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(54) Title: PROCESS FOR RECYCLING REINFORCED ELASTOMER COMPONENTS AND REINFORCED ELASTOMER COMPONENTS CONTAINING RECYCLED MATERIALS

(57) Abstract: Reinforced elastomer components which contain a strength carrier of thermoplastic polymer and a matrix or support of thermoplastic elastomer, wherein the materials of the strength carrier and the thermoplastic elastomer are compatible to such an extent that they can be processed above the melting temperature of the materials to a homogeneous single-phase mixture or at least a stable disperse multiphase mixture. The present invention further relates to methods for recycling corresponding reinforced elastomer components, methods for the production of new reinforced elastomer components and corresponding new reinforced elastomer components in which recycle produced according to the invention is used, and a use of thermoplastic polymers in reinforced elastomer components, which additionally include thermoplastic elastomer, for providing improved recyclability.

Description

Process for recycling reinforced elastomer components and reinforced elastomer components containing recycled materials.

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The present invention relates to reinforced elastomer components which contain a strength carrier and a support of thermoplastic elastomer, wherein the materials of the strength carrier and the thermoplastic elastomer are compatible to such an extent that they can be processed above the melting temperature of the materials to a homogeneous single-phase or multiphase mixture. The present invention further relates to methods for recycling corresponding reinforced elastomer components, methods for producing new reinforced elastomer components and corresponding new reinforced elastomer components in which recycle produced according to the invention is used, and a use of thermoplastic polymers in reinforced elastomer components, which additionally comprise a thermoplastic elastomer, for which help provide improved recyclability.

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State of the art

For the transport of goods of various kinds, such as bulk goods, luggage, food or waste, conveyor belts are often used, upon which various requirements are placed, depending on the use.

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In general, due to the usually relatively long conveyor distances, especially in the longitudinal direction, a certain extensibility of the conveyor belt in conjunction with a low bending stiffness must be provided in order to minimize an elongation of the conveyor belt in operation and at the same time, for example, to enable the deflection of the conveyor belt around guide and / or drive drums.

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To convey the required properties, textile fabrics, steel cables, or both, are usually introduced into or as at least one layer of a conveyor belt. This layer is usually called pull carrier and is usually located between two further layers, the supporting side and the running side. These conveyor belts can thus be differentiated, on the basis of the introduced carrier, into steel cable conveyor belts and textile conveyor belts.

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A disadvantage in the incorporation of fabrics or steel cables into such a formed conveyor belt is the lack of, or complexity for recyclability.

The steel cable and textile conveyor belts described are the most widely used conveyor belt variants. In addition, unreinforced conveyor belts and different embodiments of conveyor belts are known, which contain fibers in a disordered manner in the belts.

A considerable problem of the conveyor belts of the prior art unfortunately exists in their poor recyclability, which results from the combination of different materials used. This requires that the materials be separated from each other first before they are put to further use, which is often uneconomical due to the associated costs. There is therefore a need for a conveyor belt system that can be recycled for further use as easily as possible and at low cost. In particular, there is a need for a conveyor belt system components that come as close as possible to a use and reuse circular scenario.

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DE 10 2017 101 562 A1 describes a process for recycling conveyor belts with material fiber or filament-shaped reinforcing materials embedded in a matrix, which remain in the matrix material as part of recycling, and optionally are refreshed with additional fibers and matrix material. In this method, the matrix material of the tensile carrier and / or the conveyor belt materials have a lower melting point than the filaments introduced into the tensile carrier, which may make it possible to separate the filaments from the molten matrix mixture. In the conveyor belts described in DE 10 2017 101 562 A1, the tensile carrier is formed from filaments embedded in a matrix material, which are present in an undirected state within the matrix material.

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In the investigations underlying the invention, it was surprisingly found that an easily recyclable belt material can be produced by tensile carrier and matrix or support material which are formed from different, but miscible materials. For recycling, in this case, the tensile carrier and the matrix or support material can be melted together, where the materials mix homogeneously and form a uniform phase or at least a stable dispersed mixture. If the weight fraction of the tensile carrier moves in the single-digit, or at least in the low two-digit range, the mechanical properties change only insignificantly by this

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mixing, while larger changes can be compensated by the admixture of additional matrix or support material.

Accordingly, the present invention relates in a first aspect to a reinforced elastomer component having a strength carrier of thermoplastic polymer and a matrix of thermoplastic elastomer, wherein the strength carrier is formed from a polymer material that can be processed under melting with the melting phase of the thermoplastic elastomer to a single-phase or multiphase mixture. In other words, the strength carrier and the thermoplastic elastomer are formed from materials with similar melting points, so that it is possible to mix the strength carrier and the thermoplastic elastomer by increasing the temperature and to bring them into a plastically deformable mass without one being decomposed.

As a reinforced elastomer component, any components may be used that are conventionally manufactured for reinforcement with strength carriers. Preferably, the reinforced elastomer component is useful in a hose, air spring, drive or control belt, component for vibration damping, sealing element such as an O-ring, etc., or as a conveyor belt. In the context of this invention, a conveyor belt is particularly preferred as a reinforced elastomeric component.

A thermoplastic elastomer, in the context of the present invention and according to the general understanding of this terminology, is a polymer or plastic that behaves at room temperature comparable to a classic elastomer, but can be plastically deformed under heat supply and thus shows a thermoplastic behavior. The "thermoplastic" polymer, on the other hand, has no relevant elastic properties at operating temperature (about 25 ° C). In the context of this invention, an elastic material or elastomer is to be understood as an elastic material having an modulus of 50 MPa or less and preferably of 10 MPa (determined according to ISO 527) or less, while the thermoplastic polymer has an modulus of more than 50 MPa, usually more than 400 Mpa, and preferably more than 950 MPa. As an upper limit, the thermoplastic polymers have a modulus of up to 5000 Mpa, and particularly up to 4000 MPa according to the scope of this disclosure.

The materials of the strength carrier and the thermoplastic elastomer are matched to each other so that they can be homogenized in the melt with each other, i.e. either a single-phase mixture or at least a sufficiently stable dispersion of one material in the other material, which may have several (i.e. two or more) phases. The materials of the strength carrier and the thermoplastic elastomer are preferably matched to each other so that only one phase is formed in the melt. Expediently, the thermoplastic elastomer and the thermoplastic polymer of the strength carrier have melting points or differences between the mean value from the start and end point of the melting range, which have a maximum temperature difference of 70° C, preferably a maximum of 50° C, and particularly preferably a maximum of 40° C.

The presence of only one phase in the mixture can be detected in the present case, for example, by means of DSC, wherein only one melting range without two distinguishable melting points can be determined. The skilled person is accordingly able to determine a suitable combination of materials for the thermoplastic elastomer and the thermoplastic polymer on the basis of his expert background knowledge and, if necessary, some tests for the miscibility of the materials.

If the thermoplastic elastomer is formed as a "matrix" in the reinforced elastomer component of the invention, it encloses the strength carrier of thermoplastic polymer, ie, if the strength carrier is formed, for example, from a fabric, this may be penetrated by the thermoplastic elastomer, which is correspondingly also present in cavities of the strength carrier. Alternatively, the strength carrier may not be penetrated by the thermoplastic elastomer, so that the thermoplastic elastomer is formed as a "support". Embodiments with a thermoplastic elastomer as a matrix and embodiments in which the thermoplastic elastomer is formed as a "support", the skilled person can produce such on the basis of knowledge in the art.

In some reinforced elastomer components according to the invention, the support may be present only on one side of the elastomer component, or on both sides of the elastomer component; in this case, the strength carrier is disposed between two support layers. An embodiment with a support on only one side is shown in Figures 1 and 3, wherein 1 denotes the strength carrier and 2 the support made of thermoplastic elastomer. In Figure 3,

the thermoplastic elastomer is also contained in the cavities of the strength carrier. In Figure 2, an embodiment is shown in which the strength carrier 2 is positioned between two support layers 1 and 3 of thermoplastic elastomer.

5 In a particularly preferred embodiment, the strength carrier and the thermoplastic elastomer are each formed in a layered form, wherein, e.g., the strength carrier is formed as a layer of a strength carrier fabric in a matrix of thermoplastic elastomer with a layer support of the thermoplastic elastomer, or formed as a layer of a strength carrier with a layer layer of thermoplastic elastomer.

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The strength carrier may be present in the reinforced elastomer component according to the invention as one or more strips, single threads or cords, each of which may have a round or rectangular cross-section, as fabric, knitted fabrics, knitted fabrics or as nonwoven material or felt material. The strength carrier consists in the context of the invention described

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herein not exclusively of undirected embedded in a Matrixmaterial filaments.

The strength carrier is formed from a thermoplastic polymer that improves the mechanical properties and in particular the resistance of the carrier belt to a tensile load compared to a belt formed only from thermoplastic elastomer. Preferably, the strength carrier also has a

20 tensile strength determined according to DIN EN ISO 527-1, of at least 100 N / mm, and preferably in the range of 100 N / mm to 4000 N / mm.

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Suitable materials from which the strength carrier is formed include, for example, polyethylene, preferably with high density (HDPE) with density in the range of 0.94 and

25 0.99 g / cm³, preferably 0.97 to 0.98 g / cm³, ultra high molecular weight polypropylene (UHMW-PE), preferably having a density in the range of 0.895 to 0.92 g / cm³, and in particular 0.90 to 0.91 g / cm³, polyamide, in particular in the form of polyamide 6.6, preferably having a density in the range of 1.13 to 1.15 g / cm³, polyester, in particular in the form of polyethylene terephthalate, preferably with a density in the range of 1, 37 to

30 1.45 g / cm³, and in particular in the range of 1.37 to 1.39 g / cm³, and polyaramide, preferably with a density in the range of 1.43 to 1.45 g / cm³.

Suitable materials from which the thermoplastic elastomer may be formed include, for example, EPDM (ethylene-propylene-diene rubber), or mixtures thereof with polyolefins, preferably in the form of polypropylene. Such mixtures can be used as TPO (thermoplastic polyolefin) or TPV (thermoplastic vulcanisate = crosslinked "thermoplastic polyolefin"). A particularly suitable polypropylene that can be used in such mixtures is, for example, a polypropylene having a density of 0.90 to 0.91 g / cm³. Other suitable thermoplastic elastomer materials include ethylenacrylate rubber (AEM) and acrylate rubber (ACM), preferably in combination with polyamide, and thermoplastic polyurethane elastomers (TPU).

As EPDM, an ethylene-propylene-diene rubber having an ethylene content in the range of 45 to 75 weight %, and in particular 45 to 55 weight % is preferred. The diene content may be in the range of 0.1 to 12 weight %, preferably in the range of 2 to 10 weight %, and particularly preferably in the range of 3 to 9 weight %. As dienes, any dienes used in EPDM can be used, wherein preferred dienes include, but are not limited to, cyclopentadiene, ethylidene norbornene and 1,4-hexadiene.

In a preferred embodiment, the strength carrier is formed from a polyolefin, preferably a polyethylene or polypropylene, and the thermoplastic elastomer is based on polyolefins, preferably EPDM alone or in mixture with another polyolefin polymer, in particular polypropylene. In a further preferred embodiment, the strength carrier is formed from a polyamide, and the thermoplastic elastomer is based on an ethylene acrylate elastomer (AEM) or an acrylic elastomer (ACM), preferably in mixture with a polyamide. In an even more preferred embodiment, the strength carrier is formed from a polyolefin, preferably from polyethylene or polypropylene, or from a polyamide, and the thermoplastic elastomer is based on a thermoplastic polyurethane elastomer.

The thermoplastic elastomer and / or the thermoplastic polymer may contain customary additives for formulation purposes, such as fibers for reinforcing purposes, or formulation auxiliaries. Preferably, the thermoplastic elastomer and / or the thermoplastic polymer contains such components at most in a proportion of up to 40 weight%, e.g. in a proportion of 10 to 30 weight %. Furthermore, it is preferred if the reinforced elastomer component contains no components that counteract an intimate mixing of the components of the

thermoplastic elastomer and the thermoplastic polymer. In one embodiment, the thermoplastic elastomer and the thermoplastic polymer in the reinforced elastomer component according to the invention contain no fibers or filaments.

- 5 Another aspect of the present invention relates to a method for recycling a reinforced elastomer component with a strength carrier of thermoplastic polymer and a thermoplastic elastomer, preferably a reinforced elastomer component as described above, wherein the method comprises the joint melting and intimately blending of strength carrier and thermoplastic elastomer while obtaining a single-phase or multiphase mixture. In this case,
10 the mixture can be used for the manufacture of new products, which may be elastomer components such as conveyor belts or other products.

Another aspect of the present invention relates to a process for producing a reinforced elastomer component with a strength carrier and a thermoplastic elastomer, wherein the
15 method involves the melting and intimately blending of a reinforced elastomer component with a strength carrier and a thermoplastic elastomer while obtaining a single-phase or multiphase mixture of the materials of the reinforced elastomer component, and the formation of a new elastomer component in which the thermoplastic elastomer is formed from the mixture of the melted reinforced elastomer component. The reinforced elastomer
20 component thus produced also preferably includes a strength carrier based on a thermoplastic polymer, the thermoplastic polymer whose thermoplastic polymer can be processed with melting with the melting phase of the thermoplastic elastomer of the reinforced elastomer component to a single-phase or multiphase mixture. In this way, the reinforced elastomer component that is used in the process as a starting material, and the
25 reinforced elastomer component produced within the process have a comparable structure, which has the consequence that the reinforced elastomer component produced can be processed via an analogous process again to a new reinforced elastomer component.

For the reinforced elastomer components and methods described in the above, it is further
30 preferred if the strength carrier provides a proportion of 2 to 20 weight %, and preferably 5 to 15 weight %, of the total amount of strength carriers and thermoplastic elastomer in the reinforced elastomer components or the reinforced elastomer components used in the process as starting material. These ranges can easily ensure in the process that the

mechanical properties of the thermoplastic elastomer deteriorate in a non-critical manner due to the interference of the thermoplastic polymer, without having to be compensated by the addition of pure thermoplastic elastomer.

- 5 The melting and mixing of thermoplastic polymer and thermoplastic elastomer is carried out in the context of the methods described herein preferably in an extrusion process that can be carried out in any suitable extrusion device. It is particularly useful when a twin-screw extruder is used as an extrusion device.
- 10 In addition, it is preferred if the thermoplastic elastomer of the reinforced elastomer component produced by the method described are formed in layers from the mixture of the melted-in reinforced elastomer component and the reinforcement for the reinforced elastomer component.
- 15 Another aspect of the present invention relates to a reinforced elastomer component which was prepared by a method described above.

In the method described above or the resulting product, it is preferred if the thermoplastic elastomer in the reinforced elastomer component produced has a Shore D hardness
20 (determined according to DIN ISO 7619-1 [2]) of 36 ± 10 and / or a tear resistance (determined according to DIN 53504, type 2) of ≥ 12 MPa and / or a elongation at break (determined according to DIN 53504, type 2) of $> 300\%$ (preferably $> 500\%$) and / or a further tear resistance (determined according to ISO 34-1 / A) of ≥ 10 N / mm (preferably ≥ 20 N / mm). It is particularly preferred if the thermoplastic elastomer in the reinforced
25 elastomer component produced has all these properties, i.e. a Shore D hardness (determined according to DIN ISO 7619-1 [2]) of 36 ± 10 and a tear resistance (determined according to DIN 53504, type 2) of ≥ 12 MPa and a elongation at break (determined according to DIN 53504, type 2) of $> 300\%$ (preferably $> 500\%$) and a tear resistance (determined according to ISO 34-1 / A) of ≥ 10 N / mm (preferably ≥ 20 N / mm). For the
30 tear resistance, a value in the range of 12 to 25 Mpa, and in particular 14 to 20 Mpa, is considered particularly suitable. For the elongation at break, a value in the range of 500 to 700%, and in particular 550 to 630%, is considered particularly suitable. For the tear

resistance, a value in the range of 20 to 50 N / mm, and in particular 25 to 40 N / mm, is considered particularly suitable.

Another aspect of the present invention relates to the use of a strength carrier of
5 thermoplastic polymer in a reinforced elastomer component in combination with a
thermoplastic elastomer for providing a simplified recyclability, wherein the material of
the thermoplastic polymer is matched to the thermoplastic elastomer so that a
homogeneous single-phase or dispersed multiphase polymer mixture is formed when the
thermoplastic polymer and the thermoplastic elastomer can be melted together and
10 intimately mixed.

In the following, the present invention is illustrated in more detail by means of some
embodiments, which, however, should not be understood in any way as limiting to the
scope of the application.

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Example 1:

A strength carrier of HDPE or polypropylene fabric was coated with a thermoplastic vulcanizate in the form of a mixture of ethylene-propylene-diene rubber and polypropylene in a ratio of 50:50, wherein the strength carrier accounted for a weight fraction of 10%,
 5 based on the total weight of the conveyor belt.

A corresponding conveyor belt was crushed and processed in a twin-screw extruder to a uniform mixture (samples 2a and 2b). The mixture thus obtained was admixed as an
 10 addition of 10% to pure thermoplastic vulcanizate (samples 3a and 3b). The mechanical properties of the mixtures thus obtained are shown in the following Table 1. As a comparison, the properties of pure thermoplastic vulcanizate (sample 1) are given.

Table 1

	Sample 1	Sample 2a	Sample 2b	Sample 3a	Sample 3b
TPV [%]	100	90	90	90	90
Further polymer [%]	-	10 HPDE	10 PP	10 out of 2a	10 out of 2b
Density [g/cm ³]	0.95	0.96	0.95	0.95	0.95
Shore D Hardness	36	39	41	36	36
Rice strength [MPa]	16.5	16.8	18.8	16.9	16.8
Rice elongation [%]	577	579	586	579	581
Tear resistance [N/mm]	29.7	30.7	39.5	25.9	28.5

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The experiments show that HDPE and PP behave very similarly chemically. Even with a content of 10% PP or HDPE in the thermoplastic vulcanizate, hardly any changes in the

material properties can be observed (2a and 2b). At a lower proportion, the effect is even less pronounced (3a and 3b).

Example 2:

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A strength carrier made of HDPE or polypropylene fabric was coated with a thermoplastic elastomer based on polyurethane as an elastomer component, wherein the strength carrier accounted for a weight fraction of 10%, based on the total weight of the conveyor belt.

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A corresponding conveyor belt was crushed and processed in a twin-screw extruder to a uniform mixture (samples 5a and 5b). The mixture thus obtained was admixed as an addition of 10% to pure thermoplastic polyurethane (samples 6a and 6b). The mechanical properties of the mixtures thus obtained are shown in the following Table 2. As a comparison, the properties of pure thermoplastic vulcanizate (sample 4) are given.

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Table 2

	Sample 4	Sample 5a	Sample 5b	Sample 6a	Sample 6b
TPU [%]	100	90	90	90	90
Further polymer [%]	-	10 HPDE	10 PP	10 out of 5a	10 out of 5b
Density [g/cm ³]	1.19	1.16	1.15	1.18	1.18
Shore A Hardness	90	91	91	89	90
Rice strength [MPa]	47.0	49.9	31.6	52.0	52.5
Rice elongation [%]	582	526	420	524	511
Tear resistance [N/mm]	71.0	67.8	61.5	69.3	64.4

The experiments show that even with materials that are less well compatible in terms of their polarity (here PP or HDPE in TPU), good mechanical properties can still be obtained. With the addition of small amounts of the strength carrier material, only minor effects are observed (6a and 6b). At higher levels (5a and 5b) a better compatibility was observed for
5 HDPE as well as for PP.

In Examples 1 and 2, a thermoplastic elastomer is obtained in each case, which can be used again for the production of components or articles.

Claims

1. A reinforced elastomer component with a strength carrier made of thermoplastic polymer and a matrix or support made of thermoplastic elastomer, wherein the strength carrier is formed from a polymer material which can be processed with melting with the melting phase of the thermoplastic elastomer to a homogeneous single-phase or multiphase mixture.
2. The reinforced elastomer component according to claim 1, wherein the strength carrier is present as one or more strips, single threads or cords, which may have a round or rectangular cross-section, as fabrics, knitted fabrics, knitted fabrics or as nonwoven or felt material, and wherein the strength carrier and the thermoplastic elastomers are preferably each layered.
3. The reinforced elastomer component according to claim 1, wherein the strength carrier is formed from a polyolefin, preferably of polyethylene or polypropylene or a combination thereof, and the thermoplastic elastomer is based on polyolefins, preferably on EPDM alone or in mixture with another polyolefin polymer.
4. The reinforced elastomer component according to claim 1, wherein the strength carrier is formed from a polyamide, and the thermoplastic elastomer is based on an ethylene acrylate elastomer (AEM) or an acrylic elastomer (ACM), preferably in Mischung with a polyamide.
5. The reinforced elastomer component according to claim 1, wherein the strength carrier is formed from a polyolefin, preferably of polyethylene or polypropylene or a combination thereof, and the thermoplastic elastomer is based on a thermoplastic polyurethane.
6. A process for recycling a reinforced elastomer component with a strength carrier of thermoplastic polymer and a thermoplastic elastomer, preferably a reinforced elastomer component according to claim 1, wherein the method comprises the joint melting and intimately mixed of strength carrier and thermoplastic elastomer while obtaining a homogeneous single-phase or multiphase mixture.

7. A process for producing a reinforced elastomer component with a strength carrier and a thermoplastic elastomer, wherein the method involves the melting and intimately blending of a reinforced elastomer component with a strength carrier and a thermoplastic elastomer while obtaining a homogeneous single-phase or multiphase mixture of the elastomer component materials, and the formation of a reinforced elastomer component with a strength carrier and a thermoplastic elastomer in which the thermoplastic elastomer is formed from the mixture of the melted reinforced elastomer component.
8. The method according to claim 7, wherein the strength carrier in the reinforced elastomer component produced by the method is based on a thermoplastic polymer, which can be processed into a single-phase mixture under melting with the melting phase of the thermoplastic elastomer of the reinforced elastomer component.
9. The method according to claim 7, wherein the melting and intimately mingling of thermoplastic polymer and thermoplastic elastomer in an extrusion process and preferably in a Dopole screw extruder is carried out.
10. The method according to claim 7, wherein the thermoplastic elastomer from the mixture of the melted reinforced elastomer component and the strength carrier layer are formed.
11. The method according to claim 7, wherein the strength carrier provides a proportion of 2 to 20 and preferably 5 to 15 weight % of the total amount of strength carrier and thermoplasticelastomer.
12. A reinforced elastomer component, prepared by a method according to claim 7.
13. The method according to claim 7, wherein the thermoplastic elastomer has a Shore D hardness (determined according to DIN ISO 7619-1 [2]) of 36 ± 10 and / or a tear resistance (determined according to DIN 53504, type 2) of ≥ 12 MPa and / or a elongation at break (determined according to DIN 53504, type 2) of $> 300\%$ and / or a tear resistance

(determined according to ISO 34-1 / A) of ≥ 10 N / mm, and wherein the thermoplastic elastomer preferably meets all specified specifications.

14. Use of a thermoplastic polymer strength carrier in a reinforced elastomer component in
5 combination with a thermoplastic elastomer to mediate a simplified recyclability, wherein
the material of the thermoplastic polymer is matched to the thermoplastic elastomer so that
a homogeneous single-phase or dispersed multiphase polymer mixture is formed when the
thermoplastic polymer and the thermoplastic elastomer are melted together and be
intimately mixed.

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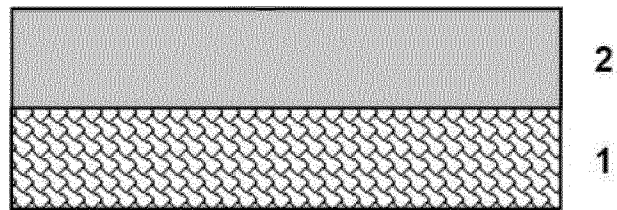


FIG. 1

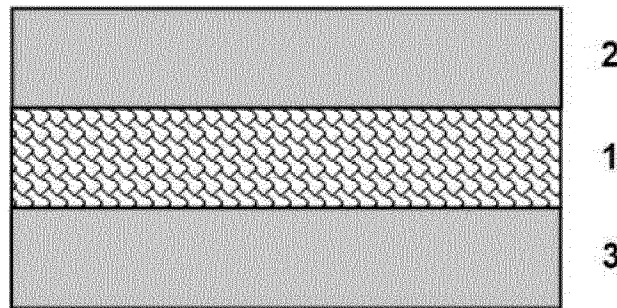


FIG. 2

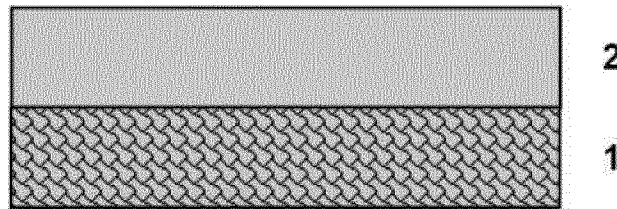


FIG. 3

INTERNATIONAL SEARCH REPORT

International application No
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A. CLASSIFICATION OF SUBJECT MATTER
INV. B29B17/00 B29D29/06 B65G15/34 C08L23/16 B29B7/48
ADD.

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)
B29B B29K B65G B29D C08L

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

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP H10 265616 A (BRIDGESTONE CORP; UBE INDUSTRIES) 6 October 1998 (1998-10-06) paragraphs [0004], [0005], [0003], [0020] -----	1, 4, 5, 7-13 2, 3, 6, 14
X	EP 1 063 345 A2 (JOHNS MANVILLE INT INC) 27 December 2000 (2000-12-27) paragraphs [0005] - [0009], [0007], [0003], [0010], [0016], [0003] -----	1-14
X	US 2018/281329 A1 (SONE NAOYUKI [JP]) 4 October 2018 (2018-10-04) paragraphs [0095], [0169], [0003], [0107], [0163], [0169], [0081], [0083] ----- -/--	1-14

Further documents are listed in the continuation of Box C. See patent family annex.

* Special categories of cited documents :

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