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**AT BE CH DE DK ES FR GB GR IE IT LI LU MC  
NL PT SE**(71) Applicant: **MONTEFIBRE S.p.A.**  
**Via Pola, 14**  
**I-20124 Milano (IT)**(72) Inventor: **Honorati, Giorgio**  
**Via Aldo Manuzio, 13**  
**I-20124 Milano (IT)**  
Inventor: **Carboneri, Daniele**  
**Via Vittorio Veneto, 11**  
**I-13047 San Germano Vercellese (IT)**  
Inventor: **D'Ettore, Camillo**  
**Via G. Verdi, 17**  
**I-20039 Varedo ( Milano ) (IT)**(74) Representative: **Fusina, Gerolamo et al**  
**Ing. Barzanò & Zanardo Milano S.p.A.**  
**Via Borgonuovo, 10**  
**I-20121 Milano (IT)**(54) **Polyester fibre-based thermoformable composite articles.**

(57) Linings obtained from fibres of two types of polyester of two different melting points are described.

These linings are thermoformable, because of the difference in melting points of the components, and recyclable at the end of their life because of their entirely polyester based composition.

These linings find application in the furnishing field and in particular for the manufacture of accessories for the automobile industry.

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This invention relates to polyester fibre based composite articles.

More specifically, the invention relates to composite articles shapeable at will by heat treatment, which are free from resins or adhesives or in any event do not comprise the use of polymers other than polyester.

The composite articles of the present invention may be used as linings for flat or undulated structures, for example in the furnishing field or, in particular, the automobile sector.

Synthetic fibre based composite articles are widely used in the automobile industry as internal linings, for example carpets, roof panel linings, rear window underpanel linings etc.

Such linings generally consist of a double layer, namely a felt-like exposed layer and a layer which confers shape to the article.

The exposed layer, known as the pile, is generally obtained by using fibres worked according to the needle punching method, whereby numerous barbed needles repeatedly penetrate a bed of fibres, deposited by dry or wet methods, which causes interweaving of the fibres to obtain a felt.

Polyamide, polypropylene or polyester fibres are generally used to produce this felt. An acrylic resin and/or polyethylene layer is subsequently added to the exposed layer, to adhere to this latter by means of heat treatment. In a further heat treatment at a higher temperature, the resin layer melts, becoming thermoformed to give the article its final shape. This resin layer is commonly known in the art as the backing, which will be the term used hereinafter in the description and claims.

Products obtained in this way, although widely used, present numerous drawbacks in their preparation stage and in their final characteristics.

In the first place, their preparation requires numerous production stages comprising:

- carding and needle punching of the fibres constituting the pile of the final product;
- resin bonding, ie the addition of the polymer which constitutes the backing to the felt produced in the preceding operation; and finally,
- thermoforming of the article.

Another drawback is the fact that resin bonding is potentially polluting and toxic, in that the acrylic resin or polyethylene are used in fine powder form which develops dust clouds during resin handling and loading.

A further drawback of these articles is the fact that the backing produced in the thermoforming operation is impermeable and non-transpirable making the articles thus obtained hygienically unsuitable for lining large surfaces.

Finally, these articles consist of materials which are chemically different, giving rise to problems in their reuse and recycling.

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In this respect, an economically accessible means of disposing of these articles at the end of their life is by dumping or burning them. This solution is, however, economically disadvantageous and goes against the general tendency to construct 100% recyclable articles, ie whereby every part may be reused or at least recycled for other uses at the end of its life.

Linings made from a single material have been proposed to overcome the above drawbacks, as for example carpets made entirely of polyester fibres marketed by the firm Hoechst-Celanese. This solution is unsuitable for constructing thermoformable linings, however. In this case, different layers of the same polyester fibres are used so that shaping of the article by heat treatment is impossible due to the equal melting points of the various layers.

An object of the present invention is to provide composite articles suitable for the production of thermoformable linings consisting of a single polymer material, and capable of overcoming the drawbacks previously described in the known art.

According to the present invention, this and further objects are attained by using a non-woven fabric formed from:

- an upper exposed part, known as the pile, consisting of polyester fibres; and
- a lower part, known as the backing, consisting of a blend of fibres of the same polyester as that of the upper part and of fibres consisting totally or partially of a low-melting copolyester, in which the low-melting part has a melting point at least 60 °C lower than that of the polyester used for the pile fibres.

The pile is obtained from polyester fibres with a count of between 0.8 and 30 dtex, preferably between 3 and 20 dtex.

Such fibres are produced by melt-spinning a polyester in which at least 95% of the acid radicals are terephthalic radicals, the remaining 5% being either radicals derived from other aromatic dicarboxylic acids eg isophthalic acid, 2,6-dinaphthalene-dicarboxylic acid etc, or aliphatic dicarboxylic acids; and in which at least 95% of the glycolic radicals derive from ethylene glycol, the remaining 5% being radicals derived from butyleneglycol, diethyleneglycol etc. The preferred polyester is polyethyleneterephthalate (PET) having an intrinsic viscosity of between 0.5 and 0.7 dl/g and a density of between 1.3 and 1.5 g/cm<sup>3</sup>. These fibres may contain small quantities of opacifiers, antistatic agents, antioxidants, optical whiteners etc. in accordance with formulation methods well known in the art. The fibres may be used undyed, or staple or spun-dyed, in accordance with methods known in the art.

The lower part of the articles (backing) consists of a blend of polyester fibres of the aforescribed

pile type and of thermobonding copolyester fibres having a count in the same range as those used for the pile. The ratio of the two types of fibre in the blend can vary within a wide range, even though weight ratios of between 80/20 and 20/80 are generally used. Blends in which the thermobonding fibre content is between 25 and 70 wt% are preferred.

The low-melting copolyester fibres are produced by melt-spinning a copolyester obtained by the well known method of polycondensing a mixture of dicarboxylic acids with a glycol or a mixture of glycols. The most used are those obtained by polycondensing terephthalic acid with one or more other dicarboxylic acids such as isophthalic acid, 2,6-naphthalene-dicarboxylic acid etc. with a glycol. In place of said acids their functional derivatives, such as esters or anhydrides, may be used for the preparation of the copolyesters. The glycol generally used is ethylene glycol, with the possible addition of variable percentages of diethyleneglycol.

The melting point of these fibres varies on the basis of their composition, and in particular of the mixture of acid radicals present in the fibre. For example, fibres obtained from a copolyester containing 90% of terephthalic radicals and 10% of isophthalic radicals have a melting point of about 60 °C less than fibres of pure polyethyleneterephthalate; with greater percentages of isophthalic residues, larger fibre melting point reductions are obtained. Fibres of this type are described for example in Japanese patent J-89-30926, in the name of the company Kuraray.

The acid part of the fibres in this patent consists of a mixture of terephthalic and isophthalic acids and the glycolic part consists of ethylene glycol and diethylene glycol, this latter component being present in quantities of between 5 and 25 mol% on the total composition.

The low-melting fibres may also be obtained by combining the aforescribed polyesters and copolyesters, to form bicomponent fibres. These fibres thus consist of a higher-melting part and a low-melting part acting as a binder at temperatures lower than the melting point of the polyester.

The combining of the two materials may be carried out according to known methods. In a first method the melted polyesters and copolyesters are extruded simultaneously through a spinneret, thus obtaining fibres known in the art as side-by-side. As an alternative the polyester and copolyester can be extruded using a special spinneret so as to obtain a bicomponent fibre in which a sheath of low-melting copolyester covers an interior high-melting part, termed sheath-core fibres.

The fibres used in the present invention for the preparation of the backing of thermoformable com-

posite articles are preferably of the sheath-core type.

The external part of these fibres consists of a copolyester of terephthalic and isophthalic acids in proportions varying between 50/50 and 90/10, esterified with ethylene glycol which may be substituted by diethylene glycol in a quantity varying between 2 and 25 mol%. This copolyester has an intrinsic viscosity of between 0.5 and 0.6 dl/g and a density of between 1.2 and 1.6 g/cm<sup>3</sup>.

Small quantities of opacifiers, anti-static agents etc may be added to the thermobonding fibres as in the case of the polyester fibres used for the pile.

According to a preferred embodiment of the present invention, the polyester based thermoformable composite articles of the present invention are produced by a process comprising the following stages:

a) preparing a non-woven fabric of polyester fibre for use as the pile in accordance with the following procedure:

- blending the fibres using conventional technology;
- preparing and carding a fibre bed using any type of woollen card;
- web-laying;
- passing through a needle punching device or a like method, to mechanically link together the fibres;
- possibly finally passing through a textile finishing machine suitable for improving the appearance and feel of the article (for example machines of the type DILOUR<sup>R</sup> and DILOOP<sup>R</sup> etc of the German firm Dilo).

The weight of the product thus obtained may vary between 300 and 800 g/m<sup>2</sup>.

b) preparing a non-woven fabric of mixed polyester plus thermobonding polyester composition for use as the backing, by the following procedure:

- blending the fibres using conventional technology;
- conventional carding, using any type of woollen card;
- web-laying;
- passing through a needle punching device or a like method, to mechanically link together the fibres.

The weight of the product thus obtained may vary between 200 and 500 g/m<sup>2</sup>.

c) joining together the non-woven fabrics obtained as described under points a) and b) by passing through a needle punching device or a similar machine (DILOUR<sup>R</sup>);

d) preforming; this operation is done by oven heating the article at a temperature in the range 150-180 °C for about 1-2 minutes.

The pile is joined to the backing (stage c) by using particular expedients which allow the aesthetic characteristics of the article produced in the preceding stages to be preserved. In particular, by using for example dilourised pile with dyed fibres, a backing with undyed fibres and assuming joining to take place by the needle punching device, this operation is carried out in such a way as to ensure that the needle penetrates from the backing towards the pile, taking care not to convey the white fibres of the undyed backing polyester onto the exposed surface, this being attainable by adjustment of the needle punching device.

The linings and carpets of the present invention are particularly suitable in the automobile sector for the first textile floor covering, for lining side doors, luggage compartment, roof panel, rear window underpanel and other thermoformed parts.

Such linings are also suitable as textile coverings for car furnishings and in any application where preformability of the product is required, for example as coverings for decorative parts in the furnishing sector.

The articles of the present invention, in addition to providing a solution to the drawbacks outlined in the introduction, are characterised by a high tensile strength and resistance to abrasion, have a fastness to light typical of polyester and are rot-proof, and have a greater flame resistance and transpirability than linings made of traditional backing.

Finally, the articles of the present invention are substantially monocomponent, consisting entirely of polyester, hence satisfying the recyclability requirements of current industrial trends, particularly in the automobile industry. Such articles may be recycled together with other polyethyleneterephthalate and/or polyethyleneisophthalate articles; recycling may be carried out by known methods such as depolymerising, regrading, extrusion recycling, etc.

The following illustrative examples are provided to enable the present invention to be better understood but in no way limit the scope of the invention. In the description of the examples, all the parts and percentages are by weight unless otherwise specified.

## EXAMPLE 1

### a) Preparation of the exposed part (pile)

A blending chamber is fed with 75 parts of spun-dyed polyester staple with the following characteristics:

- count: 17 dtex
- tenacity: >30 cN/tex
- extensibility: 70%
- length: 76 mm

and 25 parts of spun-dyed polyester staple with the

following characteristics:

- count: 3.6 dtex
- tenacity: >39 cN/tex
- extensibility: 54%
- length: 76 mm

This blend is sprayed with a solution consisting of water, a silicon based emulsion and an anti-static cohesioneing product, in such quantities as to give a final mixture containing 1% water, 1% silicon emulsion and 0.5% anti-static cohesioneing product. The fibre blend thus obtained is fed through a gravimetric feeder to a woollen card 2.5 m in height which produces a web of 10-12 g/m<sup>2</sup>.

The exit web is folded and superimposed by a web-laying apparatus and fed into a fixed flat woollen card 2.5 m in height, producing a web of 20 g/m<sup>2</sup>. The web produced by the second card is folded and subjected to the action of a malivlies 3.7 m in height. The non-woven fabric thus obtained is treated in a dilour which delivers 680 penetrations/cm<sup>2</sup> at an advancement speed of 3 m/min; the final weight is 400 g/m<sup>2</sup>.

### b) Preparation of the backing

A blending chamber is fed with 50 parts of undyed polyester staple with the following characteristics:

- count: 17 dtex
- tenacity: >35 cN/tex
- extensibility: 55%
- length: 76 mm

and 50 parts of thermobonding polyester staple with the following characteristics:

- count: 4.4 dtex
- tenacity: 24 cN/tex
- extensibility: 56%
- length: 51 mm

The staple blend is treated as described in point a), omitting however the last dilour treatment, to obtain a non-woven fabric with a weight of 400 g/m<sup>2</sup>.

### c) Joining the exposed part to the backing

The non-woven fabrics obtained under points a) and b) are joined together by treatment in a needle punching device using a table with 10,000 needles with a penetration of 1.04 mm and 75 pricks/cm<sup>2</sup>, obtaining a product with a weight of 800 g/m<sup>2</sup>.

### d) Preforming

The product obtained as described in c) is fed into an oven at 160 °C for 90 seconds and subsequently modelled with a mould of the desired shape.

**EXAMPLE 2****a) Preparation of the exposed part (pile)**

Spun-dyed polyester staple with the following characteristics:

- count: 17 dtex
- tenacity: >30 cN/tex
- extensibility: 70%
- length: 76 mm

is opened by means of a carding willow and opener and fed by means of a gravimetric and volumetric feeder into a woollen card 2.5 m high with a production rate in the range 250-300 kg/h. The product leaving the card is passed to the web-laying stage and subsequently to a pre-needle punching device with 1,500 needles of fineness 32. The pre-needled product obtained is then treated in a needle punching device with 11,500 needles of fineness 32 at 250 pricks/cm<sup>2</sup>. The product is subjected to dilour treatment, giving a non-woven fabric of 400 g/cm<sup>2</sup> and a pile height of 0.7 mm.

**b) Preparation of the backing**

A blending chamber is fed with 50 parts of undyed polyester staple with the following characteristics:

- count: 17 dtex
- tenacity: >35 cN/tex
- extensibility: 55%
- length: 76 mm

and 50 parts of thermobonding polyester staple with the following characteristics:

- count 4.4 dtex
- tenacity: 24 cN/tex
- extensibility: 56%
- length: 51 mm.

The two-staple blend is opened by a carding willow and opener and treated as described in point a), except for the dilour treatment, to obtain a product with a weight of 400 g/m<sup>2</sup>.

**c) Joining the exposed part to the backing**

The non-woven fabrics obtained at points a) and b) are joined together by treatment in a needle punching device using a table with 7,000 crown needles with a penetration of 0.7 mm and 100 pricks/cm<sup>2</sup>, obtaining a product with a weight of 800 g/m<sup>2</sup>.

**d) Preforming**

The product obtained as described in c) is fed into an oven at 160 °C for 90 seconds and subsequently modelled using a mould of the desired shape.

**Claims**

1. Thermoformable composite articles obtained by using a non-woven fabric formed from:
  - an upper exposed part, known as the pile, consisting of polyester fibres; and
  - a lower part, known as the backing, consisting of a blend of fibres of the same polyester as that of the upper part and of fibres consisting totally or partially of a low-melting copolyester, wherein the low-melting part has a melting point at least 60 °C lower than that of the polyester used for the pile fibres.
2. Articles as claimed in claim 1, wherein the fibres forming the pile are produced by melt-spinning a polyester in which at least 95% of the acid radicals are terephthalic radicals.
3. Articles as claimed in claim 2, wherein the polyester has an intrinsic viscosity of between 0.5 and 0.7 dl/g.
4. Articles as claimed in claim 2, wherein the polyester has a density of between 1.3 and 1.5 g/cm<sup>3</sup>.
5. Articles as claimed in claim 2, wherein the pile is obtained with polyester fibres of claims 2 to 4 having a count of between 0.8 and 30 dtex.
6. Articles as claimed in claim 5, wherein the polyester articles have a count of between 3 and 20 dtex.
7. Articles as claimed in claim 5 or 6, wherein the fibres contain opacifiers, anti-static agents, antioxidants, optical whiteners, etc.
8. Articles as claimed in claim 1, wherein the backing is produced from a blend of the fibres of claims 2 to 7 and fibres consisting exclusively of a thermobonding polyester.
9. Articles as claimed in claim 8, wherein the thermobonding copolyester has a terephthalic/isophthalic comonomer ratio of between 50/50 and 90/10.
10. Articles as claimed in claim 9, wherein the thermobonding copolyester has an intrinsic viscosity of between 0.5 and 0.6 dl/g.
11. Articles as claimed in claim 9, wherein the thermobonding copolyester has a density of between 1.2 and 1.6 g/cm<sup>3</sup>.

12. Articles as claimed in claim 8, wherein the fibres formed from the thermobonding copolyester of claims 9 to 11 have a count of between 0.8 and 30 dtex. 5
13. Articles as claimed in claim 12, wherein the thermobonding fibres have a count of between 3 and 20 dtex.
14. Articles as claimed in claims 12 and 13, wherein the thermobonding fibres contain opacifiers, anti-static agents, antioxidants, optical whiteners etc. 10
15. Articles as claimed in claim 1, wherein the backing is produced from a blend of the fibres of claims 2 to 7 and bicomponent fibres. 15
16. Articles as claimed in claim 15, wherein the bicomponent fibres are of the side-by-side type obtained by melt-extruding the polyesters of claims 2 to 4 and thermobonding copolyesters of claims 9 to 11. 20
17. Articles as claimed in claim 15, wherein the bicomponent fibres are of the sheath-core type, obtained by melt-extruding the polyesters of claims 2 to 4 and thermobonding copolyesters of claims 9 to 11. 25
18. Articles as claimed in claim 16 or 17, wherein the bicomponent fibres have a count of between 0.8 and 30 dtex. 30
19. Thermoformable composite articles consisting completely of polyester produced by a process comprising the following stages: 35
- a) preparing a polyester fibre non-woven fabric for use as the pile;
  - b) preparing a non-woven fabric of mixed polyester plus thermobonding polyester composition for use as the backing; 40
  - c) joining together the non-woven fabrics obtained as described in points a) and b) by passing through a needle-punching device or similar machine; 45
  - d) preforming.

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## EUROPEAN SEARCH REPORT

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| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                        |                                                  |                                              |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|----------------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Citation of document with indication, where appropriate, of relevant passages                                                                                                          | Relevant to claim                                | CLASSIFICATION OF THE APPLICATION (Int.Cl.5) |
| A                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | DE-U-90 13 113 (POLYVLIES FRANZ BEYER GMBH & CO.)<br>* whole document *<br>---                                                                                                         | 1, 19                                            | D04H1/00                                     |
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| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                        |                                                  |                                              |
| Place of search<br>THE HAGUE                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                        | Date of completion of the search<br>29 July 1994 | Examiner<br>V Beurden-Hopkins, S             |
| <b>CATEGORY OF CITED DOCUMENTS</b><br>X : particularly relevant if taken alone<br>Y : particularly relevant if combined with another document of the same category<br>A : technological background<br>O : non-written disclosure<br>P : intermediate document<br>T : theory or principle underlying the invention<br>E : earlier patent document, but published on, or after the filing date<br>D : document cited in the application<br>L : document cited for other reasons<br>-----<br>& : member of the same patent family, corresponding document |                                                                                                                                                                                        |                                                  |                                              |