(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 200 789**
A1

(12) # EUROPEAN PATENT APPLICATION

published in accordance with Art. 158(3) EPC

(21) Application number: **85905430.6**

(22) Date of filing: **31.10.85**

Data of the international application taken as a basis:
(86) International application number:
PCT/JP 85/00605
(87) International publication number:
WO 86/02627 (09.05.86 86/10)

(51) Int. Cl.⁴: **B 68 G 5/02**

(30) Priority: **01.11.84 JP 166899/84 U**
02.10.85 JP 219937/85

(43) Date of publication of application: **12.11.86**
Bulletin 86/46

(84) Designated Contracting States: **BE DE FR GB IT NL SE**

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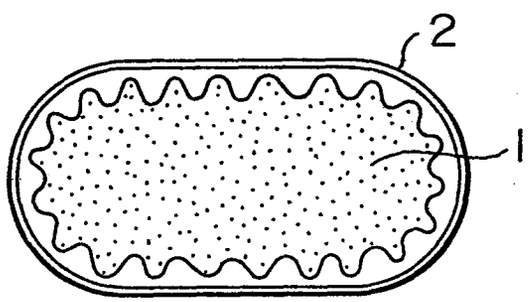
(54) **CUSHION MATERIAL AND PRODUCTS USING THEREOF.**

(57) A cushion material consisting of a composite material of a water-swellable high molecular material and a high molecular material of the non-hydrolyzing-type crosslinked structure, becomes more than three times to less than 15 times larger in volume when swollen with water, and has excellent pressure dispersibility and excellent durability. Further, a cushion product is obtained by wrapping the cushion material with a water-impermeable material. More preferably, the high molecular material consists of a rubber material which has a breaking strength of 8 kgf/cm² or greater and an elongation at breakage of 500% or more. After crosslinked, the high molecular material exhibits the stress at 300% elongation of 5 kgf/cm² or smaller.



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SPECIFICATION

CUSHIONING MATERIALS AND PRODUCTS

TECHNICAL FIELD

This invention relates to a cushioning material excellent in distribution of the indentation pressure caused by the human body (hereinafter referred to as pressure distribution) and in durability, which is prepared by treating with water a composite comprising a polymer substance swellable in water and a polymer substance having a nonhydrolyzable crosslinked structure to cause expansion by swelling to a volume as large as 3 to 15 times the orginal volume. The invention relates also to a cushioning product comprising said cushioning material and an exterior package impervious to water.

BACKGROUND ART

There have been known cushioning products which make use of urethane foams, natural rubber latex foams, various natural or synthetic fibers, and springs, such as, for example, sitting floor cushions, mattresses, sofa, and seats for vehicles and automobiles. However, when used for a long period of time, such cushioning products confronted problems such as decline in elasticity or mechanical breakdown.

On the other hand, polymer substances which swell in water have found new uses as a mixture with water in water or ice pillows. The present inventors paid

attention to the excellent flexibility of such products and conducted an extensive study to develop cushioning products utilizing the polymer substances swellable in water. However, since the polymer substances swellable in water are generally in powder form, the aqueous swollen mixture changes into a jelly-like semifluid retaining some degrees of fluidity and, as a consequence, presents problems such that when a breakdown took place in some part of the exterior package, which prevents the cushioning product from loss of water by evaporation, by the exertion of a momentary large pressure or by the puncture with a needle-like article, the swollen jelly-like polymer substance will burst out. Furthermore, owing to the low mechanical strengths of the swollen polymer substance itself, there occurs breakdown of the polymer substance by frequent use of the cushioning product, resulting in decline of the cushioning action, that is, reduction in the durability of the product.

Cushioning products excellent in the pressure distribution, one of the most important characteristics of the cushioning materials, are those which utilize the cushioning characteristics of water, as exemplified by water mat or water bed which is used many hours a day by disabled persons or patients. Although excellent in pressure distribution, the cushioning product utilizing water as cushioning material gives rise to a phenomenon of pitching and rolling when the user changes the body position, causing the user to suffer from "seasickness"

just like what the user will experience on a boat on a stormy day.

For the above reasons, cushioning products utilizing as cushioning material a gel-like substance in place of water have been developed and in actual use. Such a product, however, has a disadvantage of inferior pressure distribution as compared with a cushioning product employing water as cushioning base material. To improve, even in a minor degree, the pressure distribution, it is necessary to increase the thickness of cushioning material. The increase in thickness, however, accompanies an increase in the weight of cushioning products and only an insufficient improvement in the pressure distribution. There is a strong demand for the improvement of pressure distribution among disabled persons, patients, and persons engaged in sedentary work (e.g. drivers of trucks, buses, and electric locomotives).

The primary object of this invention is to provide a novel cushioning material and a cushioning product which makes use of said novel cushioning material.

There is known vulcanized rubber products swellable in water which make use of a rubber of the ethylene-α-olefin type as described in Japanese Patent Application "Kokai" (Laid-open) Nos. 33,032/81 and 119,972/82. Such products, however, are too low in the degree of swelling to be useful as cushioning materials. Japanese Patent Application "Kokai" (Laid-open) No. 145,230/84 discloses an improvement in the degree of

swelling but no mention is made about the fact that a rubber having specific crosslinking characteristics is suitable for use in a cushioning product with both the ability to pressure distribution and the sufficient durability.

DISCLOSURE OF THE INVENTION

According to this invention, there is provided a cushioning material excellent in pressure distribution and in durability, which is produced by subjecting a polymer composition swellable in water comprising a polymer substance and a polymer substance swellable in water to crosslinking treatment and allowing the resulting crosslinked composition to swell in water to a volume of 3 to 15 times the original volume, and also there is provided a cushioning product comprising said cushioning material and an exterior package impervious to water. The crosslinked polymer substance has a nonhydrolyzable crosslinked structure.

Although not limitative, examples of polymer substances capable of forming nonhydrolyzable crosslinkage include ethylene-α-olefin copolymer rubbers, ethylene-α-olefin-noncojugated diene terpolymer rubbers (hereinafter these copolymers and terpolymers are referred to collectively as ethylene-base rubbers), styrene-butadiene rubbers (SBR), isobutylene-isoprene rubbers (IIR), butadiene rubbers (BR), acryl rubbers (ACM), chloroprene rubbers (CR), various thermoplastic elastomers, natural

rubber (NR), resins such as polyethylene and ethylene-vinyl acetate copolymers. These polymers are used each alone or in mixtures.

The nonhydrolyzable crosslinkage is formed by use of crosslinking agents suitable for each polymer such as sulfur, organic peroxides, and metal oxides. According to this invention, it is of important significance for the production of cushioning products excellent in durability to use a polymer substance having a nonhydrolyzable crosslinkage structure. If rubbers or resins having no crosslinked structure are used, there is produced no durable product. A hydrolyzable crosslinked structure such as a crosslinked urethane structure is gradually broken down to deteriorate the durability of cushioning products. Of the polymer substances listed above, most preferred are ethylene-base rubbers because of excellent resistances to water and bacteria, and good low temperature properties, and high loading property of fillers.

As examples of α-olefins used in the ethylene-base rubbers, mention may be made of propylene, 1-butene, 1-hexene, 1-keptene, 1-decene, 4-methyl-1-pentene, and 4-methyl-1-hexene. Typical of these α-olefins are propylene and 1-butene. Examples of nonconjugated dienes are 1,4-hexadiene, dicyclopentadiene, and ethylidene norbornene.

The weight ratio of ethylene to α-olefin in the ethylene-base rubbers is from 90/10 to 20/80,

preferably from 75/25 to 40/60. The nonconjugated diene is used in an amount of 0 to 50, preferably 0 to 25 in terms of iodine value.

As examples of polymer substances swellable in water, there may be mentioned saponified ethylene-vinyl ester of carboxylic acid-acrylate ester copolymers, crosslinked acrylic acid-acrylate salt copolymers, saponified starch-acrylonitrile graft copolymers, crosslinked alkali metal salts of starch-acrylic acid graft polymers, alkali metal salts of the reaction product between polyvinyl alcohol and maleic anhydride, salts of styrene-maleic anhydride copolymers, crosslinked polyethylene glycols, and saponified polyacrylonitrile. Of these polymer substances, particularly preferred are saponified ethylene-vinyl easter of carboxylic acid-acrylate ester copolymers and crosslinked acrylic acid-acrylate salt copolymers because of excellent swellability in water.

Examples of crosslinking agents used in forming the crosslinked structure are sulfur crosslinking agents comprising sulfur and, if necessary, a properly selected accelerators, peroxide crosslinking agents comprising peroxides and, if necessary, a properly selected crosslinking aids, quinoid crosslinking agents, and resin crosslinking agents. Of these crosslinking agents, particularly useful are sulfur crosslinking agents because of their versatility which permits crosslinking under varied conditions of temperature and time by proper

selection of the type and quantity of accelerators and because of excellent physical properties of the vulcanizate. The nonhydrolyzable crosslinkage, as herein referred to, can be formed also by the exposure to an electron beam or ultraviolet rays, not necessarily in the presence of a crosslinking agent.

The composite of this invention comprising a swellable polymer substance and a polymer substance having a nonhydrolyzable crosslinked structure is obtained generally from a swellable polymer in the form of powder or, preferably, fine powder, a polymer substance capable of forming nonhydrolyzable crosslinkage, a crosslinking agent forming said crosslinkage, and, if necessary, various additives such as organic or inorganic fillers including carbon black, talc, clay, calcium carbonate, and silica, plasticizers such as a process oil, blowing agents, blowing aids, antioxidants, processing aids, various stabilizers, pigments, and rust preventives. Above all, the incorporation of carbon black, white fillers, and process oil is preferred, because they impart to the cushioning material mechanical strengths or a soft touch or serve as an extender to reduce the cost. The fillers, which are used if necessary, are preferably those having a high hydrophilicity such as clay which has also good reinforcing properties. Carbon black and talc which are both hydrophobic are used, in most cases, in combination with hydrophilic fillers. The process oil is used in relatively large proportion because of its effectiveness

in improving the swelling degree by imparting flexibility to the crosslinked rubber. The addition of a surface ative agent is effective in increasing the rate of swelling.

The swellable polymer substance is used in an amount of 10 to 300, preferably 20 to 150, parts by weight for 100 parts by weight of the rubber material. When a large amount of fillers are used, the swellable polymer substance is used also in a large amount exceeding 300 parts by weight.

When an ethylene-based rubber is used, sulfur can be used as crosslinking agent in an amount of 0.05 to 10 parts by weight for 100 parts by weight of the rubber material. In case a high degree of swelling is intended, sulfur is used in an amount as low as 0.1 to 5 parts by weight, whereas a higher amount of sulfur is favorable for the improvement in durability. The amount added of carbon black and white fillers which are used if necessary is 0 to 1,000, preferably 50 to 600, parts by weight for 100 parts by weight of the rubber material. The process oil is used in an amount of 0 to 1,000, preferably 10 to 600, parts by weight for 100 parts by weight of rubber. With the increase in the amount of carbon black or white fillers, a larger amount of process oil is added. The surface active agent is used in an amount of 0 to 200, preferably 5 to 100, parts by weight for 100 parts by weight of rubber. With the increase in the amount of fillers and with the decrease in the

amount of process oil a larger amount of surface active agent is used but in some cases the upper limit is imposed to avoid the risk of bleeding.

It is preferable to make a foamed body of the crosslinked material by use of a blowing agents and a blowing aids from the view point of the rapid and increased swelling in water and the improvement in the touch of cushioning products. According to this invention a foamed body is produced in case where the starting rubber material has sufficiently high strength and elongation. The blowing agent and blowing aid are used in an amount of 1 to 50, preferably 3 to 20, parts by weight for 100 parts by weight of the rubber materials.

According to this invention, the rubber composition described above is subjected to crosslinking treatment. The primary purpose of crosslinking is to prevent the swollen material from breaking crack which tends to occur owing to a large volume increase by the swelling and to impart durability to the swollen cushioning material. The crosslinking treatment, therefore, is an important step for the cushioning material to achieve a high durability in practical sense. The crosslinked rubber material has excellent physical properties and swelling characteristics, and desirably has a low modulus of 10 $kg \cdot f/cm^2$ or below, preferably 5 $kg \cdot f/cm^2$ or below at 300% elongation for the excellent cushioning characteristics and the soft touch as in this invention. With the increase in the modulus at 300%

elongation, the swellability in water tends to decrease while the material becomes harder to touch at the same level of swelling and both the pressure distribution and the adaptability to the movement of human body become inferior, said adaptability being evaluated in terms of horizontal sliding effect. The cushioning material of this invention employing a crosslinked rubber material of low modulus is excellent in the above properties and is suitable for use in the cushioning products for disabled persons and patients who are unable to move freely the body, because it is necessary for these people to use a cushioning product not interfering with the blood circulation. According to this invention a base polymer substance having a large tensile strength and a large elongation at rupture is used in the cushioning material of low tensile modulus (i.e. low tensile stress at given elongation).

As described above, in order to improve the cushioning characteristics such as pressure distribution, a swelling treatment with water is carried out to produce a large volume increase. It was found that in order to prevent the highly swollen cushioning material from rupture, it is desirable to use a base rubber having a high tensile strength and a high elongation at rupture. This is important especially in the case where it is required to increase the swelling degree. Excellent results are obtained by using a base rubber having a tensile strength of 8 $kg \cdot f/cm^2$ or above and an elongation

at rupture of 500% or above. If a base rubber insufficient in both the tensile strength and the elongation at rupture is used, there occurs cracking (breaking crack) of swollen cushioning material, which is also undesirable from the viewpoint of durability. The tensile strength and the elongation at rupture, as herein refered to, are determined at 20°C and at a extension rate of 500 mm/minute by using No. 3 dumbbell test pieces, 2 mm in thickness, as specified in JIS K-6301.

As most suitable polymer substances, there are used ethylene-α-olefin copolymer rubbers and ethylene-α-olefin-nonconjugated diene terpolymer rubbers. In order to obtain a low-modulus cross-linked rubber material, there are used a base rubber having a high tensile strength and a high elongation at rupture, a relatively large amount of a process oil, and a small amount of a crosslinking agent, the crosslinking time being sufficiently short.

The compounding materials including polymer substances, swellable polymer substances, and crosslinking agents are mixed by means of a Banbury mixer, kneader, or mixing rolls. The resulting rubber composition is formed into sheeting, plate, ribbon, rod, and any other shapes. The formed rubber composition can be corrugated, punched, or cut to chips or strips to accelerate the rate of swelling or to improve the cushioning characteristics. The method of molding and crosslinking can be freely selected to meet the intended

use of the product. Typical examples of molding and crosslinking processes include a press curing, an autoclave curing, a combination of the extrusion molding and the continuous vulcanization in a suitable equipment, and simultaneous molding and curing by the injection molding process. Although the conditions for the crosslinking treatment vary depending on the intended use of the product and the crosslinking process, it is general practice to carry out the crosslinking by heating at a temperature of 100° to 250°C for a period of several minutes to several hours.

The swelling treatment is performed by the immersion of the crosslinked molded material into an aqueous medium which may contain, if necessary, additives such as fungicides and alcohol. The aqueous medium is generally at room temperature or can be moderately heated. The immersion time is freely selected but it is desirable to attain a high degree of swelling in a short time. The conditions for the immersion are selected so as to increase the volume of molded material to three times the original volume or more. Although cushioning characteristics such as pressure distribution become better with the increase in the degree of swelling, yet an excessive increase of the volume by swelling results in deterioration of durability and tends to cause the seasickness. For this reason, it is desirable to adjust the final volume to be as large as 3 to 15 times the original volume. To achieve such a high degree of

swelling in a short period of time, it is desirable to select a highly swellable polymer and to use such a polymer in an increased amount.

In making a cushioning product, the swollen cushioning material obtained as described above is packed in a package impervious to water in order to protect the swollen material from volatilization loss of water. Examples of such impervious materials are polyethylene film, flexible polyvinyl chloride film, and ethylene-vinyl acetate copolymer film. If necessary, the resulting cushioning product is combined with an auxiliary cushioning material such as urthane foam, ethylene-vinyl acetate foam, foam rubber, or cotton. Further, the cushioning product can be packed in an outermost covering made of cloth, leather, or sheet metals. In some instances, the crosslinked rubber material is placed in a package and, before use, is allowed to swell by the addition of water.

BRIEF DESCRIPTION OF THE DRAWINGS

Figs. 1 and 2 represent sectional views of examples of the present cushioning products. In both figures, 1 is a cushioning material swollen with water and 2 is an external package made of a film material impervious to water. In Fig. 2, 3 is an auxiliary cushioning material, 4 is an outermost covering, and 5 is a sheet metal.

BEST MODE FOR CARRYING OUT THE INVENTION

The invention is illustrated in detail below with reference to Examples, but the invention is not limited thereto.

EXAMPLES 1 to 4 and COMPARATIVE EXAMPLES 1 and 2

Various ethylene-base rubbers were tested for the swelling characteristics in water with the results as shown in Table 1 for reference.

Table 1

	Example				Comparative Example	
	1	2	3	4	1	2
Type of ethylene-propylene rubber	A*	B	C*	C/E=1/1	D	E
Mooney Viscosity ML_{1+4} 100°C	55	95	55	-	45	50
Third constituent (iodine value)	DCPD(16)	ENB(12)	ENB(12)	-	ENB(24)	ENB(12)
Tensile strength (kg f/cm^2)	26	>23	37	>20	7.8	6.7
Elongation at rupture (%)	1,100	>1,300	970	>600	1,600	420
Compounding formula (part by weight)						
Ethylene-propylene rubber	100 (polymer in oil-extended rubber)					
Clay	400					
Paraffinic oil	200 (including the oil in oil extended rubber)					
Sumika gel ® 520	80					
Surface active agent	20					
Zinc oxide	10					

(To be continued)

Table 1 (Cont'd)

Stearic acid	2					
Soxinol® BZ } accelerator	4					
" TT } accelerator	1					
" TRA } accelerator	1					
" M } accelerator	2					
Sulfur	1.5					
Swelling characteristics: volume expansion (number of times the original volume)						
After 3 days	4.0	3.8	3.5	3.7	3.1	3.6
After 5 days	5.8	4.9	5.1	5.3	Undeterminable due to cracking	

Note: 1. * Oil extended rubber (polymer/oil = 1/1)

2. Milled in a kneader.

3. Crosslinking conditions: 160°C, 20 minutes, press cure.

4. Swelling conditions: A test piece, 40 x 40 x 5 mm, was immersed in water for prescribed number of days at room temperature.

5. Sumika gel® 520: A highly water-absorptive polymer produced by Sumitomo Chemical Co.

It was found from the results obtained in Examples 1 to 4 and Comparative Examples 1 and 2 that in order to achieve, by swelling, a volume expansion as large as five-fold or more, it is necessary to use an ethylene-propylene rubber having a high tensile strength and a high elongation at rupture. When a rubber such as E having a low tensile strength and a low elongation at rupture is used to improve the processability, it should be used jointly with another rubber such as C having a high tensile strength and a high elongation at rupture, thereby to keep balance between the strength and the processability (Example 4). In order to obtain a swollen rubber satisfactory for the cushioning material, it is desirable to use a starting rubber having a tensile strength of 8 $kg \cdot f/cm^2$ or above and an elongation at rupture of 500% or above.

EXAMPLES 5 to 8 and COMPARATIVE EXAMPLE 3

1. Crosslinking and swelling treatment with water:

In Tables 2 and 3 are shown the results of examination on the relationship between the characteristics of crosslinked rubbers obtained under varied crosslinking conditions and the swelling characteristics of the crosslinked rubbers.

Table 2

	Example				Comparative Example
	5	6	7	8	3
Type of ethylene-propylene rubber	A	A	A/F	A	A
Compounding formula (parts by weight)					
Ethylene-propylene rubber	100	100	20/80	100	100
Clay	400	400	150	400	400
Paraffinic oil (including extender oil)	300	300	90	300	300
Sumika gel® 520	80	80	60	80	80
Surface active agent	20	20	5	20	20
Calcium oxide	-	-	6	-	-
Soxinol® BZ	4	4	-	4	-
" TT	1	1	-	1	-
" TRA	1	1	1.5	1	-
" M	2	2	3	2	-
" PZ	-	-	1.5	-	-

(To be continued)

Table 2 (Cont'd)

Sulfur	0.6	1.2	1.5	1.8	-
Urea-base blowing agent	-	-	8	-	-
Urea-base blowing aid	-	-	8	-	-

Note: 1. Physical properties of ethylene-propylene rubber F:
Mooney viscosity ML_{1+4}, 100°C : 75
ENB type, iodine value: 24
Tensile strength: 5.6 $Kg \cdot f/cm^2$
Elongation at rupture: 560%

2. Milled in a kneader.

3. Crosslinking conditions:
Examples 5, 6 and 8: 160°C, 10 minutes, press cure.
Example 7: 120°C, 12 minutes, press cure and foaming.
Comparative Example 3: 100°C, 10 minutes, press cure.

Table 3

	Example				Comparative Example
	5	6	7	8	3
Physical properties of crosslinked rubber sheeting:					
Modulus at 100% elongation ($Kg \cdot f/cm^2$)	1.6	2.7	3.9	5.2	1.2
" 200% " (")	2.3	4.0	5.4	7.3	1.8
" 300% " (")	2.6	4.8	6.5	8.3	2.1
Tensile strength (")	9.5	17.9	12.0	30.0	3.4
Elongation at rupture (%)	1200	1070	690	970	670
Hardness	50	55	57	59	48
Swelling treatment:					
Duration of immersion in water (days)	3	5	5	15	2

(To be continued)

Table 3 (Cont'd)

Characteristics of swollen material					
Volume expansion (number of times the orginal volume)	3.9	3.7	3.8	3.2	5.4
Flexibility	◎	○	○	△	◎
Hardness	39	41	45	45	37

Note: 1. Swelling treatment: A test piece, 40 x 40 x 5 mm, was kept immersed at room temperature in an aqueous solution containing 0.2% by weight of butyl p-hydroxybenzoate until the test piece had become about 60 x 60 mm in size.

2. Flexibility: ◎ excellent, ○ good, △ fair

3. Hardness: Tested by means of a hardness tester (SRIS 0101 type C).

4. Modulus was tested on a No. 2 dumbbell test piece specified in JIS K6301.

A pair of test pieces, each 150 x 150 x 5 mm, were cut from crosslinked rubber sheets obtained in Examples 5, 6 and 7 which showed desirable swelling characteristics and from the rubber sheet of Comparative Example 3. The test pieces were kept at room temperature in an aqueous solution containing 0.2% by weight of butyl p-hydroxybenzoate until they become about 300 x 300 mm in size.

2. Characteristics of cushioning products obtained from each swollen rubber sheet.

The swollen rubber sheet of about 300 mm square obtained from Examples 5, 6 and 7 and Comparative Example 3 after treatments shown in Tables 2 and 3 were tested for the hardness and each pair of swollen test pieces were placed one over the other, then packed in polyethylene film, 50 μ in thickness, then heat sealed, further packed in a polyvinyl chloride film covering, and sealed tightly by means of a high frequency welder to obtain a cushioning product.

Evaluation of cushioning product:

The cushioning characteristics of the cushioning products obtained above were evaluated by testing the compression characteristics, repeated compression endurance, horizontal sliding effect of indentation load, and pressure distribution. The test procedures were as described below.

1. Compression characteristics and repeated compression endurance test:

Hydraulic oscillation fatigue tester of the electronic type was used. The cushioning product was compressed by means of an indentor plate, 200 mm in diameter, at a rate of 4 Kg/second to an ultimate load of 100 Kg. The strain corresponding to a load was determined from the record stress-strain curve. Compression endurance was then tested by subjecting the test piece to 80,000 cycles of repeated compression at a rate of 60 cpm under a load of 10 Kg to 100 Kg. The permanent deformation in thickness after the test was recorded as permanent set.

2. Horizontal sliding effect of indentation load test:

A brick carrying a load thereon (26 Kg in total) was placed on the test piece and pulled horizontally so that the brick may slide on the surface. The displacement of brick was measured at a tractive force of 2 Kg and 4 Kg.

3. Pressure distribution test:

A total of 46 pressure sensors were arranged over the test specimen at a longitudinal interval of 30 mm and a lateral interval of 20 mm to detect the distribution of pressure exerted to the specimen by a test person sitting thereon.

The test results were as shown in Table 4. The cushioning product of Comparative Example 4 is a commercial product comprising a gel-like substance produced by Company A in USA.

Table 4 Evaluation of cushioning product

	Comparative Example 3	Example 5	Example 6	Example 7	Comparative Example 4 (Company A)
Hardness of swollen material	18	20	23	25	-
Dimension of cushioning material (cm)	29x28x2.6	29x27x2.2	29x27x2.0	28x27x2.5	40x39x4.0
Weight of cushioning material (Kg)	2.1	2.0	2.0	2.0	5.7
Compression characteristics					
Strain at 10 Kg load (%)	28	24	10	4	8
" 20 " " "	38	29	16	6	14
" 50 " " "	54	44	30	11	31
" 100 " " "	68	62	48	19	50
Repeated compression endurance					
Appearance	Cracking	No change	No change	No change	No change
Permanent set (%)	Undeterminable due to cracking	0.5	1	0.0	4.5

(To be continued)

Table 4 Evaluation of cushioning product - (Cont'd)

Horizontal sliding effect test					
Displacement of brick at 2 Kg traction (mm)	-	6	5	1	6
" 4 " "	-	25	19	16	18
Pressure distribution					
Test person A					
Maximum pressure (g/cm^2)	-	227	214	228	225
Average pressure (")	-	71	73	85	80
Test person B					
Maximum pressure (g/cm^2)	-	407	418	455	587
Average pressure (")	-	86	80	92	89

Note: Test person A: 154 cm in height, 46 Kg in weight, female, normal physique.

Test person B: 175 cm in height, 56 Kg in weight, male, slender type.

As is apparent from Table 4, the cushioning product of Comparable Example 3, the rubber of which has not been crosslinked, is poor in repeated compression endurance and is unsuitable for practical use. Excellent characteristics were shown by the cushioning products of Example 5, 6 and 7, which were obtained by the swelling treatment of crosslinked rubber materials. Although thinner in thickness and lighter in weight, these cushioning products showed characteristics favorably comparable to those of the cushioning product made from commercial gel-like material. The pressure distribution was better, maximum pressure being lower, in the case of a person of the slender type like the test person B, wherein the indentation body pressure tends to concentrate in the region around the ischium or coccyx.

Well-balanced cushioning characteristics including the horizontal sliding effect value were shown in the cases of cushioning products of Examples 5 and 6 which were derived from the crosslinked rubber material having a low tensile stress less than 5 $kg \cdot f/cm^2$ at 300% elongation.

INDUSTRIAL APPLICABILITY

Patients and disabled people, who are confined to their beds or wheelchairs for an extended period of time, tend to suffer from decubitus ulcer in the region where the indentation body pressure is especially large. In order to protect these people from the decubitus ulcer,

it is necessary to use cushioning products excellent in pressure distribution and horizontal sliding effect. Being excellent in these performance characteristics and in durability, the cushioning materials and products are suitable for the above purpose.

What is claimed is:

1. A cushioning material excellent in pressure distribution and in durability, which is made by molding into prescribed form a composition comprising a polymer substance swellable in water and a polymer substance capable of forming a nonhydrolyzable crosslinked structure, then subjecting the molded composition to crosslinking treatment, and treating the crosslinked composition with water to cause expansion by swelling to a volume as large as 3 to 15 times the orginal volume.

2. A cushioning material according to Claim 1, wherein the crosslinking treatment is carried out under such conditions that the resulting crosslinked composition may show a Modulus at 300% elongation of 5 $Kg \cdot f/cm^2$ or below.

3. A cushioning material according to Claim 1, wherein the polymer substance capable of forming a nonhydrolyzable crosslinking structure is a rubber material having a tensile strength of 8 $Kg \cdot f/cm^2$ or above and an elongation at rupture of 500% or above.

4. A cushioning material according to Claim 3, wherein the rubber material is an ethylene-α-olefin copolymer and/or an ethylene-α-olefin-nonconjugated diene terpolymer,

5. A cushioning product comprising a cushioning material and an outer package which encases the cushioning material, which is characterized by being such that said cushioning material is a water-swollen composite com-

prising a water-swellable polymer substance and a polymer substance having a nonhydrolyzable crosslinked structure and said outer package is impervious to water and a portion or whole of said outer package is a flexible water-impervious polymer film or sheeting.

(Amendment under Article 19 (1))

What is claimed is:

1. (amended)

A cushioning material excellent in pressure distribution and in durability, which is made by molding into prescribed form a composition comprising a polymer substance swellable in water and a polymer substance capable of forming a nonhydrolyzable crosslinked structure, then subjecting the molded composition to crosslinking treatment, to such an extent that the tensile stress at 300% elongation may become 10 $Kg \cdot f/cm^2$ or less and treating the crosslinked composition with water to cause expansion by swelling to a volume as large as 3 to 15 times the original volume.

2. A cushioning material according to Claim 1, wherein the crosslinking treatment is carried out under such conditions that the resulting crosslinked composition may show a Modulus at 300% elongation of 5 $Kg \cdot f/cm^2$ or below.

3. A cushioning material according to Claim 1, wherein the polymer substance capable of forming a non-hydrolyzable crosslinking structure is a rubber material having a tensile strength of 8 $Kg \cdot f/cm^2$ or above and an elongation at rupture of 500% or above.

4. A cushioning material according to Claim 3, wherein the rubber material is an ethylene-α-olefin copolymer and/or an ethylene-α-olefin-nonconjugated diene terpolymer.

5. A cushioning product comprising a cushioning

material and an outer package which encases the cushioning material, which is characterized by being such that said cushioning material is a water-swollen composite comprising a water-swellable polymer substance and a polymer substance having a nonhydrolyzable crosslinked structure and said outer package is impervious to water and a portion or whole of said outer package is a flexible water-impervious polymer film or sheeting.

6. (newly added)

A cushioning product according to Claim 5, wherein said cushioning material is excellent in pressure distribution and in durability, which is made by molding into prescribed form a composition comprising a polymer substance swellable in water and a polymer substance capable of forming a nonhydrolyzable crosslinked structure, then subjecting the molded composition to crosslinking treatment, to such an extent that the tensile stress at 300% elongation may become 10 $Kg \cdot f/m^2$ or less and treating the crosslinked composition with water to cause expansion by swelling to a volume as large as 3 to 15 times the original volume.

FIG. 1

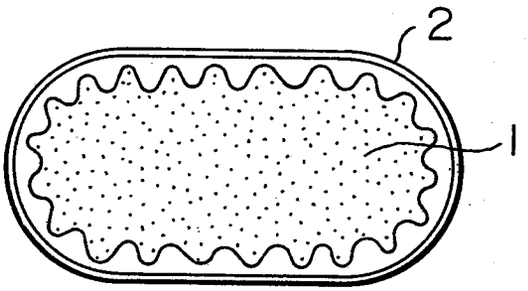
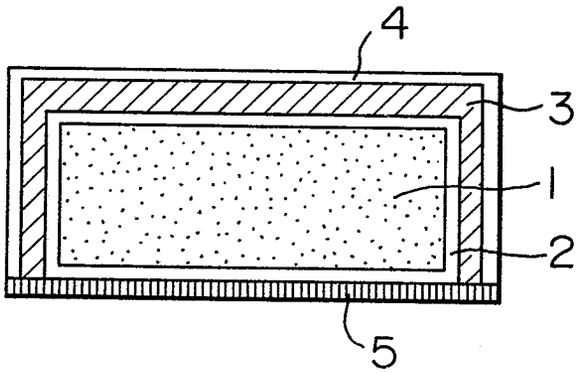


FIG. 2



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP85/00089

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl[4] B68G5/02

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC	B68G5/00-5/02, A47C27/00-27/22, C08L23/16

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

Jitsuyo Shinan Koho 1921 - 1985
Kokai Jitsuyo Shinan Koho 1971 - 1985

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category*	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
X	JP, A, 59-145230 (Sumitomo Chemical Co., Ltd.), 20 August 1984 (20. 08. 84), Page 2, right column, lines 23 to 33, page 3, right column, line 5 to page 4, left column, line 5 (Family: none)	1 - 4
A	JP, A, 59-145230 (Sumitomo Chemical Co., Ltd.), 20 August 1984 (20. 08. 84), Page 2, right column, lines 23 to 33, page 3, right column, line 5 to page 4, left column, line 5 (Family: none)	5

* Special categories of cited documents: [15]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
January 23, 1986 (23. 01. 86)	February 3, 1986 (03. 02. 86)
International Searching Authority [1]	Signature of Authorized Officer [20]
Japanese Patent Office	