8. A fabric according to claim 6 or 7 wherein the proportion of new and recycled yarns is between 50/50 and 20/80 10
9. A fabric according to claim 6 or 7 wherein the proportion of new and recycled yarns is between 50/50 and 80/20. 15
10. A fabric according to claim 3 to 4, comprising a mixture of blended yarns and recycled yarns. 20
11. A fabric according to any one of claims 3, 4 or 10, comprising a mixture of first blended yarns, having a first mix of new and recycled material, and second blended yarns, having a separate second different mix of new and recycled material. 25
12. A fabric according to any preceding claim, comprising first and second sets of yarns arranged substantially at right angles to one another, wherein the proportion of recycled material in the first set of yarns is greater than that in the second set of yarns. 30
13. An air-bag formed from a fabric according to any preceding claim. 35
14. An air-bag according to claim 13, comprising first yarns and second yarns, and wherein the first yarns are expected to be exposed, during deployment of the air-bag, to greater forces than the second fibres, and wherein the proportion of recycled material in the second yarns is greater than the proportion of recycled material in the first yarns. 40
15. A method of manufacturing an air-bag, comprising the steps of: 45
 - providing first and second yarns, the proportion of recycled material in the second yarns being greater than the proportion of recycled material in the first yarns; 50
 - selecting a first region or yarn direction of the air-bag, and a second region or yarn direction of the air-bag, wherein the first region or yarn direction is expected to be exposed, during deployment of the air-bag, to greater forces than the second region or yarn direction; and 55
 - forming the air-bag so that the second yarns comprise the second region or yarn direction of

the air-bag and the first yarns comprise the first region or yarn direction of the air-bag.





EUROPEAN SEARCH REPORT

Application Number
EP 12 17 6952

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 2012/015573 A1 (AKECHI TSUTOMU [JP] ET AL) 19 January 2012 (2012-01-19)	1-13	INV. D03D1/02
Y	* paragraphs [0001], [0028], [0029] *	14,15	
Y	US 5 865 464 A (KANUMA TADAO [JP] ET AL) 2 February 1999 (1999-02-02) * column 5, line 41 - column 6, line 44 * * column 8, line 58 - column 9, line 21 * * column 10, line 46 - column 11, line 8 * * figures 4-9 *	14,15	
			TECHNICAL FIELDS SEARCHED (IPC)
			D03D B60R
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 11 December 2012	Examiner Louter, Petrus
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 12 17 6952

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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