(54) **Titre : MATERIAU INSONORISANT PRESENTANT D'EXCELLENTES PROPRIETES D'INSONORISATION ET SON PROCEDE DE FABRICATION**
(54) **Title: SOUND-ABSORBING MATERIAL WITH EXCELLENT SOUND-ABSORBING PERFORMANCE AND METHOD FOR MANUFACTURING THEREOF**
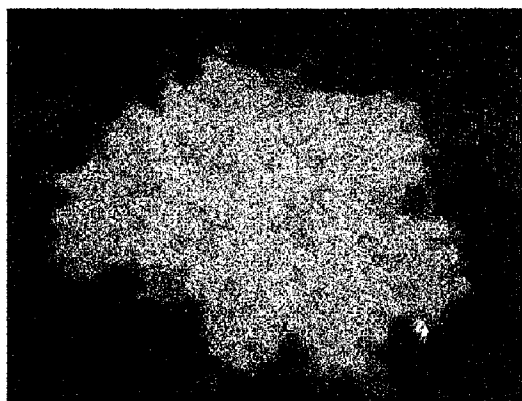
(57) **Abrégé/Abstract:**

The present invention provides a sound-absorbing material with excellent sound-absorbing performance and a method for manufacturing thereof. More particularly, it relates to a sound-absorbing material, which can improve sound absorption coefficient and transmission loss by forming large surface area and air layer, so as to induce viscosity loss of incident sound energy, may make light-weight design possible because it can express excellent sound-absorbing performance even using reduced amount of fiber, and can improve sound-absorbing performance by using binder fiber having rebound resilience, so as to maintain enough strength between fiber and also to maximize viscosity loss of sound energy transmitted to fiber structure; and a method for manufacturing thereof.

1 ABSTRACT

2   The present invention provides a sound-absorbing material with excellent

3   sound-absorbing performance and a method for manufacturing thereof.   More particularly, it

4   relates to a sound-absorbing material, which can improve sound absorption coefficient and

5   transmission loss by forming large surface area and air layer, so as to induce viscosity loss of

6   incident sound energy, may make light-weight design possible because it can express excellent

7   sound-absorbing performance even using reduced amount of fiber, and can improve

8   sound-absorbing performance by using binder fiber having rebound resilience, so as to maintain

9   enough strength between fiber and also to maximize viscosity loss of sound energy transmitted

10   to fiber structure; and a method for manufacturing thereof.

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1 **SOUND-ABSORBING MATERIAL WITH EXCELLENT SOUND-ABSORBING**
2 **PERFORMANCE AND METHOD FOR MANUFACTURING THEREOF**
3
4 **BACKGROUND**

5 **(a)   Technical Field**

6   The present invention relates to a sound-absorbing material with excellent

7 sound-absorbing performance and a method for manufacturing the same. More particularly, it

8 relates to a sound-absorbing material with excellent sound-absorbing performance, which can be

9 used for blocking inflow of external noise into vehicle interior by being attached as vehicle

10 components or interior and exterior materials of a vehicle body, and can be used in electric

11 devices and the like that use motor parts so as to improve noise insulation performance thereof.

12

13 **(b)   Background Art**

14   In general, noise introduced into a vehicle may be classified into a noise generated at an

15 engine and introduced through a vehicle body and a noise generated when tires are contacted

16 with a road surface and introduced through a vehicle body.   There may be two ways to block

17 theses noises such as improving sound-absorbing performance and improving noise insulation

18 performance. Sound-absorbing means that generated sound energy is converted into thermal

19 energy and then dissipated while it is transmitted through internal route of a material, and noise

20 insulation means that generated sound energy is reflected and blocked by a shelter.

21   According to such characteristics of sound, in order to improve Noise, Vibration &

22 Harshness (NVH) of a vehicle in general, a heavier and thicker sound-absorbing material has

23 been mainly used in luxury cars. However, when such sound-absorbing material is used, noise

24 may be reduced, but there is a problem of deteriorating fuel efficiency by increasing vehicle

25 weight.

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1   Further, in order to overcome problems of the conventional sound-absorbing material, a

2   method in which porosity of the material is improved by thinning fiber thickness have been

3   developed thereby improving sound-absorbing performance and also reducing weight of fiber

4   aggregate. However, this method may also have a weakness such that needs surface density of

5   the fiber aggregate may be improved in order to improve the desired NVH performance.

6   Further, in order to manufacture non-woven type fiber aggregate, staple fiber and binder

7   fiber are mixed together at a proper ratio. As the binder fiber, in general, staple fiber

8   manufactured by conjugate-spinning regular polyester is used for an inner layer and low melting

9   polyester is used for an outer layer.

10   However, when using this conventional binder fiber with the low melting polyester, the

11   fiber aggregate is hardened, and thus there may be a problem that vibration generated by sound

12   wave propagation and transmitted to matrix structure is not fully attenuated, thereby reducing

13   sound absorbtion coefficient mainly at low frequency region.

14

15   **SUMMARY OF THE INVENTION**

16   The present invention has been made in an effort to solve the above-described problems

17   associated with prior art.

18   The present invention is objected to provide a sound-absorbing material, which may

19   improve sound absorption coefficient and transmission loss by forming large surface area and air

20   layer, so as to maximize viscosity loss and dissipation route of incident sound energy, and

21   makes light-weight design thereof possible because it can realize excellent sound-absorbing

22   performance even using reduced amount of fiber; and a method for manufacturing thereof.

23   Further, the present invention is objected to provide a sound-absorbing material, which

24   may improve formability as well as maintain enough strength between fiber, and may have

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1   improved rebound resilience, thereby ultimately having excellent vibration attenuation capability

2   against sound energy transmitted inside matrix; and a method for manufacturing thereof.

3   To achieve the above objects, in one aspect, the present invention provides a method for

4   manufacturing a sound-absorbing material that comprises forming fiber aggregate in a

5   nonwoven fabric form, and the fiber aggregate comprises:

6   a non-circular shaped fiber satisfying the following Formula 1; and

7   a binder fiber that partly binds a plurality of the non-circular shaped fibers.

8   Formula 1

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$$1.5 \leq \frac{P}{\sqrt{4 \times \pi \times A}}$$

10   (A: Fiber cross sectional area (μm^2), P: Circumference length of fiber cross section (μm))

11   In a preferred embodiment, the sound-absorbing material may be manufactured by

12   using the non-circular shaped fiber satisfying the value of the Formula 1 of 2.6 or greater.

13   In another preferred embodiment, the sound-absorbing material may be manufactured

14   by using the non-circular shaped fiber satisfying the value of the Formula 1 of 3.0 or greater.

15   In still another preferred embodiment, the non-circular shaped fiber may be at least one

16   selected from the group consisting of six-pointed star shape, 3-bar flat type, 6 leaf type, 8 leaf

17   type and wave type.

18   In yet another preferred embodiment, the non-circular shaped fiber may be 35 to 65 mm

19   in length.

20   In still yet another preferred embodiment, the binder fiber may comprise a low melting

21   (LM) elastomer having elastic recovery modulus of 50 to 80%, and rebound resilience rate of the

22   sound-absorbing material may be 50 to 80%.

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1 In a further preferred embodiment, the binder fiber may be conjugated fiber which is

2 conjugate-spun by using the LM elastomer as one component.

3 In another further preferred embodiment, the LM elastomer may be at least one selected

4 from the group consisting of a polyester-based polymer, a polyamide-based polymer, a

5 polystyrene-based polymer, a polyvinylchloride-based polymer and a polyurethane-based

6 polymer.

7 In still another further preferred embodiment, the LM elastomer may be manufactured by

8 esterification and polymerization steps using dimethyl terephthalate(DMT) and dimethyl

9 isophthalate(DMI), or terephthalic acid(TPA) and isophthalic acid(IPA) as an acid

10 ingredient(Diacid), and 1,4-butanediol(1,4-BD) and polytetramethyleneglycol(PTMG) as a diol

11 ingredient (Diol).

12 In yet another further preferred embodiment, the sound-absorbing material may be

13 manufactured by using the non-circular shaped fiber of 50 to 80 wt% based on the total weight of

14 the sound-absorbing material and the binder fiber of 20 to 50 wt% based on the total weight of

15 the sound-absorbing material.

16 Further, in another aspect, the present invention provides a sound-absorbing material,

17 which may comprise: a non-circular shaped fiber satisfying the following Formula 1; and a binder

18 fiber which partly binds a plurality of the non-circular shaped fibers.

19 Formula 1

$$1.5 \leq \frac{P}{\sqrt{4 \times \pi \times A}}$$

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21 (A: Fiber cross sectional area (μm^2), P: Circumference length of fiber cross section (μm))

1   In a preferred embodiment, the non-circular shaped fiber may satisfy the value of the

2   Formula 1 of 2.6 or greater.

3   In another preferred embodiment, the non-circular shaped fiber may be at least one

4   selected from the group consisting of six-pointed star shape, 3-bar flat type, 6-leaf type, 8-leaf

5   type and wave type.

6   In still another preferred embodiment, the non-circular shaped fiber may be 35 to 65 mm

7   in length.

8   In yet another preferred embodiment, the non-circular shaped fiber may be 1.0 to 7.0 De

9   in fineness.

10   In still yet another preferred embodiment, the binder fiber may comprise a LM elastomer

11   having elastic recovery modulus of 50 to 80%, and rebound resilience rate of the

12   sound-absorbing material may be 50 to 80%.

13   In a further preferred embodiment, the binder fiber may be conjugated fiber which is

14   conjugate-spun by using the LM elastomer as one component.

15   In another further preferred embodiment, the LM elastomer may be at least one selected

16   from the group consisting of a polyester-based polymer, a polyamide-based, polystyrene-based

17   polymer, a polyvinylchloride-based polymer and a polyurethane-based polymer.

18   In still another further preferred embodiment, the sound-absorbing material may

19   comprise the non-circular shaped fiber of 50 to 80 wt% based on the total weight of the

20   sound-absorbing material and the binder fiber of 20 to 50 wt% based on the total weight of the

21   sound-absorbing material.

22   In yet another further preferred embodiment, the non-circular shaped fiber may satisfy

23   the value of the Formula 1 of 3.0 or greater.

24   Hereinafter, terms used in the present invention will be described.

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1   The term "wave type non-circular shaped fiber", as used in the present invention, refers

2   to fiber that may have cross section shape in wave form, and specifically, its shape is illustrated

3   in FIG. 5.

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5   The sound-absorbing material with excellent sound-absorbing performance of the

6   present invention can improves sound absorption coefficient and transmission loss by forming

7   large surface area and air layer, so as to induce viscosity loss of incident sound energy.   Further,

8   it makes light-weight design thereof possible since it can provide excellent sound-absorbing

9   performance using reduced amount of fiber, and can improve sound-absorbing performance by

10   using binder fiber having rebound resilience, so as to maintain enough bonding strength between

11   fibers and also to maximize viscosity loss of sound energy transmitted to fiber structure.

12   Accordingly, a sound-absorbing material having excellent sound-absorbing performance,

13   which can be used for improving noise insulation performance of electric devices and the like

14   using motor parts as well as used through transport such as vehicle, train, ship, aircraft and the

15   like, and a method for manufacturing thereof can be provided.

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17   **BRIEF DESCRIPTION OF THE DRAWINGS**

18   FIG. 1 is a six-pointed star shaped non-circular shaped fiber, which is contained in the

19   sound-absorbing material according to a preferred embodiment of the present invention;

20   FIG. 2 is a 3-bar flat type non-circular shaped fiber, which is contained in the

21   sound-absorbing material according to a preferred embodiment of the present invention;

22   FIG. 3 is a 6-leaf type non-circular shaped fiber, which is contained in the

23   sound-absorbing material according to a preferred embodiment of the present invention;

1   FIG. 4 is a 8-leaf type non-circular shaped fiber, which is contained in the

2   sound-absorbing material according to a preferred embodiment of the present invention;

3   FIG. 5 is a wave type non-circular shaped fiber, which is contained in the

4   sound-absorbing material according to a preferred embodiment of the present invention;

5   FIG. 6 is a 8-leaf type non-circular shaped fiber, which is contained in the

6   sound-absorbing material according to a preferred embodiment of the present invention;

7   FIG. 7 is a 8-leaf type non-circular shaped fiber, which is contained in the

8   sound-absorbing material according to a preferred embodiment of the present invention; and

9   FIG. 8 is a drawing showing L and W of the 8-leaf type non-circular shaped fiber

10   according to a preferred embodiment of the present invention as an example.

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12   **DETAILED DESCRIPTION**

13   Hereinafter reference will now be made in detail to various embodiments of the present

14   invention, examples of which are illustrated in the accompanying drawings and described below.

15   While the invention will be described in conjunction with exemplary embodiments, it will be

16   understood that present description is not intended to limit the invention to those exemplary

17   embodiments. On the contrary, the invention is intended to cover not only the exemplary

18   embodiments, but also various alternatives, modifications, equivalents and other embodiments,

19   which may be included within the spirit and scope of the invention as defined by the appended

20   claims.

21   As described above, since in the conventional sound-absorbing material for a fiber

22   structure, surface density and thickness of fiber aggregate are increased in order to improve

23   sound-absorbing performance and noise insulation performance by increasing porosity and

24   sound wave dissipation route, the vehicle becomes heavier thereby deteriorating fuel efficiency.

1   Further, when low melting polyester binder fiber is used for the conventional sound-absorbing

2   material for a fiber structure, the fiber aggregate may be hardened.   Thus, there was a problem

3   that sound absorption coefficient of low frequency is reduced since vibration generated by sound

4   wave propagation and transmitted to matrix structure is not fully attenuated.

5   Accordingly, the present invention provides a sound-absorbing material which comprises:

6   a non-circular shaped fiber satisfying the following Formula 1; and a binder fiber which partly

7   binds a plurality of the non-circular shaped fibers, to find solutions for the above described

8   problems.

9   Formula 1

$$1.5 \leq \frac{P}{\sqrt{4 \times \pi \times A}}$$

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11   (A: Fiber cross sectional area (μm^2), P: Circumference length of fiber cross section (μm))

12   As such, sound absorption coefficient and transmission loss may be improved by

13   forming large surface area and air layer, so as to induce viscosity loss of incident sound energy.

14   Further, -weight design thereof may be obtained because excellent sound-absorbing

15   performance may be obtained using reduced amount of fiber, and sound-absorbing performance

16   may be improved by using binder fiber having rebound resilience, so as to maintain enough

17   binding strength between fiber and also to maximize viscosity loss of sound energy transmitted

18   to a fiber structure.   Thus, a sound-absorbing material having excellent sound-absorbing

19   performance, which can be used for improving noise insulation performance of electric devices

20   and the like using motor parts as well as used through transport such as vehicle, train, ship,

21   aircraft and the like, and a method for manufacturing thereof may be provided.

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1   In general, when sound wave conflicts with a certain material, it may cause viscosity loss,

2   thereby causing noise reduction while mechanical energy of the sound wave is converted to

3   thermal energy.   In order to reduce noise by increasing energy loss rate against sound wave

4   introduced to the fiber aggregate with the same weight, it is advantageous to increase surface

5   area of fiber where viscosity loss of sound wave occurs.

6   The non-circular shaped fiber satisfy the η value of 1.5 or greater, calculated as

$$\eta = \frac{P}{\sqrt{4 \times \pi \times A}}$$

7

8   (A: Fiber cross sectional area(μm^2), P: Circumference length of fiber cross section(μm)),

9   and it may secure greater surface area than the fiber used to the conventional sound-absorbing

10   material for a fiber structure, and improve sound absorption coefficient and transmission loss.

11   When the η value is less than 1.5, the fiber surface area may be small. Thus, there is a problem

12   that light-weight design thereof may be impossible because a large amount of fiber needs to

13   effectively embody sound-absorbing performance.   The higher η value means the greater fiber

14   surface area.   Accordingly, more preferably, the non-circular shaped fiber used in the present

15   invention may have the η value of 2.6 or greater, and more preferably the value may be 3.0 to 7.0.

16   If the η value of the non-circular shaped fiber used in the present invention is greater than 7.0,

17   there may be a problem that production cost may be increased due to increase of nozzle

18   production cost, facilities replacement related to cooling efficiency improvement, polymer

19   modification for solidification rate improvement, productivity reduction and the like.

20   The non-circular shaped fiber of the present invention, which satisfies the η value of 1.5

21   or greater, may be a six-pointed star shape, 3-bar flat type, 6-leaf type, 8-leaf type or wave type,

22   or a combination thereof.   In the case of the wave type, when the η value satisfies 1.5 or greater,

23   specific shape such as the number of the curved point in the wave shape, length and width of the

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1 cross section and the like may vary. The number of the curved point in the wave shape means

2 the point where the direction is changed to the length direction of the cross section, and for

3 example, the number of the curved point of the wave type non-circular shaped fiber in FIG. 5 is 4.

4 Specifically, FIG. 1 is six-pointed star shape non-circular shaped fiber according to a

5 preferred embodiment of the present invention, and its η value is 1.51, and FIG. 2 is 3-bar flat

6 type non-circular shaped fiber according to a preferred embodiment of the present invention, and

7 its η value is 1.60. Further, FIG. 3 is 6-leaf type non-circular shaped fiber according to a

8 preferred embodiment of the present invention, and its η value is 1.93, FIG. 4 is 8-leaf type

9 non-circular shaped fiber according to a preferred embodiment of the present invention, and its η

10 value is 2.50, FIG. 5 is wave type non-circular shaped fiber according to a preferred embodiment

11 of the present invention, and its η value is 2.55, FIG. 6 is 8-leaf type non-circular shaped fiber

12 according to a preferred embodiment of the present invention, and its η value is 2.8, and FIG. 7 is

13 8-leaf type non-circular shaped fiber according to a preferred embodiment of the present

14 invention, and its η value is 3.2.

15 The η value of a general circular type fiber with circular cross section is 1.0, and its

16 sound absorption coefficient and transmission loss are significantly reduced because its surface

17 area is not large enough (see Comparative Example 1), and although the non-circular shaped

18 fiber are a six-pointed star shape, 3-bar flat type, 6-leaf type, 8-leaf type or wave type, if the η

19 value does not satisfy 1.5 or greater, the surface area which can generate viscosity loss of the

20 sound energy is not enough. Accordingly, those are not suitable as the non-circular shaped

21 fiber used for the sound-absorbing material of the present invention (see Comparative Examples

22 2 to 5).

23 More preferably, the non-circular shaped fiber used in the present invention may have

24 the L/W value of 2 to 3. L is the abbreviation for Length which is vertical length of fiber, and W is

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1   the abbreviation for Width which is length against horizontal direction connecting between

2   angular points. Specifically, FIG. 8 shows L and W values of the 8-leaf type non-circular shaped

3   fiber.   In the case of the cross section of the 8-leaf type non-circular shaped fiber, when the

4   longer direction is called vertical length, the length may be expressed as L, and in the 3 shorter

5   shape, the distance between angular points may be expressed as W.

6   Further, the non-circular shaped fiber used in the present invention may have 6 to 8

7   angular points more preferably, but it is not limited to the L/W or the number of the angular point.

8   The non-circular shaped fiber which satisfies the η value of 1.5 or greater may be preferred.

9   Length of the non-circular shaped fiber may be 35 to 65 mm.   When it is less than 35

10   mm, it may be difficult to form and produce fiber aggregate due to wide gap between the fibers,

11   and sound-absorbing and noise insulation performance may be reduced due to excess porosity.

12   When it is over 65 mm, porosity may be reduced due to too narrow gap between the fibers,

13   thereby reducing sound absorption coefficient.   Further, fineness of the non-circular shaped

14   fiber may be 1.0 to 7.0 De, and it may be more effective to sound-absorbing performance as

15   fineness becomes lower.   When the fineness of the non-circular shaped fiber is less than 1.0 De,

16   there may be a problem to control the optimum shape of the targeted cross section, and when it

17   is greater than 7.0 De (denier), there may be a difficulty on non-woven fiber manufacturing

18   process and a problem of reduction of sound-absorbing performance when it is manufactured as

19   the fiber aggregate.

20   The material of the non-circular shaped fiber included in the sound-absorbing material of

21   the present invention may be preferably polyethylene terephthalate (PET), but not particularly

22   limited thereto.   Polypropylene (PP), rayon, and any polymer that may be spun in fiber form may

23   be used preferably as a sound-absorbing material.

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1   Further, the sound-absorbing material of the present invention contains binder fiber

2   which partly binds a plurality of the non-circular shaped fibers.

3   The binder fiber may be any binder fiber which is generally used when manufacturing

4   fiber structure, and it may be used in the form of powder as well as fiber, and more particularly, it

5   may contain low melting (LM) elastomer.   The elastomer generally refers to a polymer material

6   having excellent elasticity such as rubbers, and i.e., it means a polymer having a characteristic

7   that stretches when it is pulled by external force, and it is back to the original length when the

8   external force is removed.   The preferable LM elastomer used in the present invention may

9   have elastic recovery modulus of 50 to 80%.   When elastic recovery modulus is less than 50%,

10   the fiber aggregate is hardened, and sound-absorbing performance may be reduced due to short

11   flexibility.   When it is greater than 80%, there may be problems that processability may be

12   reduced when manufacturing the fiber aggregate, as well as production cost of the polymer itself

13   may be increased.

14   In the past, after the binder fiber was melted down and bound major fiber together, the

15   fiber aggregate was hardened such that there was a problem that sound absorption coefficient

16   was reduced because vibration generated by sound wave propagation and transmitted to matrix

17   structure was not fully attenuated.   However, in the present invention, rebound resilience rate

18   (ASTM D 3574) of fiber structure is increased up to 50 to 80% by containing a LM elastomer

19   having elastic recovery modulus of 50 to 80% in the binder fiber of the fiber aggregate, and

20   attenuation capability for the vibration which is ultimately transmitted inside the matrix is

21   improved, and thus sound absorption coefficient and transmission loss may be improved.

22   The LM elastomer may be a polyester-based polymer, a polyamide-based polymer, a

23   polystyrene-based polymer, a polyvinylchloride-based polymer or polyurethane-based polymer,

24   or combinations thereof.

1   Further, more preferably, the LM elastomer may be manufactured by esterification and

2   polymerization steps using dimethyl terephthalate(DMT) and dimethyl isophthalate(DMI), or

3   terephthalic acid(TPA) and isophthalic acid(IPA) as an acid ingredient(Diacid); and

4   1,4-butanediol(1,4-BD) and polytetramethyleneglycol(PTMG) as a diol ingredient (Diol).

5   The acid ingredient (Diacid) uses dimethyl terephthalate (DMT) and dimethyl

6   isophthalate (DMI), or terephthalic acid (TPA) and isophthalic acid (IPA).   The dimethyl

7   terephthalate (DMT) and terephthalic acid (TPA) form a crystal region by reacting with the diol

8   ingredient, and the dimethyl isophthalate (DMI) and isophthalic acid (IPA) form a non-crystal

9   region by reacting with the diol ingredient, thereby providing low melting function and elasticity.

10   Mixing ratio of dimethyl terephthalate (DMT) and dimethyl isophthalate (DMI) may be a

11   molar ratio of 0.65~0.80: 0.2~0.35, preferably, and mixing ratio of terephthalic acid (TPA) and

12   isophthalic acid (IPA) also may be molar ratio of 0.65~0.80: 0.2~0.35, preferably.   When the

13   molar ratio of dimethyl isophthalate (DMI) and isophthalic acid (IPA) is less than the above

14   described range, elastic recovery modulus may be deteriorated, and the low melting function

15   may not be expressed.   When the molar ratio of dimethyl isophthalate (DMI) and isophthalic

16   acid (IPA) is greater than the above described range, physical properties may be deteriorated.

17   The diol ingredient (Diol) uses 1,4-butanediol (1,4-BD), polytetramethyleneglycol(PTMG),

18   and 1,4-butanediol forms a crystal region by reacting with acid ingredient and

19   polytetramethyleneglycol(PTMG) forms a non-crystal region by reacting with acid ingredient,

20   thereby providing low-melting function and elasticity.

21   Mixing ratio of the 1,4-butanediol (1,4-BD), polytetramethyleneglycol (PTMG may be a

22   molar ratio of 0.85~0.95: 0.05~0.15, preferably.   When the molar ratio of

23   polytetramethyleneglycol (PTMG) is less than the above described range, elastic recovery

24   modulus may be deteriorated, and the low-melting function may not be expressed.   When the

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1 molar ratio of polytetramethyleneglycol (PTMG) is greater than the above described range,

2 physical properties may be deteriorated. 1,4-butanediol (1,4-BD) may be used as a mixture

3 with ethyleneglycol (EG) within the above described range.

4 Further, molecular weight of the polytetramethyleneglycol (PTMG) may be in a range of

5 1500 to 2000, preferably. When the molecular weight of the polytetramethyleneglycol (PTMG)

6 is out of the said range, elasticity and physical properties of the LM elastomer to be

7 manufactured may not be suitable for use.

8 The acid ingredient and the diol ingredient may be mixed at molar ratio of 0.9~1.1:

9 0.9~1.1 and polymerized, preferably. When any one ingredient of the acid ingredient and the

10 diol ingredient is excessively mixed, it is not used to be polymerized and is discarded.

11 Accordingly, it is preferred to mix the acid ingredient and the diol ingredient at similar amounts.

12 As described above, the LM elastomer manufactured from dimethyl terephthalate(DMT),

13 dimethyl isophthalate(DMI) as the acid ingredient(Diacid) and 1,4-butanediol(1,4-BD),

14 polytetramethyleneglycol(PTMG) as the diol ingredient(Diol) is manufactured to have melting

15 point of 150~180°C and elastic recovery modulus of 50~80%.

16 Further, the binder fiber of the sound-absorbing material of the present invention may be

17 a conjugated fiber which is conjugate-spun by using the LM elastomer as one component.

18 More preferably, it may be sheath-core type or side by side type conjugated fiber. When the

19 sheath-core type conjugated fiber is formed, the LM elastomer may be used as a sheath

20 ingredient, and general polyester may be used as a core ingredient. The general polyester

21 reduces production cost and functions as fiber supporter, and the LM elastomer allows to

22 express elasticity and low melting function.

23 Preferably, the binder fiber may be manufactured by using the LM elastomer and the

24 general polyester at weight ratio of 40:60 ~ 60:40. When the LM elastomer is contained at

1   weight ratio of less than 40, elasticity and low melting function may be deteriorated, and when it

2   is contained at weight ratio of over 60, there is a problem of increase of production cost.

3   The sound-absorbing material may contain the non-circular shaped fiber of 50 to 80 wt%

4   based on the total weight of the sound-absorbing material and the binder fiber of 20 to 50 wt%

5   based on the total weight of the sound-absorbing material.   When the content of the non-circular

6   shaped fiber is less than 50 wt%, it may be difficult to embody the optimal sound-absorbing and

7   noise insulation performances due to reduced fiber surface area, but when the content of the

8   non-circular shaped fiber is greater than 80 wt%, the content of the binder fiber becomes less

9   than 20 wt%, relatively, and it may be difficult to maintain enough binding strength between the

10 fiber.   Thus, it may be difficult to form the sound-absorbing material to a certain shape and the

11 vibration, which is generated from sound wave propagation and transmitted to the matrix

12 structure, is not fully attenuated because the matrix structure is not strong, such that low

13 frequency sound absorption coefficient may be reduced.   As the content of the binder fiber is

14 increased to 20 to 50 wt%, rebound elasticity modulus (ASTM D 3574) increases up to 50 to

15 80%.

16 This fiber structure with polymorphic cross section having excellent sound-absorbing

17 performance is manufactured by a method for manufacturing a sound-absorbing material that

18 comprises forming fiber aggregate in the nonwoven fabric fabric form.   The fiber aggregate

19 comprises: a non-circular shaped fiber satisfying the following Formula 1; and binder fiber which

20 partly binds a plurality of the non-circular shaped fibers.

21 Formula 1

$$1.5 \leq \frac{P}{\sqrt{4 \times \pi \times A}}$$

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23 (A: Fiber cross sectional area (μm^2), P: Circumference length of fiber cross section (μm))

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1   The sound-absorbing material may be manufactured by forming the fiber aggregate

2   containing the non-circular shaped fiber and the binder fiber in the non-woven form having a

3   certain surface density by general manufacturing processes for a fiber structure sound-absorbing

4   material such as needle punching process or thermal adhesion process and the like.

5   Hereinafter, detailed description about the above-described non-circular shaped fiber and the

6   binder fiber, which are identically applied to the method for manufacturing the sound-absorbing

7   material of the present invention will be omitted.

8

9   **EXAMPLES**

10   The following examples illustrate the invention and are not intended to limit the same.

11

12   **Example 1**

13   Polyester-based 8-leaf type (FIG. 4, η = 2.5) non-circular shaped fiber (6.5 De, 61 mm,

14   strength 5.8 g/D, elongation rate 40%, crimp number 14.2/inch) and sheath-core type conjugated

15   fiber containing polyester-based LM elastomer as binder fiber were mixed at weight ratio of 8:2,

16   the mixture was physically broken down through needle punching process after controlling

17   weight constantly, and then non-woven type fiber aggregate having thickness of 20 mm and

18   surface density of 1600 g/m^2 was manufactured through a general thermal adhesion process.

19   Rebound resilience of the manufactured sound-absorbing material was 55%.

20   The sheath-core type conjugated fiber containing polyester-based LM elastomer as

21   binder fiber contained polyester-based LM elastomer as a sheath ingredient, and the

22   polyester-based LM elastomer used a mixture of terephthalic acid of 75 mole% and isophthalic

23   acid of 25 mole% as an acid ingredient and a mixture of polytetramethyleneglycol of 8.0 mole%

24   and 1,4-butanediol of 92.0 mole% as a diol ingredient, and manufactured by mixing and

1   polymerizing the acid ingredient and the diol ingredient at molar ratio of 1: 1. The LM elastomer

2   manufactured as mentioned above has melting point of 50 °C, intrinsic viscosity of 1.4 and

3   elastic recovery modulus of 80%. As the core ingredient, polyethylene terephthalate(PET)

4   having melting point of 260 °C and intrinsic viscosity of 0.65 was used, and conjugated fiber

5   having fineness of 6 D, strength of 3.0 g/D, elongation rate of 80%, crimp number of 12/inch and

6   fiber length of 64 mm was manufactured by spinning using a conjugate spinning nozzle, which

7   can conjugate spin the polyester-based LM elastomer and the general PET at spinning

8   temperature of 275 °C and winding speed of 1,000 mm/min, elongated by 3.3 folds at 77 °C, and

9   finally heated at 140 °C.

10   **Example 2**

11   The procedure of Example 1 was repeated except for manufacturing non-woven type

12   fiber structure having thickness of 20 mm, surface density of 1200 g/m^2.

13   **Example 3**

14   The procedure of Example 1 was repeated except for manufacturing a sound-absorbing

15   material using six-pointed star shaped (FIG. 1, η = 1.51) non-circular shaped fiber.

16   **Example 4**

17   The procedure of Example 1 was repeated except for manufacturing a sound-absorbing

18   material using 3-bar flat type (FIG. 2, η = 1.60) non-circular shaped fiber.

19   **Example 5**

20   The procedure of Example 1 was repeated except for manufacturing a sound-absorbing

21   material using 6-leaf type (FIG. 3, η = 1.93) non-circular shaped fiber.

22   **Example 6**

23   The procedure of Example 1 was repeated except for manufacturing a sound-absorbing

24   material using wave type (FIG. 5, η = 2.55) non-circular shaped fiber.

17

1   **Example 7**

2   The procedure of Example 1 was repeated except for manufacturing a sound-absorbing

3   material using 8-leaf type (FIG. 6, η = 2.8) non-circular shaped fiber non-circular shaped fiber.

4   **Example 8**

5   The procedure of Example 1 was repeated except for manufacturing a sound-absorbing

6   material using 8-leaf type (FIG. 7, η = 3.2) non-circular shaped fiber non-circular shaped fiber.

7   **Example 9**

8   The procedure of Example 1 was repeated except for manufacturing a sound-absorbing

9   material using low melting PET fiber as binder fiber.   Rebound resilience of the manufactured

10 sound-absorbing material was 30%.

11   **Comparative Example 1**

12   The procedure of Example 1 was repeated except for manufacturing a sound-absorbing

13   material using circular (η = 1.0) shaped fiber.

14   **Comparative Example 2**

15   The procedure of Example 1 was repeated except for manufacturing a sound-absorbing

16   material using five-pointed star shape (η = 1.30) non-circular shaped fiber.

17   **Comparative Example 3**

18   The procedure of Example 1 was repeated except for manufacturing a sound-absorbing

19   material using wave type (η = 1.42) non-circular shaped fiber.

20   **Comparative Example 4**

21   The procedure of Example 1 was repeated except for manufacturing a sound-absorbing

22   material using Y type (η = 1.26) non-circular shaped fiber.

23   **Comparative Example 5**

1   The procedure of Example 1 was repeated except for manufacturing a sound-absorbing

2   material using six-pointed star shape (η = 1.41) non-circular shaped fiber.

3   **<Test Example>**

4   In order to evaluate sound-absorbing and noise insulation performances of the

5   sound-absorbing materials manufactured according to Examples 1 to 9 and Comparative

6   Examples 1 to 5, the materials were tested as the following measuring methods, and the results

7   were shown in Tables 1 and 2.

8   **1. Sound absorption coefficient**

9   In order to measure sound absorption coefficient, 3 specimens applicable to ISO R 354,

10   Alpha Cabin method were manufactured, respectively, sound-absorbing coefficients were

11   measured and the mean of the measured sound-absorbing coefficients were shown in Table 1.

12   **2. Transmission loss**

13   In order to measure noise insulation effect, 3 specimens applicable to a transmission

14   loss coefficient evaluating device (APAMAT-II) were manufactured, respectively, insertion loss

15   was measured, and the mean value of the measured insertion loss was shown in Table 2.

16   **3. Elastic recovery modulus**

17   A dumbbell shape specimen having thickness of 2 mm and length of 10 cm was

18   elongated 200% at a rate of 200%/min using Instron, waited for 5 sec, and the elongated length

19   after recovered at the same rate was measured, and then elastic recovery modulus was

20   calculated by the following Formula.

$$\text{Elasticity Recovery Rate}(\%) = \frac{20-(L-10)}{20} \times 100 \quad (L: \text{Elongated Length})$$

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1   **4. Rebound resilience rate (Ball Rebound)**

2   After dropping a metal ball from a certain height to a test specimen, the height of the

3   rebound ball was measured (JIS K-6301, unit: %).   Test specimen was made into a square

4   having a side length of 50 mm or greater and thickness of 50 mm or greater, and a steel ball

5   having weight of 16 g and diameter of 16 mm was dropped from a height of 500 mm to the test

6   specimen, and then the maximum rebound height was measured.   Then, for each 3 test

7   specimens, the rebound value was measured at least 3 times in a raw within 1 min, and the

8   median value was used as rebound resilience rate (%).

9

10

1   Table 1

	Sound absorption coefficient per frequency(Hz)			
	1000Hz	2000Hz	3150Hz	5000Hz
Example 1	0.67	0.75	0.84	0.96
Example 2	0.54	0.63	0.77	0.85
Example 3	0.62	0.67	0.78	0.88
Example 4	0.59	0.71	0.81	0.90
Example 5	0.62	0.69	0.80	0.90
Example 6	0.66	0.77	0.85	0.97
Example 7	0.67	0.78	0.89	0.99
Example 8	0.68	0.79	0.91	1.00
Example 9	0.50	0.70	0.79	0.89
Comparative Example 1	0.51	0.61	0.74	0.83
Comparative Example 2	0.57	0.65	0.75	0.86
Comparative Example 3	0.57	0.62	0.76	0.86
Comparative Example 4	0.56	0.64	0.75	0.85
Comparative Example 5	0.61	0.65	0.75	0.86

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1 Table 2

	Transmission loss(dB) per frequency(Hz)			
	1000Hz	2000Hz	3150Hz	5000Hz
Example 1	25	27	35	43
Example 2	23	24	32	41
Example 3	22	25	32	40
Example 4	24	25	33	41
Example 5	24	26	33	41
Example 6	25	27	35	44
Example 7	26	28	36	45
Example 8	27	30	38	47
Example 9	21	24	31	40
Comparative Example 1	22	23	31	40
Comparative Example 2	21	24	31	40
Comparative Example 3	22	24	32	41
Comparative Example 4	21	24	31	40
Comparative Example 5	22	24	32	40

2   As shown in Tables 1 and 2, as comparing the results of measuring sound-absorbing

3 and noise insulation performances in Examples 1 to 9 and Comparative Examples 1 to 5, it was

22

1   found that sound-absorbing and noise insulation performances of the fiber aggregate were

2   improved as the fiber surface areas were increased.

3   Specifically, as comparing the result of measuring performances of Example 2 and

4   Comparative Example 1, it was found that the sound-absorbing material using the non-circular

5   shaped fiber of the present invention had better sound-absorbing and noise insulation

6   performances than the fiber sound-absorbing material using fiber with circular cross section

7   generally used, despite the reduced surface density of the fiber aggregate, and therefore,

8   light-weight design thereof is possible by using reduced amount of fiber.

9   It is found that Examples 1 to 9 satisfying the η value of 1.5 or greater had improved

10   sound absorption coefficient and transmission loss than Comparative Examples 1 to 5 having the

11   η value of less than 1.5.   It was found that Comparative Example 5 having the value of less than

12   1.5 also had low effect on sound absorption coefficient and transmission loss due to small

13   surface area, although six-pointed star shape non-circular shaped fiber was used.

14   Further, as comparing the results of measuring performances of Example 9 using the

15   low melting PET fiber as binder fiber and Examples 1 to 8 using the low melting elastomer, it was

16   found that flexible structure having rebound elasticity rate of 55% was obtained by using low

17   melting elastomer as binder fiber, and sound-absorbing performance was improved by improved

18   attenuation capability of the vibration transmitted to the matrix structure.

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WHAT IS CLAIMED IS:

1. A method for manufacturing a sound-absorbing material, comprising

forming a fiber aggregate in a nonwoven fabric form,

wherein the fiber aggregate comprises:

a non-circular shaped fiber satisfying the following Formula 1; and

a binder fiber that partly binds a plurality of the non-circular shaped fibers,

wherein the non-circular shaped fiber is about 50 to 80 wt % based on the total weight of

the sound-absorbing material and the binder fiber is about 20 to 50 wt % based on the total

weight of the sound-absorbing material,

Formula 1

$$1.5 \leq \frac{P}{\sqrt{4 \times \pi \times A}}$$

wherein A is a fiber cross sectional area (μm^2), P is a circumference length of fiber cross

section (μm).

2. The method for manufacturing a sound-absorbing material of claim 1, wherein the

sound-absorbing material is manufactured by using the non-circular shaped fiber satisfying the

value of the Formula 1 of 2.6 or greater.

3. The method for manufacturing a sound-absorbing material of claim 1, wherein the

non-circular shaped fiber is at least one selected from the group consisting of six-pointed star

shape, 3-bar flat type, 6-leaf type, 8-leaf type and wave type.

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4. The method for manufacturing a sound-absorbing material of claim 1, wherein the non-circular shaped fiber is 35 to 65 mm in length.

5. The method for manufacturing a sound-absorbing material of claim 1, wherein the binder fiber comprises a low melting (LM) elastomer having elastic recovery modulus of 50 to 80%.

6. The method for manufacturing a sound-absorbing material of claim 5, wherein the binder fiber is a conjugated fiber which is conjugate-spun by using the LM elastomer as one component.

7. The method for manufacturing a sound-absorbing material of claim 5, wherein the LM elastomer is at least one selected from the group consisting of a polyester-based polymer, a polyamide-based polymer, a polystyrene-based polymer, a polyvinylchloride-based polymer and a polyurethane-based polymer.

8. The method for manufacturing a sound-absorbing material of claim 5, wherein the LM elastomer is manufactured by esterification and polymerization steps using dimethyl terephthalate(DMT) and dimethyl isophthalate(DMI) or terephthalic acid(TPA) and isophthalic acid(IPA) as an acid ingredient(Diacid), and 1,4-butanediol(1,4-BD), polytetramethyleneglycol(PTMG) as a diol ingredient (Diol).

9. The method for manufacturing a sound-absorbing material of claim 1, wherein the non-circular shaped fiber satisfies the value of the Formula 1 of 3.0 or greater.

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10. A sound-absorbing material, comprising:

a non-circular shaped fiber satisfying the following Formula 1; and

a binder fiber that partly binds a plurality of the non-circular shaped fibers,

wherein the non-circular shaped fiber is about 50 to 80 wt % based on the total weight of the sound-absorbing material and the binder fiber is about 20 to 50 wt % based on the total weight of the sound-absorbing material,

Formula 1

$$1.5 \leq \frac{P}{\sqrt{4 \times \pi \times A}}$$

wherein A is a Fiber cross sectional area (μm^2), P is a Circumference length of fiber cross section (μm).

11. The sound-absorbing material of claim 10, wherein the non-circular shaped fiber satisfies the value of the Formula 1 of 2.6 or greater.

12. The sound-absorbing material of claim 10, wherein the non-circular shaped fiber is at least one selected from the group consisting of six-pointed star shape, 3-bar flat type, 6-leaf type, 8-leaf type and wave type.

13. The sound-absorbing material of claim 10, wherein the non-circular shaped fiber is 35 to 65 mm in length.

14. The sound-absorbing material of claim 10, wherein the non-circular shaped fiber is 1.0 to 7.0 De in fineness.

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15. The sound-absorbing material of claim 10, wherein the binder fiber comprises a low melting (LM) elastomer having elastic recovery modulus of 50 to 80%.

16. The sound-absorbing material of claim 15, wherein the binder fiber is conjugated fiber which is conjugate-spun by using the LM elastomer as one component.
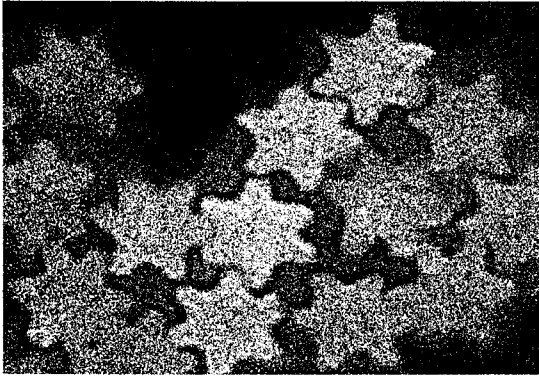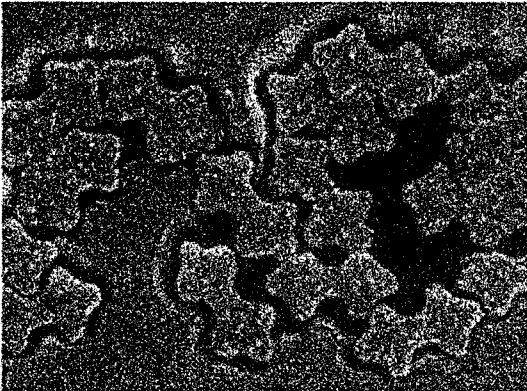
17. The sound-absorbing material of claim 15, wherein the LM elastomer is at least one selected from the group consisting of a polyester-based polymer, a polyamide-based polymer and a polyurethane-based polymer.

18. The sound-absorbing material of claim 10, wherein the non-circular shaped fiber satisfies the value of the Formula 1 of 3.0 or greater.

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[Fig. 1]

[Fig. 2]

[Fig. 3]
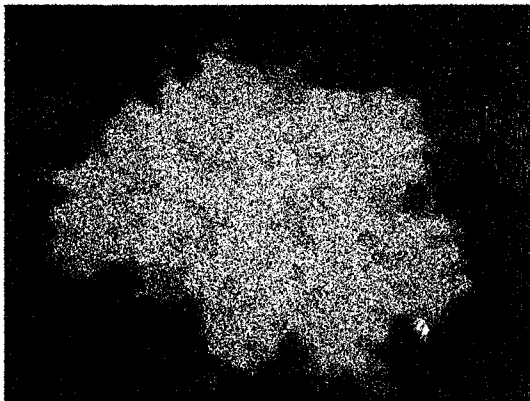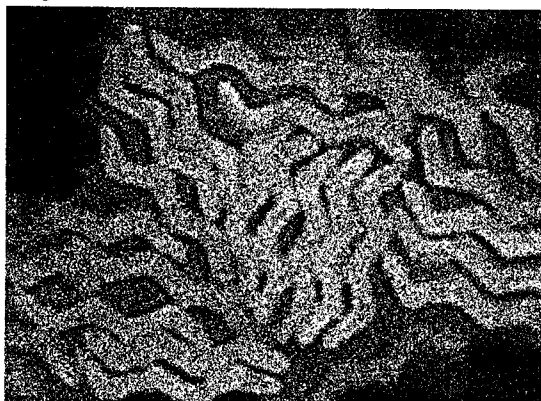
[Fig. 4]

[Fig. 5]

[Fig. 6]

[Fig. 7]

[Fig. 8]