Abstract:
The present invention relates to a fabric comprising: at least one upper layer (20) and one lower layer (20) of a transparent and water-repellent material; at least one layer (15) of carbon interposed between said two layers (20). In accordance with the invention the carbon layer (15) is formed by a plurality of single carbon fibres arranged according to a random order.
A CARBON FIBRE FABRIC, IN PARTICULAR FOR INTERIOR UPHOLSTERY FOR CARS

Scope of the invention

The present invention relates to the technical sector inherent to the field of fabrics. In particular, the invention relates to an innovative carbon fibre fabric.

Brief outline of the prior art

Carbon, which has been known for some time, has an infinite number of technical properties connected with its lightness and, at the same time, its mechanical resistance.

In that sense, it is now widely used in many sports sectors ranging from the automotive sector to cycling.

In the automotive sector various structural components are now made of carbon fibre precisely because this material is able to unite remarkable lightness with high mechanical performance.

The same can be said for the cycling or other sectors, such as the construction of structural elements for windsurfs and the like.

However, although there is wide use and knowledge of carbon, it is not currently used in the field of fabrics, in particular for making interior upholstery for cars, since processing would be required in order to make it sufficiently flexible.

Current interior upholstery for cars is made of leather or normal fabric, such as cotton.

The drawback of these ordinary fabrics is that they have a limited durability over time and are therefore easily worn; moreover, they lose their aesthetic effect over time. Above all, they often require complex colouring.
Summary of the invention

It is therefore an object of the present invention to provide an innovative fabric that solves the aforementioned technical drawbacks, in particular a fabric for interior upholstery for cars.

In particular, an object of the present invention is to provide an innovative fabric that is durable over time and therefore with a low tendency to get worn and that at the same time maintains its aesthetic characteristics.

These and other objects are obtained with the fabric in accordance with claim 1.

Such a fabric comprises:

- At least one upper layer (20) and one lower layer (20) of a transparent and water-repellent material;
- At least one layer (15) of carbon interposed between said two layers (20).

In accordance with the invention the carbon layer (15) is formed by a plurality of single carbon fibres arranged according to a random order.

In this way the upper and lower layers provide waterproofing and being transparent allow light to pass through. They also reinforce and give excellent mechanical resistance to the intermediate carbon fibre layer which in itself, being made of single fibres, is very flexible but has low mechanical resistance.

The intermediate layer, being made of free fibres arranged according to a random order, is such as to be at least partially transparent to light, in the sense that light can pass through the free spaces between one fibre and another.

The final result is a carbon fabric that is particularly flexible and strong, water-repellent and, at
the same time, transparent to light.

The transparency to light easily allows light effects to be obtained that would otherwise not be obtainable.

Further advantages can be inferred from the dependant claims.

**Brief description of the drawings**

Further characteristics and advantages of the present fabric, according to the invention, will appear more clearly from the following description of some embodiments, provided by way of non-limiting example, with reference to the appended drawings, wherein:

- Fig. 1 schematically shows the carbon fibres used;
- Fig. 2 shows a process for obtaining the carbon fibre sheet;
- Fig. 3 depicts the process for the formation of the final fabric, in accordance with hot coupling (thermoforming) with thin polyurethane layers;
- Fig. 4 shows the carbon sheet only, obtained with the process of Fig. 2.
- Fig. 5 further shows a carbon fibre sheet during the preparation step, i.e. with the arrangement of the nylon filament;
- Fig. 6 further shows a complete carbon fibre sheet.

**Description of some preferred embodiments**

In accordance with the invention, in a first step the carbon fibres are collected and arranged.

Such carbon fibres are single fibres that preferably come from waste material and each single fibre preferably has a length of no more than 6-7 cm. The preferred fibres have lengths in the order of about 2 cm or 3 cm. However, there is nothing to exclude the use of fibres with lengths over 7 cm.

As clarified immediately below, the advantage of
using short fibres whose length is comprised between 2cm-
3cm is that the carbon fabric obtained has a more light
transparent effect and is much more flexible.

Figure 1 therefore depicts the collection of such
single fibres 1, which may, for example, be arranged
within a suitable container.

A first sheet formed by such fibres must therefore
be made.

The sheet obtained, according to the method
described below, is shown in figure 4 and in figure 6, and
is a carbon fibre sheet with a similar texture to cotton.

Since the fibres are short, an ordered weave
according to weft and warp cannot be obtained, as happens
with very long fibres, i.e. bands of filament much longer
than the aforementioned 6-7 centimetres in length but, on
the contrary, the basis is a disorderly accumulation of
free single fibres.

These are therefore bound and compacted together so
as to form the fabric in accordance with the invention.

In particular, as schematically shown in figure 2,
the fibres are arranged on a plane in an absolutely random
way and such as to form a first layer 100. Onto said layer
a web 110 of nylon filament is arranged, and then a second
upper layer 120 is arranged, still made of free carbon
fibres, also obviously arranged in an absolutely random
way.

The layers are compacted together using a press 200
such that the single fibres, together with the interposed
fabric, remain pressed and thickened together.

Figure 5 shows, for example, an intermediate product
phase in which the nylon net is applied to the first layer
of fibres.

The characteristic of such fabric is that, due to
its design, it peels away easily exactly like cotton,
since the absolutely random order of the carbon fibres means many empty spaces are left throughout the whole thickness and through which light can pass and filter.

The light passage effect is not actually obtained with traditional carbon sheets made with a weft and warp and therefore with proper reels of filament.

This type of carbon sheet made of relatively short fibres but arranged in a random way is for example produced by the manufacturer SGLGROUP and of which a technical data sheet for the product can be found at the website address indicated below:


The production method for this carbon sheet is therefore known and is not the specific subject matter of the present patent.

At this point, the carbon fibre sheet obtained must be processed further in order to give it better strength and water-repellence mechanical properties, while maintaining transparency to light.

The process described below therefore allows the product characteristics to be optimised.

For this purpose a well known thermoforming method is used wherein two or more layers are made to adhere to one another through a hot pressing process.

For example, one of these thermoforming methods is described in patent MO99A000177 in the name of Alain MESTDAGH entitled "A PROCESS FOR MANUFACTURING PRODUCTS IN WHICH RIGID AND SOFT PARTS ARE COMBINED".

Such technology describes a technique that allows a particularly strong product to be manufactured envisaging the hot coupling between a sheet of polyurethane elastomer
based on polyester which is hot coupled between a layer of material coated in resin and a soft layer.

In this case the reference patent is indicated as an example of thermoforming given that it, specifically, describes through thermoforming a coupling of a polyurethane sheet that is comprised between a carbon sheet coated in resin (therefore rigid) and a soft sheet. In this way, through the hot coupling (which generally takes place in a specific mould) the resin is hardened and gives the final product significant hardness. The final sheet obtained will therefore have a good compromise between strength and comfort, also allowing different shapes to be obtained.

Therefore, through the hot coupling in accordance with a thermoforming process, as schematically represented in figure 3, an upper layer and a lower layer 20 formed by a thin polyurethane film is now coupled to an intermediate carbon fibre layer (intermediate layer as described and implemented in accordance with figure 2 and in particular the product made by SGLGROUP). The film preferably has a thickness that is comprised within a range between 0.3 mm and 1.4 mm, even if higher thicknesses could also be used.

The three layers are hot coupled to one another with the aforementioned thermoforming process, obtaining a single sheet which is remarkably strong and partially transparent to light thanks to the empty spaces present in the intermediate layer of carbon.

The polyurethane guarantees that the carbon sheet maintains its high flexibility and in itself it is obviously also transparent to light.

With this technology it is also then possible to be able to add other layers of polyurethane, hence further increasing the strength.

The use of polyurethane film is preferred since it
gives the water-repellent characteristics to the fabric and is transparent. It also easily adheres with the thermofoming process since when hot it acquires a soft texture which adheres upon cooling.

Coloured polyurethane sheets could also be used but which, however, maintain their transparency, hence also providing an overall colouring effect to the product.

However, there is nothing to prevent the use of other different transparent and water-repellent materials from polyurethane (still in the form of flexible film) and that could potentially be connected to the intermediate carbon layer.

Although glues could also be used in the connections, they would in part obstruct the light passage holes, stiffening the carbon sheet and, for that reason, flexible, transparent, water-repellent materials suitable for a thermofoming process are preferred materials.

In all cases, precisely to make the fabric totally waterproof, it is preferable for the two upper and lower films to totally cover the intermediate carbon layer. However, partial coverage may also be provided.

Hence, figure 3 represents the mould 10 within which the intermediate carbon layer 15 is hot coupled and becomes interposed between the two thin layers of polyurethane 20.

The fabric thus obtained therefore has many characteristics including transparency to light, strength and water resistance, since it is hydro-repellent.

This allows such fabric to be used for many different applications, not only for interiors in the automotive sector.

In fact, thanks to the passage of light this product can be used as a fabric for producing lamps, hence in the technical lighting field (which is not feasible with a
classic carbon fabric made with a weft and warp through which no light passes.

The same fabric can be used for making bags, since the short fibres allow final shapes to be obtained in a much more effective way with respect to carbon fabric made with a weft and warp. Furthermore, the application inside the bag of a coloured lining, thanks to the transparency of the carbon sheet to light, allows a colouring effect to be obtained on the outside of the bag (hence on the carbon layer), otherwise unobtainable except with complex colouring processes (it is to be noted that in itself carbon only has a dark grey like colour tone).

Other fields of application may therefore be those related to interior design and fashion accessories in general.

In the present description, the term "short fibres" means fibres whose length does not exceed 7-8 cm.
CLAIMS

1. A fabric comprising:
   - At least one upper layer (20) and one lower layer (20) of a transparent and water-repellent material;
   - At least one layer (15) of carbon interposed between said two layers (20);
   - Characterized in that the carbon layer (15) is formed by a plurality of single carbon fibres arranged according to a random order.

2. A fabric, according to claim 1, wherein said lower (20) and upper layers (20) are configured to be connectable to the carbon layer (15) through a thermofoming process.

3. A fabric, according to claim 1 or 2, wherein said lower (20) and upper layers (20) are made of a polyurethane material.

4. A fabric, according to one or more of the preceding claims, wherein the layer (20) of polyurethane material is in the form of a thin film.

5. A fabric, according to one or more of the preceding claims, wherein the thickness of the layer (20) is comprised within a range between 0.3 mm and 1.4 mm.

6. A fabric, according to one or more of the preceding claims, wherein the intermediate carbon layer has a plurality of openings passing through its thickness in such a way as to allow an at least partial passage of light.

7. A fabric, according to claim 1, wherein the single
carbon fibres have a maximum length of 7 cm, preferably comprised between 2 cm and 3 cm.

8. The use of a fabric according to one or more of the preceding claims from 1 to 7 to obtain interior upholstery for cars and means of transport in general.

9. A method for obtaining a carbon fibre fabric, the method foreseeing the arrangement of at least one upper layer (20) and one lower layer (20) of a transparent and water-repellent material and the arrangement of at least one carbon layer (15) arranged between said two layers (20), the carbon layer (15) being obtained through a plurality of single carbon fibres arranged according to a random order.

10. A method, according to claim 9, wherein the carbon fibres are pressed together.
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FIG. 5

FIG. 6
## INTERNATIONAL SEARCH REPORT

**International application No**

PCT/IB2016/053964

### A. CLASSIFICATION OF SUBJECT MATTER

INV.

B32B9/04  B32B5/00  B32B5/02  B32B5/12  B32B5/22  
B32B5/26  B32B7/00  B32B7/02  B32B7/04  B32B9/00  
B32B7/20  B32B7/06  B32B7/12  B32B7/24  B32B7/40

According to International Patent Classification (IPC) or to both national classification and IPC

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

| B32B |

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
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<td>KR 2010 0061609 A (LEE CHANG GU [KR]) 8 June 2010 (2010-06-08) EP000C abstract - &quot;intermedi ate materi al made of carbon fiber&quot; figure 2 WPI abstract - &quot;seal ed&quot;</td>
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<td>X</td>
<td>WO 2013/124759 AI (AUTOMOBILI LAMBOGHINI SPA [IT]) 29 August 2013 (2013-08-29) abstract claim 5 claims 6-11 figures page 1, line 3 - page 3, line 29</td>
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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:
  
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**Date of the actual completion of the international search**

19 September 2016

**Date of mailing of the international search report**

07/10/2016

**Name and mailing address of the ISA**

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Authorised officer

Hammond, Andrew
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