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[Continued on next page]

(54) Title: IMPROVED FLOOR MATS

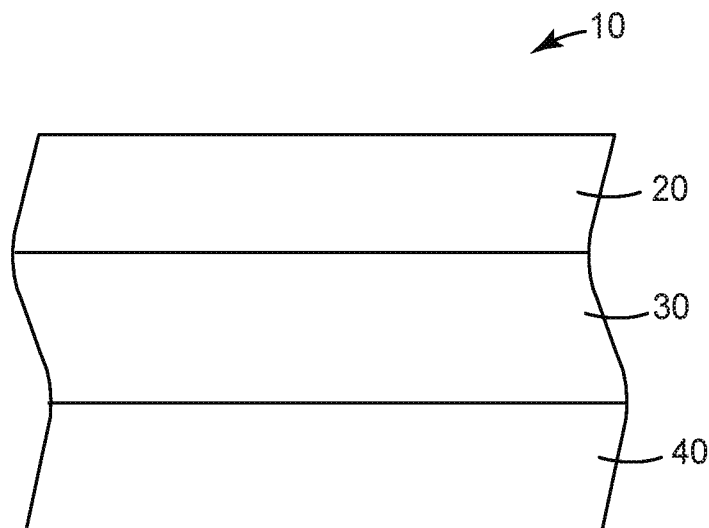


FIG. 1

(57) Abstract: The present disclosure relates generally to multilayer articles for potential use as floor mats and to methods of making the same. In some embodiments, the multilayer articles include a first layer including a closed cell foam; a second layer directly adjacent to the first layer and including an open cell foam, and a third layer directly adjacent to the second layer and including a closed cell foam.

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IMPROVED FLOOR MATS

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Technical Field

[0001] The present disclosure relates generally to multilayer articles for potential use as floor mats and methods of making the same. The present disclosure relates generally to articles including two closed cell
10 foam layers between which is an open cell foam layer and methods of making the same.

Background

[0002] Many conventional floor mats require some degree of water resistance. For example, floor mats for use in gyms, exercise centers, or kitchens are repeatedly exposed to liquid substances. Floor mats
15 used in these locations often include closed cell foams which prevent water or air from passing through the floor mat. Some exemplary such floor mats include 100% closed cell foam either in a single or multiple layers. Chinese Publication No. 202237005, for example, describes such a floor mat.

[0003] Other conventional floor mats require some degree of sound proofing. In Chinese Publication No. 103774833, a floor mat having excellent sound proofing is achieved by arranging a closed cell foam
20 layer directly adjacent to an open cell foam layer.

[0004] Other conventional floor mats include a layer of open cell polyurethane with a foam or film on either side thereof. Patent Publication No. TW M 275955, for example, describes such a floor mat.

Summary

[0005] The inventors of the present disclosure recognized that conventional floor mats exhibit inadequate
25 compression deformation resistance and/or shock absorption. The inventors of the present disclosure recognized that at least one of compression deformation resistance and/or shock absorption in floor mats could be improved while maintaining at least one of water resistance and/or sound resistance.

[0006] The inventors of the present disclosure recognized that at least one of these features could be improved in some floor mat embodiments by positioning a layer of closed cell foam on either side of a
30 layer of open cell foam. The resulting floor mat exhibits excellent shock absorption (due to the presence of the open cell foam) as well as water resistance (due to the presence of close cell foam on either side of the open cell foam). The inventors recognized that these embodiments would have applicability in all floor mats, and especially in safety floor mats for children.

[0007] In some embodiments, the present disclosure relates to a floor mat, comprising: a first layer
35 including a closed cell foam; a second layer including an open cell foam; and a third layer including a closed cell foam; wherein the first layer is directly adjacent to the second layer, and wherein the second layer is directly adjacent to the third layer.

[0008] In some embodiments, at least one of the first layer or the third layer includes at least one of a polyolefin or an ethylene vinyl acetate. Either may also include an elastomer or other additive. In some embodiments, the polyolefin is at least one of polyethylene and/or polypropylene.

[0009] In some embodiments, at least one of the first layer or the third layer has a thickness of between about 0.5 mm and about 3.0 mm. In some embodiments, at least one of the first layer or the third layer has a thickness of between about 1 mm and about 2 mm.

[0010] In some embodiments, at least one of the first layer or third layer include at least 50% of closed cell foam as measured by testing under ASTM D6226-14. In some embodiments, at least one of the first layer or third layer include at least 60% of closed cell foam as measured by testing under ASTM D6226-14. In some embodiments, at least one of the first layer or third layer include at least 70% of closed cell foam as measured by testing under ASTM D6226-14. In some embodiments, at least one of the first layer or third layer include at least 80% of closed cell foam as measured by testing under ASTM D6226-14.

[0011] In some embodiments, the second layer includes at least one of a polyolefin, a polyurethane, or an ethylene vinyl acetate. In some embodiments, the second layer includes a polyethylene. In some embodiments, the second layer has a thickness of between about 10 mm and about 30 mm. In some embodiments, the second layer has a thickness of between about 15 mm and about 22 mm. In some embodiments, the second layer includes at least 80% of open cell foam as measured by testing under ASTM D6226-14. In some embodiments, the second layer includes at least 90% of open cell foam as measured by testing under ASTM D6226-14. In some embodiments, the second layer is at least 50% of the total floor mat thickness. In some embodiments, the second layer has an expansion ratio that is less than the expansion ratio of either the first layer or the third layer.

[0012] In some embodiments, the floor mat has a compression deformation of less than 40% after 40 minutes of recovery time as measured when tested under ASTM D3575-14 (Suffix B). In some embodiments, the floor mat has a compression deformation of less than 5% after 240 hours of recovery time as measured when tested under ASTM D3575-14 (Suffix B).

[0013] In some embodiments, the floor mat further includes at least one of an anti-slip coating formulation, treatment, or coating or an anti-scratch formulation, treatment, or coating.

[0014] In some embodiments, the floor mat has a shock absorption of less than 200 m/s^2 at an initial state when measured under the SATRA TM142 test method; and a shock absorption of less than 300 m/s^2 after 40 hours of recovery time when measured under the ASTM D3575-14 compression deformation test method; and a shock absorption of less than 250 m/s^2 after 240 hours of recovery time when measured under the ASTM D3575-14 compression deformation test method.

[0015] Some embodiments relate to a method of forming a floor mat, comprising: providing a first layer including a closed cell foam; providing a second layer including an open cell foam; and providing a third layer including a closed cell foam; bonding the first, second, and third layers so that the first layer is directly adjacent to the second layer and the second layer is directly adjacent to the third layer. In some embodiments, the bonding step involves thermal hot melting.

Brief Description of Drawings

[0016] Fig. 1 shows a side view of an exemplary embodiment of the present disclosure in which a layer of closed cell foam on either side of a layer of open cell foam.

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Detailed Description

[0017] Various embodiments and implementations will be described in detail. These embodiments should not be construed as limiting the scope of the present application in any manner, and changes and modifications may be made without departing from the spirit and scope of the inventions. For example, many of the embodiments, implementations, and examples are discussed with specific reference to floor mats, but these should not be construed to limit the application scope to this one exemplary implementation. Further, only some end uses have been discussed herein, but end uses not specifically described herein are included within the scope of the present disclosure. As such, the scope of the present disclosure should be determined by the claims.

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[0018] The inventors of the present disclosure recognized that a floor mat having excellent compression deformation resistance and/or shock absorption and/or water resistance and/or sound proofing could be made by forming a floor mat including a layer of closed cell foam directly on either side of a layer of open cell foam.

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[0019] In general, foam structures include a solid material that is filled with voids or bubbles. Foams are typically generated by forming gas bubbles in a liquid base as the liquid hardens into a solid. The properties of the liquid and the gas determine the final structure of the foam. Two of the primary categories of foam materials are (1) open cell foam and (2) closed cell foam.

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[0020] In open cell foams, the voids intersect each other, forming paths through the solid. As a result, open cell foams are generally soft and compressible. Open cell foams also typically act as good insulators because they trap air or other gases within the cells. Open cell foams can absorb liquid into their cells (and are thus often used as, for example, sponges). Open cell foam has a generally low cost per R value making its use in various applications such as sound dampening, shock absorbers, cushioning and pillows, cost-effective.

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[0021] In contrast, closed cell foams include individual closed spheres. The presence of individual, closed spheres results in an inability of most gases (eg: air) or fluids to permeate this type closed cell foam, making them generally waterproof and/or water-resistant. Closed cell foams also generally provide greater structural stiffness than open cell foams. In some embodiments, the individual, closed cells are filled with gasses (*e.g.*, often gases other than air) during fabrication. Closed cell foams can be used to prevent water or air from passing from one area to another. Closed cell foam is denser than open cell foam, and is thus generally more expensive to manufacture.

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[0022] "Memory foam" can be either closed cell foam or open cell foam. It is typically a polyurethane including additives that increase its viscosity and density. It is often referred to as "viscoelastic" polyurethane foam, or low-resilience polyurethane foam.

5 [0023] In some embodiments, the present disclosure relates to a floor mat, comprising: a first layer including a closed cell foam; a second layer including an open cell foam; and a third layer including a closed cell foam; wherein the first layer is directly adjacent to the second layer, and wherein the second layer is directly adjacent to the third layer. One exemplary embodiment of such a floor mat 10 is shown in Fig. 1. Floor mat 10 of Fig. 1 includes a first layer 20 including closed cell foam. First layer 20 is
10 directly adjacent to a second layer 30 including open cell foam. Second layer 30 is directly adjacent to a third layer 40 including closed cell foam.

[0024] Closed Cell Foam Layers. In some embodiments, the first and third layers of the floor mat of the present disclosure include closed cell foam. In some embodiments, at least one of the first layer or the
15 third layer includes at least one of a polyolefin, an ethylene vinyl acetate, and/or an elastomer. In some embodiments, the polyolefin is at least one of polyethylene and/or polypropylene. In some embodiments, the first and third layers include the same materials. In some embodiments, the first and third layers include different materials. In some embodiments, the elastomer is ethene-1-octene copolymer. In some
20 embodiments, the first and third layers have the same composition; in some embodiments, the first and third layer have different compositions.

[0025] In some embodiments, at least one of the first layer or the third layer has a thickness of between about 0.5 mm and about 3.0 mm. In some embodiments, at least one of the first layer or the third layer has a thickness of between about 1 mm and about 2 mm. In some embodiments, the first and third layers have the same thickness; in some embodiments, the first and third layer have different thicknesses.

25 [0026] In some embodiments, at least one of the first layer or third layer include at least 50% of closed cell foam as measured by testing under ASTM D6226-14. In some embodiments, at least one of the first layer or third layer include at least 60% of closed cell foam as measured by testing under ASTM D6226-14. In some embodiments, at least one of the first layer or third layer include at least 70% of closed cell foam as measured by testing under ASTM D6226-14. In some embodiments, at least one of the first layer
30 or third layer include at least 80% of closed cell foam as measured by testing under ASTM D6226-14. In some embodiments, the first and third layers have the same closed cell foam content; in some embodiments, the first and third layer have different closed cell foam content.

[0027] In some embodiments, at least one of the first and third layers have an expansion ratio of greater than 20x. In some embodiments, the first and third layers have the same expansion ratio; in some
35 embodiments, the first and third layer have different expansion ratio.

[0028] In some embodiments, at least one of the first and third layers may include within or be coated with at least one of an anti-slip coating formulation, treatment, or coating or an anti-scratch formulation, treatment, or coating.

5 [0029] Open Cell Foam Layers. In some embodiments, the second layer of the floor mat of the present disclosure includes open cell foam. In some embodiments, the second layer includes at least one of a polyolefin, polyurethane, or an ethylene vinyl acetate. In some embodiments, the polyolefin is polyethylene or polypropylene.

10 [0030] In some embodiments, the second layer has a thickness of between about 10 mm and about 30 mm. In some embodiments, the second layer has a thickness of between about 15 mm and about 22 mm. In some embodiments, the second layer is at least 50% of the total floor mat thickness.

[0031] In some embodiments, the second layer includes at least 80% of open cell foam as measured by testing under ASTM D6226-14. In some embodiments, the second layer includes at least 90% of open cell foam as measured by testing under ASTM D6226-14.

15 [0032] In some embodiments, the second layer has an expansion ratio that is less than the expansion ratio of at least one of the first layer or the third layer. In some embodiments, the expansion ratio of the second layer is between 10x and 30x.

20 [0033] Floor Mats. In some embodiments, the floor mat has a compression deformation of less than 40% after 40 minutes of recovery time as measured when tested under ASTM D3575-14 (Suffix B). In some embodiments, the floor mat has a compression deformation of less than 5% after 240 hours of recovery time as measured when tested under ASTM D3575-14 (Suffix B).

[0034] In some embodiments, the floor mat further includes at least one of an anti-slip coating formulation, treatment, or coating or an anti-scratch formulation, treatment, or coating.

25 [0035] In some embodiments, the floor mat has a shock absorption of less than 200 m/s² at an initial state when measured under the SATRA TM142 test method; and/or a shock absorption of less than 300 m/s² after 40 hours of recovery time when measured under the ASTM D3575-14 compression deformation test method; and/or a shock absorption of less than 250 m/s² after 240 hours of recovery time when measured under the ASTM D3575-14 compression deformation test method.

30 [0036] Methods of Making. Some embodiments relate to a method of making or forming a floor mat, comprising: providing a first layer including a closed cell foam; providing a second layer including an open cell foam; and providing a third layer including a closed cell foam; bonding the first, second, and third layers so that the first layer is directly adjacent to the second layer and the second layer is directly adjacent to the third layer. In some embodiments, the bonding step involves thermal hot melting. In some embodiments, there is no adhesive present between the first and second layers and/or between the second and third layers. The elimination of adhesive in the floor mat eliminates or reduces some of the

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toxicity in the floor mat, which is especially beneficial for floor mats used in, for example, safety or kitchen applications.

[0037] The following examples describe some exemplary constructions of various embodiments of layers, methods, and articles of the present disclosure. The following examples describe some exemplary constructions and methods of constructing various embodiments within the scope of the present disclosure. The following examples are intended to be illustrative, but are not intended to limit the scope of the present disclosure.

Examples

[0038] Example 1

[0039] A floor mat having three layers as shown in Figure 1 was prepared having first and third, closed cell foam outer layers and a second, open cell foam inner layer positioned between the first and third outer layers. The foam material used for the first and third outer layers was obtained from Holyfoam Chemical Industry Group, Taipei, Taiwan (Holyfoam product number YR1502). Each of the first and third layers was a 2 mm thick, closed cell foam material that included ethylene vinyl acetate and an ethene-1-octene copolymer elastomer (closed cell content >50%). The second, open cell foam inner layer was also obtained from Holyfoam Chemical Industry Group. The inner layer included two 8 mm thick, polyethylene/ethylene vinyl acetate open cell foam materials (Holyfoam product number OP2508) that had been thermally laminated together to provide a 16 mm, thick open cell foam layer (Holyfoam product number OP2516). The open cell content of the second layer was 99% based on ASTM D6226. The three foam layers were thermally bonded together using conventional calendaring equipment with the calender rolls maintained at a temperature of about 210 - 250°C.

[0040] The floor mat of Example 1 was tested for compression deformation resistance using ASTM test method "Standard Test Methods for Flexible Cellular Materials Made From Olefin Polymers" (ASTM D3575-14, Suffix B-Compression Set Under Constant Deflection). Competitive floor mat products C1-C5 were also tested. C1 was an EVA Alphabet Mat sold by Dau Cheng Enterprise Co., Ltd., in Taipei, Taiwan. C2 was a Baby Great Puzzle Mat sold by Great Ball Enterprise Co., Ltd., in Taichung, Taiwan. C3 was an EVA Circle Traction Heart Mat sold by Dau Cheng Enterprise Co., Ltd., Taipei, Taiwan. C4 was a Skip Hop PlaySpot Interlocking Foam Tile sold by Skip Hop, Inc., New York City, NY (www.skiphop.com). C5 was a LOG® Puzzle Mat sold by Echain Tech. Corporation (www.logtoy.com.tw).

[0041] Data is provided in Table 1. Thickness measurements were obtained at 23°C. The initial thickness (T1) was the thickness of the floor mat measured prior to any compression. After having been compressed 50% for 22 hours, the thickness (T2) was measured after 30-40 minutes recovery time, and then the thickness (T3) was measured again after 240 hours recovery time. Deformation #1 was calculated as $T1 - T2 / T1 \times 100$. Deformation #2 was calculated as $T1 - T3 / T1 \times 100$.

[0042] Table 1. Thickness and Deformation Results for Example 1 and Comparative Products.

Sample	T1 Thickness (mm)	T2 Thickness (mm) (after 30-40 minutes recovery)	Deformation #1 (%)	T3 Thickness (mm) (after 30-40 minutes recovery)	Deformation #2 (%)
Example - sample 1	20.11	15.69	21.98	19.82	1.44
Example - sample 2	20.12	15.70	21.97	19.83	1.44
C1 - sample 1	26.55	10.07	62.07	21.13	20.41
C1 - sample 2	26.58	10.84	59.22	21.65	18.55
C2 - sample 1	29.26	14.17	51.57	24.66	15.72
C2 - sample 2	29.09	15.01	48.40	24.56	15.57
C3 - sample 1	21.18	11.76	44.48	19.61	7.41
C3 - sample 2	21.27	10.39	51.15	18.44	13.31
C4 - sample 1	25.20	10.31	59.09	21.94	12.94
C4 - sample 2	25.24	9.86	60.94	23.19	8.12
C5 - sample 1	21.46	10.61	50.56	12.30	42.68
C5 - sample 2	21.97	10.63	51.62	12.59	42.69

[0043] The data indicates that the Example 1 floor mat exhibits improved compression deformation resistance compared to the competitive floor mat products (approximately 22% compared to approximately 44-62% after 30-40 minutes recovery time, and approximately 1% compared to approximately 8-43% after 240 hours recovery time).

[0044] The Example 1 floor mat was also tested for shock absorption performance according to the SATRA test method “Falling Mass Shock Absorption Test - May 1992” (SATRA TM142, SATRA Test Methods Catalogue – September 2104, SATRA Technology Center, United Kingdom). Prior to testing for shock absorption the floor mat samples were subjected to compression deformation as described above. Competitive floor mat products C1-C5 were similarly tested for comparison. The initial shock absorption data was obtained prior to any compression. Shock absorption data was then obtained after 30-40 minutes recovery time and then again after 240 hours recovery time. The shock absorption data is summarized in Tables 2 and 3, and is reported as peak deceleration (Gmax).

[0045] Table 2. Shock Absorption Results for Example 1 and Comparative Products

Sample	FG Thickness (mm)	Initial Shock Absorption Gmax (m/s ²)	Shock Absorption Gmax (m/s ²) (after 30-40 minutes recovery)	Shock Absorption Gmax (m/s ²) (after 240 hours recovery)
Example 1	20.11	72	137	71
C1	13.64	128	717	434
C2	14.38	93	363	163
C3	12.34	153	572	348
C4	12.34	146	660	326
C5	22.56	71	325	206

[0046] Table 3. Shock Absorption Results for Example 1 and Comparative Products – Thickness Adjusted

Sample	FG Thickness (corrected to 20mm) (mm)	Initial Shock Absorption Gmax (m/s ²)	Shock Absorption Gmax (m/s ²) (after 30-40 minutes recovery)	Shock Absorption Gmax (m/s ²) (after 240 hours recovery)
Example 1	20.11	72	137	71
C1	20	95	481	267
C2	20	85	271	126
C3	20	98	324	172
C4	20	94	381	164
C5	22.56	71	325	206

[0047] A low Gmax value indicates good shock absorption characteristics. The data indicates that the Example 1 floor mat had improved shock absorption after compression deformation compared to the competitive floor mat products. Compared to the Gmax values for the competitive floor mat products, the Gmax values for the Example 1 floor mat were at least 50% lower after 30-40 minutes recovery time and at least 45% lower after 240 hours recovery time.

[0048] The recitation of all numerical ranges by endpoint is meant to include all numbers subsumed within the range (*i.e.*, the range 1 to 10 includes, for example, 1, 1.5, 3.33, and 10).

[0049] The terms first, second, third and the like in this disclosure, including in the claims, are used for distinguishing between elements / layers and not necessarily for describing a sequential or chronological order. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein.

[0050] Those having skill in the art will appreciate that many changes may be made to the details of the above-described embodiments and implementations without departing from the underlying principles thereof. Further, various modifications and alterations of the present disclosure will become apparent to those skilled in the art without departing from the spirit and scope of the disclosure. The scope of the present disclosure should, therefore, be determined only by the following claims.

What is claimed is:

1. A floor mat, comprising:

a first layer including a closed cell foam;

a second layer including an open cell foam; and

a third layer including a closed cell foam;

wherein the first layer is directly adjacent to the second layer, and wherein the second layer is directly adjacent to the third layer.

2. The floor mat of claim 1, wherein at least one of the first layer or the third layer includes at least one of a polyolefin, an ethylene vinyl acetate, or an elastomer.

3. The floor mat of claim 1 or claim 2, wherein at least one of the first layer or the third layer has a thickness of between about 0.5 mm and about 3.0 mm.

4. The floor mat of claim 1 or claim 2, wherein at least one of the first layer or the third layer has a thickness of between about 1 mm and about 2 mm.

5. The floor mat of any of the preceding claims, wherein at least one of the first layer or third layer include at least 50% of closed cell foam as measured by testing under ASTM D6226-14.

6. The floor mat of any of the preceding claims, wherein at least one of the first layer or third layer include at least 60% of closed cell foam as measured by testing under ASTM D6226-14.

7. The floor mat of any of the preceding claims, wherein at least one of the first layer or third layer include at least 70% of closed cell foam as measured by testing under ASTM D6226-14.

8. The floor mat of any of the preceding claims, wherein at least one of the first layer or third layer include at least 80% of closed cell foam as measured by testing under ASTM D6226-14.

9. The floor mat of any of the preceding claims, wherein the second layer includes at least one of a polyolefin, a polyurethane, or an ethylene vinyl acetate.

10. The floor mat of claim 9, wherein the second layer includes at least one of a polyethylene or a polypropylene.

11. The floor mat of any of the preceding claims, wherein the second layer has a thickness of between about 10 mm and about 30 mm.

12. The floor mat of any of the preceding claims, wherein the second layer has a thickness of between about 15 mm and about 22 mm.

13. The floor mat of any of the preceding claims, wherein the second layer includes at least 80% of open cell foam as measured by testing under ASTM D6226-14.

14. The floor mat of any of the preceding claims, wherein the second layer includes at least 90% of open cell foam as measured by testing under ASTM D6226-14.

15. The floor mat of any of the preceding claims, wherein the second layer is at least 50% of the total floor mat thickness.

16. The floor mat of any of the preceding claims, wherein the second layer has an expansion ratio that is less than the expansion ratio of either the first layer or the third layer.

17. The floor mat of any of the preceding claims, wherein the floor mat has a compression deformation of less than 40% after 40 minutes of recovery time as measured when tested under ASTM D3575-14 (Suffix B).

18. The floor mat of any of the preceding claims, wherein the floor mat has a compression deformation of less than 5% after 240 hours of recovery time as measured when tested under ASTM D3575-14 (Suffix B).

19. The floor mat of any of the preceding claims, further including at least one of an anti-slip coating formulation, treatment, or coating or an anti-scratch formulation, treatment, or coating.

20. The floor mat of any of the preceding claims, wherein
the floor mat has a shock absorption of less than 200 m/s^2 at an initial state when measured under the SATRA TM142 test method; and
a shock absorption of less than 300 m/s^2 after 40 hours of recovery time when measured under the ASTM D3575-14 compression deformation test method; and
a shock absorption of less than 250 m/s^2 after 240 hours of recovery time when measured under the ASTM D3575-14 compression deformation test method.

21. A method of forming a floor mat, comprising:
providing a first layer including a closed cell foam;
providing a second layer including an open cell foam; and
providing a third layer including a closed cell foam;

5 bonding the first, second, and third layers so that the first layer is directly adjacent to the second layer and the second layer is directly adjacent to the third layer.

22. The method of claim 16, wherein the bonding step involves thermal hot melting.

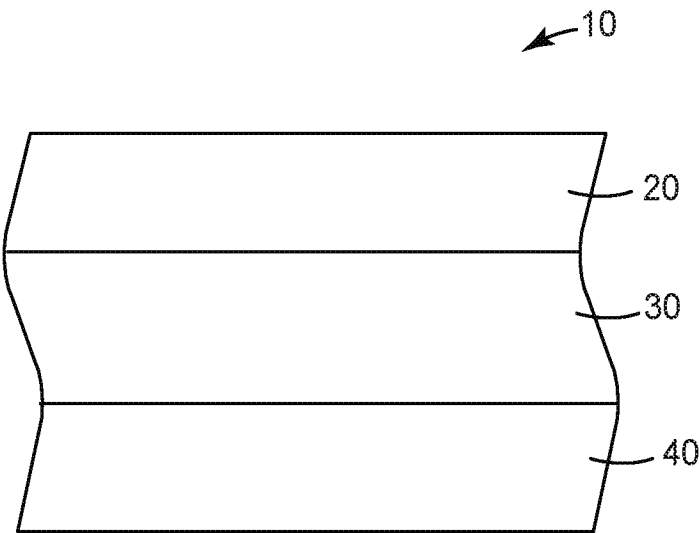


FIG. 1

A. CLASSIFICATION OF SUBJECT MATTER**B32B 5/18(2006.01)i, B32B 5/32(2006.01)i**

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 5/18; B32B 5/32

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords: floor mat, multilayer, cell foam, open, closed, polyolefin, ethyl vinyl acetate, elastomer, bond, thermal hot melting

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 06-046941 U (TAISEI CO., LTD.) 28 June 1994	1-4
Y	See abstract; paragraph [0013]; table 1; claims 1, 2; and figures 1, 2.	21,22
Y	WO 93-15905 A1 (WALTERS, I.) 19 August 1993 See page 5, lines 6-9; claim 4; and figure 4.	21,22
A	JP 2000-301645 A (SUMITOMO CHEM. CO., LTD.) 31 October 2000 See claim 1; and figures 1-4.	1-4,21,22
A	CN 103774833 A (ZHEJIANG RUN YANG NEW MATERIAL TECHNOLOGY CO., LTD.) 07 May 2014 See abstract; claim 1; and figures 1, 2.	1-4,21,22
A	CN 202237005 U (JIANGYIN CIVILIZED SPORTS PLASTICS CORPORATION) 30 May 2012 See abstract; claim 1; and figure 1.	1-4,21,22



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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

"E" earlier application or patent 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 when the document is taken alone

"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

Date of the actual completion of the international search

21 July 2016 (21.07.2016)

Date of mailing of the international search report

25 July 2016 (25.07.2016)

Name and mailing address of the ISA/KR

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2016/021133

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☒ Claims Nos.: 10
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
Claim 10 is unclear since it is referring to the multiple dependent claim which does not comply with PCT Rule 6.4(a).

3. ☒ Claims Nos.: 5-9, 11-20
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of any additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2016/021133Patent document
cited in search reportPublication
datePatent family
member(s)Publication
date

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28/06/1994

None

WO 93-15905 A1

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None

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30/05/2012

None