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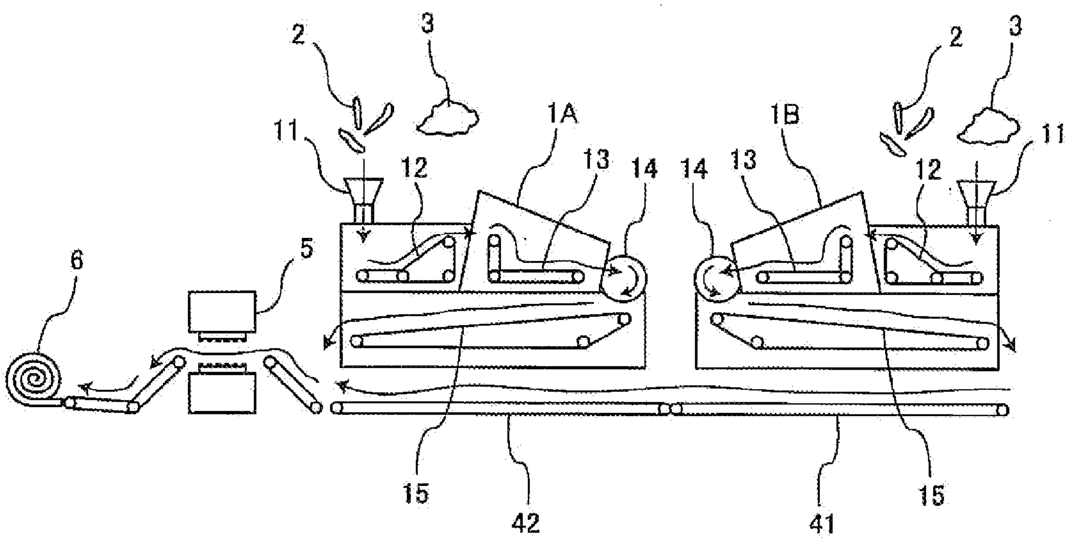
(54) **Mat material and method for manufacturing the same**

(57) A lightweight mat material having excellent sound absorption and thermal insulation properties comprises a mixture of glass fibers and sheath-core composite fibers, wherein the melting temperature of the sheath portion is lower than the melting temperature of the core portion. The glass fibers are fused with the sheath portions of the composite fibers by melting on at least one surface of the sheet-shaped mat material.

Fig.1



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Description

[0001] The present invention relates to a mat material and a method for manufacturing the same, and in certain preferred embodiments, to a lightweight mat material or the like having excellent sound absorption and/or thermal insulation properties.

[0002] Various proposals have been made to achieve a mat material having excellent sound absorption and thermal insulation properties. For example, Japanese Patent Publication No. 2008-291393 discloses a vehicle mat material obtained by uniformly mixing an inorganic fiber having high heat resistance, a crimpable inorganic fiber or a flame-retardant organic fiber, and an organic fiber having a low melting point, and subjecting the cotton-like material to heat treatment.

[0003] However, known mat materials have thus far been unable to achieve sufficient sound absorption and thermal insulation properties for certain applications and uses.

[0004] Therefore, it is an object of the present invention to provide an improved mat material, such as but not limited to a lightweight mat material having excellent sound absorption and thermal insulation properties, as well as a method for manufacturing the same.

[0005] A mat material according to one aspect of the present teachings comprises a mixture of an inorganic fiber and a sheath-core composite fiber. The melting temperature of a thermoplastic resin forming or comprising the sheath portion of the composite fiber is lower than the melting temperature of a thermoplastic resin forming or comprising the core portion of the composite fiber. The mixed fibers are formed into a sheet-like base material and then heated. The inorganic fiber thereby fuses with the melted sheath portion at least on a surface of the sheet-like base material.

[0006] In one aspect of the present teaching, a glass fiber may be used as the inorganic fiber. In addition or in the alternative, a fine count fiber having an outer diameter of 3 to 9 μm is preferably used. The outer diameter of the inorganic (preferably glass) fiber is more preferably between about 4 to 6 μm, most preferably about 5 μm. If the fine count fiber is used, the number of fibers increases, so that a porous material is obtained. Accordingly, sound energy is readily converted into thermal energy in such a porous material, thereby improving the sound absorption properties of the mat material.

[0007] In addition or in the alternative, with respect to the sheath-core composite fiber, both of the sheath portion and the core portion thereof may be comprised at least substantially of polyethylene terephthalate. In the alternative, the sheath portion may be comprised at least substantially of polyethylene terephthalate and the core portion may be comprised at least substantially of polypropylene. Other composite fibers having similar constituents may also be used with the present teachings. In addition or in the alternative, the composite fiber preferably has a linear mass density in the range of 1 to 4 decitex (g/10000 m), more preferably between 2.5-3.5 decitex and most preferably about 2 decitex.

[0008] In addition or in the alternative, the inorganic fiber and the sheath-core composite fiber are preferably mixed at a mass ratio of 20 to 80(%):80 to 20(%), and most preferably 50(%):50(%) when the total mass is assumed to be 100%.

[0009] In another aspect of the present teachings, a representative method for manufacturing the mat material includes mixing an inorganic fiber and a sheath-core composite fiber according to the above-noted teachings. The mixed fibers may be then fed into a forming machine in order to form or shape the mixed fibers into a sheet-like shape. Then, a nonwoven sheet material is formed by entangling or intertwining the sheet-like mixed fibers using a needle punch and the nonwoven sheet material is heated to melt the sheath portion of the composite fibers, thereby obtaining a mat material having a structure in which the inorganic fibers are fused with the melted sheath portions of the composite fibers, at least on one outer surface of the mat material. The method may be supplemented with any of the additional disclosures mentioned above or below without restriction on whether the disclosures are combined together in a single paragraph or claim or are mentioned separately.

[0010] Mat materials according to the present teachings may have one or more of: improved flame retardant properties, decreased specific heat capacity and/or improved heat retention and thermal insulation properties due to the presence of the inorganic fibers. In particular, a fine count sheath-core composite fiber is preferably used, and the inorganic fiber is mixed with the sheath-core composite fiber, which preferably have different specific gravities from each other. In this case, a mat material is formed, in which sound energy is readily converted into thermal energy, so that good sound absorption properties are exhibited. Furthermore, if a semi-fused sheath-core composite fiber is used as the sheath-core composite fiber, a porous material is obtained, because the fibers will have a variety of diameters, thereby also improving the sound absorption properties.

[0011] As described above, in at least certain aspects of the present teachings, a lightweight mat material having excellent sound absorption and thermal insulation properties can be obtained.

[0012]

FIG. 1 is a schematic view illustrating the configuration of a representative apparatus capable of manufacturing a mat material according to the present teachings;

FIG. 2 is a schematic view illustrating the configuration of a continuation of the representative apparatus of Fig. 1;

FIG. 3 is a graph comparing the sound absorption coefficient measured for an exemplary mat material according to the present teachings with the sound absorption coefficient of known mat materials; and

FIG. 4 is a graph comparing the specific heat capacity measured for an exemplary mat material according to the present teachings with the specific heat capacity of a known mat material.

[0013] FIGS. 1 and 2 illustrate an apparatus and a process for manufacturing a mat material according to the present teachings.

[0014] FIG. 1 shows a representative process for manufacturing a nonwoven sheet material. In FIG. 1, two airlay-type forming machines 1A and 1B are provided. Glass fiber (GF) 2 and a sheath-core composite fiber (referred to as "SCC fiber" below) 3 made of two types of polyethylene terephthalate (PET) (forming the respective core and sheath portions) are fed together into each of the respective forming machines 1A and 1B at a mass ratio of 50(%):50(%). "LMF" manufactured by Huvis Corporation in Korea would be preferably used as the SCC fiber and "ECD" manufactured by Nitto Boseki Co., Ltd. in Japan would be preferably used as the GF. The two fiber materials, comprised of the GF 2 and the SCC fiber 3, are received by a chute 11 and then conveyed on a first conveyor 12 in each of the forming machines 1A and 1B (the routes of the respective fiber materials through the machines A1 and 1B are indicated by arrows in FIG. 1). The resulting-mixed fiber material is then shaped or formed in a second conveyor 13 so as to have a uniform width, and is subsequently transported to a main cylinder 14. The mixed fiber material is defibrated and blown off at the main cylinder 14, thereby accumulating in a sheet-like manner on a third conveyor 15, which further transports the sheet-like material.

[0015] The sheet-like mixed fiber material discharged from the forming machine 1A is then layered onto the sheet-like mixed fiber material discharged from the forming machine 1B, which has been conveyed on conveyors 41 and 42. That is, the lower layer of fiber material comes from forming machine 1B and the upper layer of fiber material comes from forming machine 1A.

[0016] The stacked sheet-like mixed fiber materials are then transferred to a needle punch 5 at the next stage. By stacking the sheet-like mixed fiber materials in two layers, local variations in area density can be reduced. The sheet-like mixed fiber materials stacked in two layers are entangled or intertwined using the needle punch 5, so that a nonwoven sheet material 6 is obtained. The nonwoven sheet material 6 is then wound into a roll shape for storage purposes.

[0017] In an alternative manufacturing method, a cardtype forming machine may be used as the forming machine instead of the airlay-type forming machine.

[0018] The nonwoven sheet material is then formed into a mat material using the heating process shown in FIG. 2. More specifically, in FIG. 2, the nonwoven sheet material 6 is unwound from the roll, and passed through a heating oven 7 having a far-infrared heater 71. The nonwoven sheet material 6 is heated by the heater 71 during its passage through the heating oven 7, thereby producing a mat material having a structure, in which the sheath portion of the SCC fiber in the nonwoven sheet material 6 is melted, and the GF fuses with the melted sheath portion.

[0019] The mat material exiting from the heating oven 7 is then passed through a heating roller 8. The heating roller 8 smoothes the nap of the surface and adjusts the overall thickness. The mat material is then passed through a cooling roller 9 at the final stage, where the final thickness is set and the molten mat material 10 is cooled down. The mat material 10 is subsequently wound into a roll shape.

[0020] In FIG. 3, line X indicates a sound absorption property of the exemplary mat material manufactured according to the method above. The exemplary mat material had an area density of 400 g/m2. As shown in FIG. 3, the exemplary mat material exhibits an excellent sound absorption coefficient over the frequency band from 500 Hz to 6300 Hz, even though the exemplary mat material is lighter than a known thermal- and sound-absorption mat (area density: 477 g/m2) (line Y) and a known polyester mat (area density: 415 g/m2) (line Z).

[0021] With respect to the thermal insulation properties, as shown in FIG. 4, the exemplary mat material (line X) has a smaller specific heat capacity (J/g·k) within the temperature range of 20 to 120°C than the above thermalinsulation and sound-absorption mat (line Y) having an equivalent area density (400 g/m2). Thus, the exemplary mat material exhibits excellent thermal insulation properties. The specific heat capacity was measured by DSC (differential scanning calorimetry) using a differential scanning calorimeter, model no. DSC-7 manufactured by Perkin Elmer Co., Ltd.

[0022] Representative, non-limiting examples of the present invention were described above in detail with reference to the attached drawings. This detailed description is merely intended to teach a person of skill in the art further details for practicing preferred aspects of the present teachings and is not intended to limit the scope of the invention. Furthermore, each of the additional features and teachings disclosed above may be utilized separately or in conjunction with other features and teachings to provide improved mat materials and methods for manufacturing the same.

[0023] Moreover, combinations of features and steps disclosed in the above detail description may not be necessary to practice the invention in the broadest sense, and are instead taught merely to particularly describe representative examples of the invention. Furthermore, various features of the above-described representative examples, as well as the various independent and dependent claims below, may be combined in ways that are not specifically and explicitly enumerated in order to provide additional useful embodiments of the present teachings.

[0024] All features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original written disclosure, as well as for the purpose of restricting the claimed subject matter, independent of the compositions of the features in the embodiments and/or the claims. In addition, all value ranges or indications of groups of entities are intended to disclose every possible intermediate value or intermediate entity for the purpose of original written disclosure, as well as for the purpose of restricting the claimed subject matter.

It is explicitly stated that all features disclosed in the description and/or the claims are intended to be disclosed separately and independently from each other for the purpose of original disclosure as well as for the purpose of restricting the claimed invention independent of the composition of the features in the embodiments and/or the claims. It is explicitly stated that all value ranges or indications of groups of entities disclose every possible intermediate value or intermediate entity for the purpose of original disclosure as well as for the purpose of restricting the claimed invention, in particular as limits of value ranges.

Claims

1. A mat material comprising a mixture of:

an inorganic fiber and
a sheath-core composite fiber, wherein the melting temperature of a thermoplastic resin at least substantially comprising a sheath portion of the composite fiber is lower than the melting temperature of a thermoplastic resin at least substantially comprising a core portion of the composite fiber,
wherein the mat material is formed in substantially a sheet-shape and the inorganic fiber is fused with the sheath portion of the composite fiber by heating on at least one surface of mat material.

2. The mat material according to claim 1, wherein the inorganic fiber has an outer diameter of 3 to 9 μm.

3. The mat material according to claim 2, wherein the outer diameter of the inorganic fiber is between 4 to 6 μm.

4. The mat material according to any preceding claim, wherein the inorganic fiber comprises at least substantially glass fiber.

5. The mat material according to any preceding claim, wherein the sheath-core composite fiber has a linear mass density of 1 to 4 decitex, more preferably 2.5-3.5 decitex.

6. The mat material according to any preceding claim, wherein the inorganic fiber and the sheath-core composite fiber are mixed at a mass ratio of 20 to 80(%): 80 to 20(%) when the total mass of the mat material is assumed to be 100%, more preferably the mass ratio is 50:50.

7. The mat material according to any preceding claim, wherein the sheath portion of the sheath-core composite fiber at least substantially comprises polyethylene terephthalate.

8. The mat material according to any preceding claim, wherein the core portion of the sheath-core composite fiber at least substantially comprises at least one of polyethylene terephthalate and polyethylene.

9. The mat material according to any preceding claim, wherein the mat material has an area density of between 390-410 g/m2, more preferably 400 g/m2.

10. A method for manufacturing a mat material, comprising:

mixing an inorganic fiber with a sheath-core composite fiber, wherein the melting temperature of a thermoplastic resin at least substantially comprising a sheath portion thereof is lower than the melting temperature of a thermoplastic resin at least substantially comprising a core portion thereof;
forming the mixed fibers substantially into a sheet-shape and intertwining the mixed fibers using a needle punch (5), thereby forming a nonwoven sheet material (6);
heating the nonwoven sheet material so to melt the sheath portion of the sheath-core composite fiber, whereby the inorganic fiber fuses with the melted sheath portion; and
cooling the nonwoven sheet material, thereby obtaining the mat material (10).

11. The method according to claim 10, wherein the step of forming the mixed fibers substantially into a sheet-shape further comprises forming a first layer of mixed fibers and disposing a second layer of mixed fibers on the first layer.

12. The method according to claim 10 or 11, wherein the heating step is performed using a far-infrared heater (71).

13. The method according to any one of claims 10-12, wherein the inorganic fiber comprises at least substantially glass fiber having an outer diameter of 3 to 9 μm, more preferably between 4 to 6 μm.

14. The method according to any one of claims 10-13, wherein the sheath-core composite fiber has a linear mass density of 1 to 4 decitex, more preferably

2.5-3.5 decitex, the sheath portion of the sheath-core composite fiber at least substantially comprises polyethylene terephthalate and the core portion of the sheath-core composite fiber at least substantially comprises at least one of polyethylene terephthalate and polyethylene.

15. The method according to any one of claims 10-14, wherein the inorganic fiber and the sheath-core composite fiber are mixed at a mass ratio of 20 to 80(%): 80 to 20(%)when the total mass of the mat material is assumed to be 100%, more preferably the mass ratio is 50:50.

Fig.1

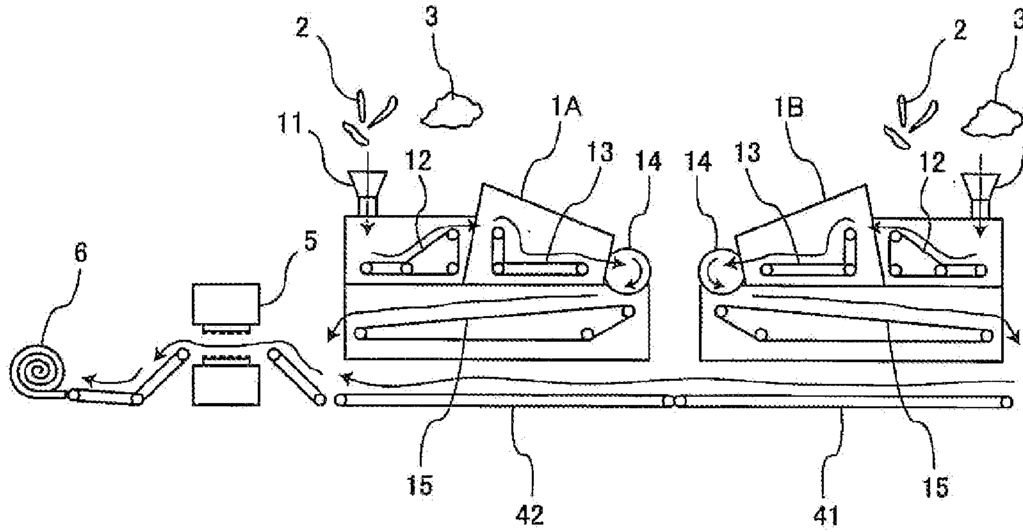


Fig.2

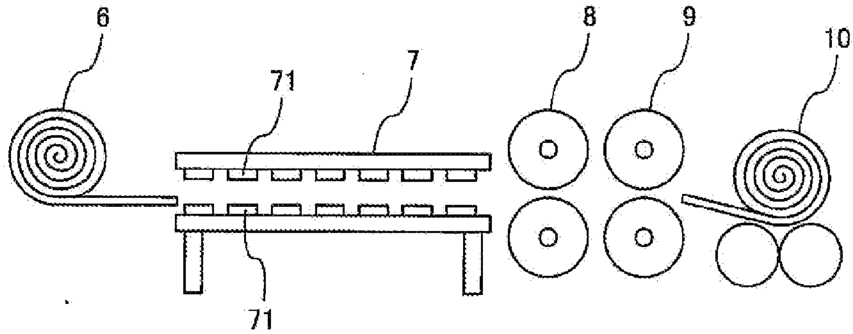
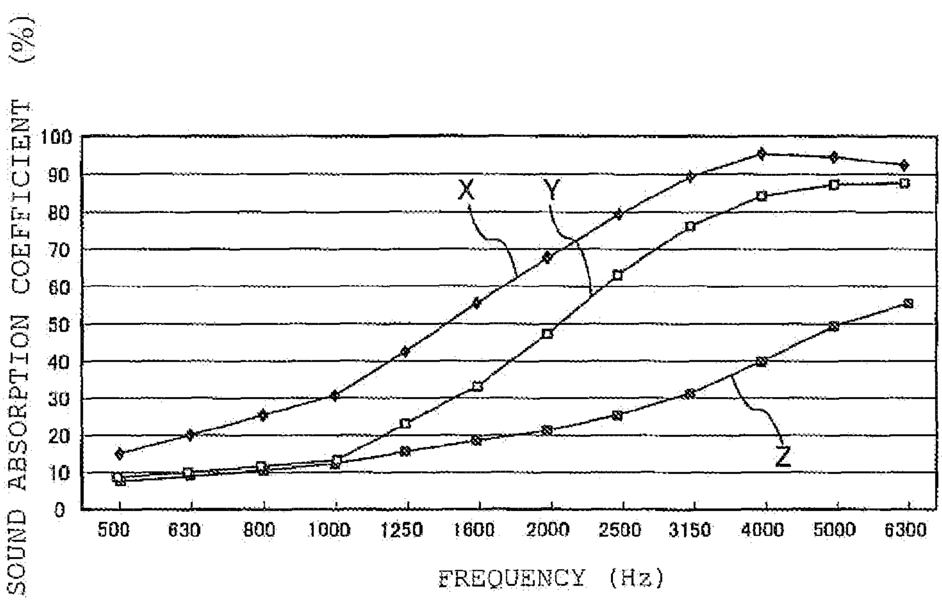


Fig.3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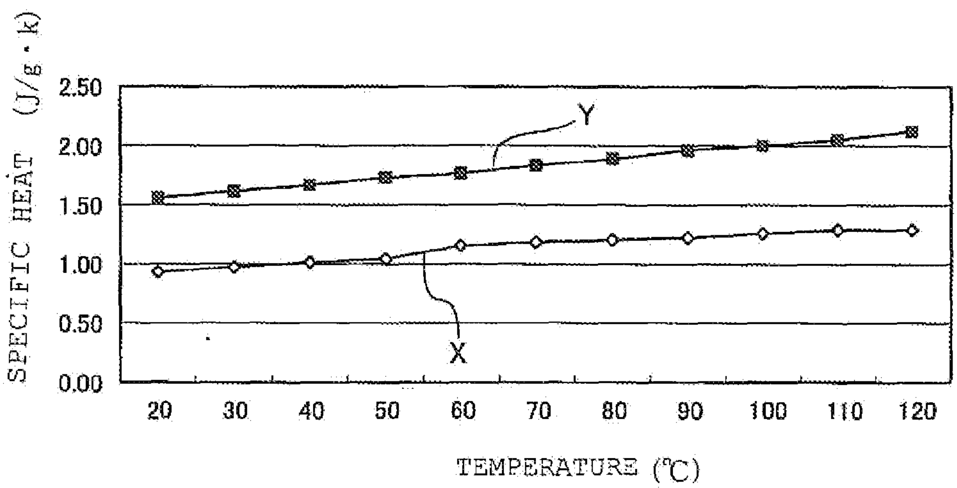
6300
FREQUENCY (Hz)

Fig.4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TEMPERATURE (℃)

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EUROPEAN SEARCH REPORT

Application Number
EP 10 17 9100

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2005/080659 A1 (SAINT GOBAIN ISOVER [FR]; TRIPP GARY [US]; YANG ALAIN [US]; TRABBOLD M) 1 September 2005 (2005-09-01) * paragraphs [0014], [0015], [0025] - [0029], [0031] * -----	1-4,7, 10,13	INV. D04H1/46 E04B1/74 E04B1/78
X	WO 01/31131 A1 (OWENS CORNING FIBERGLASS CORP [US]; ZENG QINGYU [US]; NELSON THOMAS E) 3 May 2001 (2001-05-03) * page 4 - page 10; example 1 * -----	1-4,6,7, 10,13	
X	US 4 946 738 A (CHENOWETH VAUGHN C [US] ET AL) 7 August 1990 (1990-08-07) * column 5, line 60 - column 6, line 53 * -----	1	

TECHNICAL FIELDS SEARCHED (IPC)

D04H
E04B

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	17 May 2011	Lanniel, Geneviève

CATEGORY OF CITED DOCUMENTS

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17-05-2011

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Patent documents cited in the description

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