

DESCRIPTION

Title of Invention: COVERING MATERIAL

Technical Field

5 [0001]

The present invention relates to a novel covering material. The covering material of the present invention is used to protect various base materials (frames) in buildings and other architectures from high temperatures.

10

Background Art

[0002]

Conventionally, there has been a problem in that, when civil-engineering structures or like architectural structures are exposed to high temperatures, such as those in a fire, the mechanical strength of the building frames of these structures, such as steel frames and concrete, is drastically decreased. To address this problem, a heat-resistant protective construction method, which can delay temperature increases in a building frame to temporarily restrain the deterioration of strength thereof, is adopted.

20

[0003]

Examples of heat-resistant protective construction methods include the use of dry-type covering materials, such as thermally expandable resin sheets and inorganic fiber sheets. In these methods, the building frame is covered with a dry-type covering material prepared in advance. Because the thickness of dry-type covering materials is easily controlled and curing at the construction site is unnecessary, the construction period can be shortened. In particular, thermally expandable resin sheets are drawing widespread attention as they provide a smooth surface and an excellent appearance. Examples of the dry-type covering materials include that disclosed in PTL 1, wherein "a fire-resistant foam sheet comprising, as main components, synthetic resin, a fire-resistant foaming agent, and a polyhydric alcohol"

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35

is disclosed.

Citation List

Patent Literature

5 [0004]

PTL 1: JP2002-201733A

Summary of Invention

Solution to Problem

[0005]

10 Dry-type covering materials are sometimes bent to match
the shape of the portions to which they are applied. Furthermore,
the dry-type covering materials are sometimes subject to impact
when fixed to the building frame by nailing, riveting, or the
like. If, as a result of these construction operations, the
15 covering material is partially missing, or if it partially or
entirely cracks, its inherent heat-resistant property cannot be
fully achieved. Therefore, dry-type covering materials must have
properties that can prevent parts thereof from easily ending up
missing or cracking as a result of the above-described
20 construction operations, i.e., the dry-type covering materials
must have excellent flexibility during application.

[0006]

 Attempts have been made to address the above problems,
such as adjusting the glass transition temperature of the resin
25 component, adding an additive, etc. However, these attempts alone
may cause the covering material to slide downward, etc., when it
is exposed to high temperatures. Furthermore, this may cause the
carbonized heat-insulating layer to have an insufficient foaming
ratio, strength, or the like, and adversely affect the heat-
30 resistant and fire-resistant protective properties of the
covering material.

[0007]

 The present invention has been accomplished in view of
these problems in the prior art. Specifically, an object of the
35 present invention is to provide a covering material that exhibits

excellent flexibility during application, and that can form a carbonized heat-insulating layer that exhibits satisfactory foamability, strength, etc., when exposed to high temperatures, such as those in a fire.

5

Solution to Problem

[0008]

The present inventors conducted extensive research to overcome the above problems and found that specific covering materials containing a specific binder, flame retardant, foaming agent, carbonizing agent, and filler can solve the above problems. The present invention has thus been accomplished.

10 [0009]

Specifically, the present invention relates to the following covering materials.

Item 1. A covering material comprising a binder, a flame retardant, a foaming agent, a carbonizing agent, and a filler, wherein the covering material contains, as the binder, a vinyl acetate/ethylene copolymer resin having a melt mass flow rate of 0.1 to 300 g/10 min at 190°C and having a vinyl acetate content of 15 to 50% by mass.

Item 2. The covering material according to Item 1, further comprising a liquid halogenated compound.

25 Advantageous Effects of Invention

[0010]

The covering material of the present invention exhibits excellent flexibility during application, and can form a carbonized heat-insulating layer that exhibits satisfactory foamability, strength, etc., when exposed to high temperatures such as those in a fire. The covering material of the present invention is widely applicable to various locations as a heat-resistant protective material for use in the base materials of buildings, etc.

35

Description of Embodiments

[0011]

Hereunder, the covering material of the present invention is explained in detail.

5 [0012]

The covering material of the present invention comprises a binder, a flame retardant, a foaming agent, a carbonizing agent, and a filler.

The covering material contains, as the binder, a vinyl
10 acetate/ethylene copolymer resin having a melt mass flow rate of 0.1 to 300 g/10 min at 190°C and a vinyl acetate content of 15 to 50% by mass. Each component is explained below.

[0013]

Binder (Binding component)

15 The binder (binding component) used in the present invention has the function of being carbonized in a fire to form a carbonized heat-insulating layer. The binder used in the present invention comprises, as an essential component, a vinyl acetate/ethylene copolymer resin that has a melt mass flow rate
20 (hereunder referred to as "MFR") at 190°C in a specific range and a specific vinyl acetate content (hereunder, this vinyl acetate/ethylene copolymer resin is referred to as "the vinyl acetate/ethylene copolymer resin of the present invention").

[0014]

25 The vinyl acetate/ethylene copolymer resin of the present invention has an MFR at 190°C preferably in the range of 0.1 to 300 g/10 min, more preferably 1.0 to 200 g/10 min, still more preferably 1.5 to 100 g/10 min, and most preferably 2.5 to 60 g/10 min.

30 [0015]

Attributable to the feature that the vinyl acetate/ethylene copolymer resin of the present invention has an MFR in the range described above, the covering material of the present invention can form a carbonized heat-insulating layer
35 that exhibits excellent foamability, strength, etc.

[0016]

When the MFR exceeds 300 g/10 min, exposure to high temperatures, such as those in a fire, may cause its foamability to be lowered, or may cause the covering material to fall out
5 (detach) before a carbonized heat-insulating layer is formed. The foamability may also be lowered when the MFR is lower than 0.1 g/10 min.

[0017]

In the present specification, the MFR indicates a value
10 measured based on JIS K7210: 1999 "Plastics - Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics," at 190°C and a load of 2.16 kg.

[0018]

The vinyl acetate/ethylene copolymer resin of the
15 present invention has a vinyl acetate content of generally 15 to 50% by mass, and preferably 20 to 45% by mass.

[0019]

Attributable to the feature that the vinyl acetate content falls within the range described above, the covering
20 material of the present invention exhibits excellent flexibility and, at the same time, has excellent foamability. In particular, when the vinyl acetate content is in the range of 20 to 45% by mass, the following effects can be achieved. That is, the covering material can be easily curved (for ease of construction)
25 and exhibits excellent flexibility under low temperatures. Such excellent flexibility allows the covering material to withstand both a bending process and a nailing or riveting process.

[0020]

When the vinyl acetate content is less than 15% by mass,
30 the resulting covering material may have inferior foamability. When the vinyl acetate content exceeds 50% by mass, the strength of the carbonized heat-insulating layer may be lowered.

[0021]

By having an ethylene content in the range of 50 to 85%
35 by mass (preferably, 55 to 80% by mass), the strength of the

carbonized heat-insulating layer can be maintained.

[0022]

The vinyl acetate/ethylene copolymer resin of the present invention desirably has a tensile strain at break defined
5 by JIS K7162 of 500% or greater, and more preferably 600% or greater. When the tensile strain at break falls within such ranges, even more excellent flexibility can be exhibited.

[0023]

Although the mechanism of action of the binder is not
10 clear, the following mechanism can be presumed.

[0024]

When exposed to high temperatures, such as those in a fire, the covering material of the present invention generates a nonflammable gas from the flame retardant, foaming agent, and
15 other components described below. Here, the vinyl acetate/ethylene copolymer resin of the present invention is probably in a moderately softened state. This probably causes fine bubbles of nonflammable gas to uniformly distribute in the softened resin component to form a carbonized heat-insulating
20 layer. The thus formed carbonized heat-insulating layer presumably maintains its fine structure to exhibit excellent heat-insulation due to the high foaming ratio, and a carbonized heat-insulating layer having high strength is formed.

[0025]

25 The vinyl acetate/ethylene copolymer resin of the present invention can be used as the sole binder in the present invention, or other synthetic resins may be added. Here, when a synthetic resin other than the vinyl acetate/ethylene copolymer resin of the present invention is mixed, in addition to the vinyl
30 acetate/ethylene copolymer resin of the present invention, as the binder, the mixed binder preferably has an MFR and vinyl acetate content that satisfy the ranges mentioned above. More specifically, the binder after mixture preferably has an MFR in the range of 0.1 to 300 g/10 min and a vinyl acetate content in
35 the range of 15 to 50% by mass.

[0026]

Examples of synthetic resins that can be added include organic synthetic resins such as vinyl acetate resin, vinyl acetate/vinyl versatate ester copolymer resin, vinyl acetate/vinyl versatate ester/acrylic copolymer resin, vinyl acetate/acrylic copolymer resin, acrylic resin, acryl/styrene copolymer resin, epoxy resin, urethane resin, polyester resin, polybutadiene resin, alkyd resin, and vinyl chloride resin.

[0027]

10 Flame retardant

The flame retardant used in the present invention generally exhibits, in a fire, at least one effect selected from a dehydration-cooling effect, a nonflammable gas generation effect, and a binder carbonization promotion effect so as to prevent the combustion of binder.

[0028]

There is no limitation to the flame retardant used in the present invention as long as it has such an effect, and a known flame retardant may be used. Examples of the usable flame retardants include organic phosphorus-based compounds, such as tricresyl phosphate, diphenylcresyl phosphate, octyldiphenyl phosphate, tri(β -chloroethyl)phosphate, tributyl phosphate, tri(dichloropropyl)phosphate, triphenylphosphate, tri(dibromopropyl)phosphate, chlorophosphonate, bromophosphonate, diethyl-N,N-bis(2-hydroxyethyl)aminomethyl phosphonate, and di(polyoxyethylene)hydroxymethyl phosphonate; chlorine compounds, such as chlorinated polyphenyl, chlorinated polyethylene, diphenyl chloride, triphenyl chloride, pentachloride of fatty acid ester, perchloropentacyclodecane, chlorinated naphthalene, and tetrachlorophthalic anhydride; antimony compounds, such as antimony trioxide and antimony pentachloride; phosphorus compounds, such as phosphorus trichloride, phosphorus pentachloride, ammonium phosphate, and ammonium polyphosphate; and boron compounds, such as zinc borate and sodium borate; etc.

35 These flame retardants may be used singly or in a combination of

two or more. These flame retardants may be coated or uncoated.

[0029]

In the present invention, it is particularly preferable to use ammonium polyphosphate as a flame retardant. When ammonium
5 polyphosphate is used, the dehydration-cooling effect and the nonflammable gas generation effect can be exhibited more effectively.

[0030]

The flame retardant content is preferably 50 to 1,000
10 parts by mass, more preferably 100 to 800 parts by mass, and still more preferably 150 to 600 parts by mass, relative to 100 parts by mass (solids content) of the binder. In the present invention, the relatively high content of flame retardant allows excellent performance to be achieved in terms of heat-resistant
15 protection.

[0031]

Foaming agent

The foaming agent used in the present invention generally generates a nonflammable gas in a fire to foam the
20 binder and carbonizing agent as they are being carbonized, so that a porous carbonized heat-insulating layer can be formed.

[0032]

There is no limitation to the foaming agent as long as it has the above effect, and a known foaming agent can be used.
25 Examples of the usable foaming agents include melamine and derivatives thereof, dicyandiamide and derivatives thereof, azodicarbonamide, urea, and thiourea. These foaming agents may be used singly or in a combination of two or more.

[0033]

30 Among these foaming agents, melamine, dicyandiamide, azodicarbonamide, and the like are preferable because they have excellent efficiency in generating nonflammable gas. Among these, melamine is particularly preferable.

[0034]

35 The foaming agent content is preferably 5 to 500 parts

by mass, and more preferably 30 to 200 parts by mass, relative to 100 parts by mass (solids content) of binder. Having such a foaming agent content renders excellent foamability and achieves desirable performance in terms of heat-resistant protection.

5 [0035]

Carbonizing agent

The carbonizing agent of the present invention generally carbonates the binder in a fire, and the carbonizing agent itself is carbonated by dehydrogenation, thus enabling a
10 carbonized heat-insulating layer to be formed that has sufficient thickness and excellent heat insulation.

[0036]

There is no limitation to the carbonizing agent as long as it has such an effect, and a known carbonizing agent may be
15 used. Examples thereof include polyhydric alcohols, such as pentaerythritol, dipentaerythritol, and trimethylolpropane; starch, casein, etc. These carbonizing agents may be used singly or in a combination of two or more.

[0037]

20 In the present invention, pentaerythritol and dipentaerythritol are particularly preferable due to their excellent dehydration-cooling effect and remarkable ability to form a carbonized heat-insulating layer.

[0038]

25 The carbonizing agent content is preferably 5 to 600 parts by mass, and more preferably 10 to 400 parts by mass, relative to 100 parts by mass (solids content) of binder. Having such a carbonizing agent content renders an excellent dehydration-cooling effect and ability to form a carbonized heat-
30 insulating layer, and achieves desirable performance in terms of heat-resistant protection.

[0039]

Filler

The filler used in the present invention generally has
35 the effect of maintaining the strength of the carbonized heat-

insulating layer.

[0040]

There is no limitation to the filler as long as it has such an effect and a known filler may be used. Examples thereof
5 include carbonates, such as calcium carbonate, sodium carbonate, magnesium carbonate, and aluminum oxide; metal oxides, such as titanium dioxide and zinc oxide; inorganic powders, such as silica, clay, talc, clay, kaolin, diatomaceous earth, Shirasu (deposits of volcanic ash and sand), mica, wollastonite, silica
10 sand, silica stone, quartz, vermiculite, alumina, and fly ash; etc.

[0041]

In the present invention, it is preferable that titanium dioxide and an inorganic powder having a phase
15 transition temperature of 1,000°C or higher (hereunder referred to as "the inorganic powder of the present invention;" specific examples thereof are described later) be contained as the filler. The "phase transition" includes either one of the following:

- Dehydration reaction of inorganic powder (elimination of
20 crystallization water and hydration water)
- Change of the crystal structure of inorganic powder (polymorphic transition)
- Melt or decomposition reaction of inorganic powder.

The use of the inorganic powder of the present
25 invention can prevent shifting or other defects of the covering material even when it is exposed to high temperatures. As a result, a carbonized heat-insulating layer can be formed stably. Note that the "shifting of the covering material" includes that which occurs before, during or after the formation of the
30 carbonized heat-insulating layer. The present invention can effectively prevent, in particular, the shifting of the covering material before forming the carbonized heat-insulating layer.

[0042]

The use of the inorganic powder of the present
35 invention allows a carbonized heat-insulating layer to be formed

that has a high foaming ratio and excellent strength without adversely affecting the effects of the flame retardant and foaming agent. This also allows a carbonized heat-insulating layer having uniform bubbles to be obtained.

5 [0043]

Although the mechanism of action thereof is not clear, the following mechanism can be presumed.

[0044]

When the inorganic powder undergoes a phase transition,
10 its volume or shape changes considerably. At the same time, phase transition heat is generated. Generally, because inorganic powder is highly strong, having inorganic powder in the structural framework of a carbonized heat-insulating layer having fine, combustion-formed voids presumably increases the strength of the
15 carbonized heat-insulating layer.

[0045]

However, when inorganic powder that causes a change in volume or shape exists in the structural framework of the carbonized heat-insulating layer, adhesion at the interface
20 between the carbide and the inorganic powder in the structure is reduced and this eventually lowers the strength of the entire carbonized heat-insulating layer. Furthermore, the heat of phase transition hampers the thermal decomposition of the foaming agent and flame retardant, and the gas components generated by the
25 thermal decomposition become hardly affect on the carbonization mechanism. This probably lowers the foamability of the carbonized heat-insulating layer and adversely affects the heat insulation targeted by the present invention.

[0046]

30 In contrast, when the inorganic powder of the present invention is used, the phase transition does not occur even when the temperature increases due to a fire; therefore, the thermal decomposition of the foaming agent and the flame retardant will not be hampered. The thus formed carbonized heat-insulating layer
35 probably maintains its fine structure to exhibit excellent heat-

insulation due to the high foaming ratio, and a carbonized heat-insulating layer having high strength can be formed.

[0047]

Examples of the inorganic powders of the present invention include α -alumina, calcined kaolin, calcined clay, pyrogenic silica, calcined vermiculite, Shirasu (deposits of volcanic ash and sand), Shirasu balloon, fly ash, Portland cement, calcined diatomaceous earth, flux-calcined diatomaceous earth, wollastonite, etc. In addition to those described above, usable examples also include inorganic powder obtained by pre-treating a known mineral or inorganic compound in such a manner that its phase transition temperature would become 1,000°C or higher. These inorganic powders may be used singly or in a combination of two or more.

15 [0048]

Among these inorganic powders, in order to enhance the strength of the carbonized heat-insulating layer, the inorganic powder preferably comprise at least SiO_2 . Preferable examples thereof include calcined clay, calcined kaolin, and wollastonite.

20 [0049]

The shape of the inorganic powder is not particularly limited, and examples thereof include spherical, granular, plate-like, cylindrical, flaky, acicular, and fibrous. These inorganic powders may be used singly or in a combination of two or more types. In the present invention, plate-like, flaky, acicular, or fibrous inorganic powders are preferably used.

[0050]

The titanium dioxide in the present invention is not particularly limited and anatase-type, rutile-type or other types of titanium dioxide may be used. Among these, rutile-type titanium dioxide is particularly preferable.

[0051]

When the filler comprises titanium dioxide and the inorganic powder of the present invention, the mass ratio of the titanium dioxide to the inorganic powder of the present invention

is preferably 99:1 to 1:99, more preferably 97:3 to 50:50, still more preferably 95:5 to 60:40, and most preferably 90:10 to 70:30. When the mass ratio of the titanium dioxide to the inorganic powder of the present invention falls in such ranges, a highly strong carbonized heat-insulating layer can be formed.

[0052]

The particle diameter of the filler is preferably 800 μm or less, and more preferably in the range of 0.01 to 500 μm . When the filler is in a fibrous form, the length of the fiber preferably falls in the ranges described above.

[0053]

The filler content is preferably 10 to 300 parts by mass, and more preferably 20 to 250 parts by mass, relative to 100 parts by mass (solids content) of binder. Having such a content allows the carbonized heat-insulating layer to maintain its strength and achieve excellent performance in terms of heat-resistant protection.

[0054]

Liquid halogenated compound

The covering material of the present invention preferably comprises a liquid halogenated compound, in addition to the components described above. The liquid halogenated compound effectively improves the flexibility, heat-resistant protection, and other properties of the covering material. The term "liquid" means that the compound is in a liquid state at room temperature (25°C). The liquid halogenated compound of the present invention does not include those containing phosphorus.

[0055]

Examples of halogens include fluorine, chlorine, bromine, and iodine. Among these, chlorine is preferable. An example of a preferable liquid halogenated compound is chlorinated paraffin.

[0056]

The carbon number of the chlorinated paraffin is preferably 10 or more, and more preferably 14 to 28. The chlorine

content in the chlorinated paraffin is preferably 25% or more but less than 70%, more preferably 35 to 68%, and still more preferably 40 to 65%. By using a chlorinated paraffin satisfying such conditions in the present invention, the flexibility can be further improved. This also makes it possible to form a carbonized heat-insulating layer having more improved foamability and strength.

[0057]

The liquid halogenated compound content is preferably 20 to 300 parts by mass, and more preferably 30 to 200 parts by mass, relative to 100 parts by mass (solids content) of binder.

[0058]

Fiber material

The covering material of the present invention preferably comprises a fiber material in addition to the components described above. Containing a fiber material enhances the effect of maintaining the shape of the porous carbonized layer. The length of the fiber material is preferably 1 to 30 mm and more preferably 2 to 20 mm.

[0059]

Examples of fiber materials include inorganic fibers, such as rock wool, glass fiber, silica alumina fiber, ceramic fiber, and potassium titanate fiber; and organic fibers, such as carbon fiber, pulp fiber, polypropylene fiber, vinyl fiber, and aramid fiber. Among these, inorganic fibers and carbon fibers having heat resistance are preferable.

[0060]

In the present invention, the use of glass fiber is particularly preferable. The use of glass fiber allows excellent performance to be achieved in terms of foamability when heated, readily obtaining a porous carbonized layer desirable for a heat-resistant protective material.

[0061]

The fiber material content is preferably 0.1 to 30 parts by mass, and more preferably 1 to 20 parts by mass,

relative to 100 parts by mass (solids content) of binder.

[0062]

Shape or the like of the covering material of the present invention

5 The covering material of the present invention is generally used in the form of a sheet-like molded article. The thickness of the sheet-like molded article may be suitably selected depending on the portion to be applied. The thickness is preferably about 0.2 to 10 mm, and more preferably about 0.5 to 6
10 mm.

[0063]

 The sheet-like molded article can be obtained by a known method using a mixture containing the above components uniformly mixed therein. While mixing each component, one or more
15 solvents may be further added and/or heating may be applied if necessary. When bead-like, pellet-type or other binders are used, the components can be heated to the softening temperature of the binder with a heater and then mixed while kneading using a kneader or the like.

20 [0064]

 Various additives may be added to the mixture. Examples of additives include a pigment, fibers, a wetting agent, a plasticizer, a lubricant, a preservative, an anti-mold agent, an antifungal agent, an antimicrobial agent, a thickening agent, a
25 leveling agent, a dispersant, a defoaming agent, a cross linking agent, a UV absorber, an antioxidant, and a catalyst.

[0065]

 Examples of the molding methods are described below. A mixture can be poured into a mold, and then released from the
30 mold after drying. A mixture can be applied to release paper using a heat coater, and then wound. A mixture kneaded using a kneader or the like can be formed into a sheet with an extrusion molding device. A mixture kneaded using a kneader or the like can be supplied between rolls to form a sheet. A mixture can be
35 formed into pellets and then formed into a sheet using an

extrusion molding device. A mixture kneaded using a Banbury mixer or mixing roll is rolled using a calender comprising a plurality of heated rolls to form a sheet.

[0066]

5 A reinforcing material, an adhesive, release paper and the like may be laminated onto the covering material of the present invention, if necessary. Examples of reinforcing materials include a woven fabric, a nonwoven fabric, and a mesh. Examples of the usable adhesives include known adhesives, gluing
10 agents, and others. The release paper is not limited as long as it can be laminated onto the adhesive so that the adhesive can be protected during distribution.

[0067]

 The covering material of the present invention can be
15 used as a material for covering various base materials for buildings, etc. Examples of locations in which a base material is used include walls, pillars, floors, beams, roofs, and stairs. Examples of materials for forming the base material include metal, concrete, woody materials, and resin-based materials. These base
20 materials may be suitably subjected to a backing process, corrosion-proofing, etc.

[0068]

 Various methods can be employed for adhering the covering material of the present invention onto a base material.
25 Examples thereof include the following. An adhesive is applied to the base material in advance to adhere them. A covering material provided with an adhesive layer is adhered to the base material. The covering material is fixed to the base material by nailing, riveting, etc. It should be noted that the adhesive encompasses
30 gluing agents.

[0069]

 The covering material of the present invention is adhered to the base material in such a manner that the entire surface of the target base material is covered. In the present
35 invention, two or more laminated covering materials may be

adhered to the base material.

[0070]

The butted portion between the covering materials may be handled by, for example, the following methods. The covering materials may be stacked on top of each other. A narrow sheet or tape may be overlaid. A putty material may be inserted. The butted portions may be adhered to each other using an adhesive, or by means of heating or pressing, etc. By substantially eliminating gaps between the butted portions by the above methods, the heat-resistant protective property that the covering material inherently possesses can be reliably obtained.

[0071]

A decorative surface layer may be formed on the covering material of the present invention if necessary. The decorative surface layer may be formed by a known construction technique. Examples thereof include applying various coating compositions, laminating a decorative film or decorative sheet, etc. The decorative surface layer may be such that a plurality of material types are laminated.

20

Examples

[0072]

Hereunder, the features of the present invention are explained in more detail with reference to Experimental Examples.

25 [0073]

Production Examples of Covering Materials 1 to 31

The materials were mixed in accordance with the formulations shown in Tables 1-1 to 1-3, and each resulting mixture was kneaded using a kneader heated to 120°C. The kneaded mixture was rolled and then cooled to room temperature to obtain sheet-like covering materials 1 to 31 having a thickness of 1.5 mm. The materials used are listed below.

• Binder A: vinyl acetate/ethylene copolymer resin (MFR (190°C): 65 g/10 min, vinyl acetate content: 41% by mass, tensile strain at break: 1720%)

35

- Binder B: vinyl acetate/ethylene copolymer resin (MFR (190°C): 30 g/10 min, vinyl acetate content: 33% by mass, tensile strain at break: 920%)
- Binder C: vinyl acetate/ethylene copolymer resin (MFR (190°C): 5 90 g/10 min, vinyl acetate content: 33% by mass, tensile strain at break: 1180%)
- Binder D: ethylene methyl methacrylate resin (MFR (190°C): 450 g/10 min, vinyl acetate content: 0% by mass, tensile strain at break: 320%)
- 10 • Binder E: styrene/butadiene-based thermoplastic elastomer (MFR (190°C): 2.6 g/10 min, vinyl acetate content: 0% by mass, tensile strain at break: 1100%)
- Binder F: vinyl acetate/ethylene copolymer resin (MFR (190°C): 100 g/10 min, vinyl acetate content: 46% by mass, tensile strain at break: 1740%) 15
- Binder G: vinyl acetate/ethylene copolymer resin (MFR (190°C): 18 g/10 min, vinyl acetate content: 28% by mass, tensile strain at break: >640%)
- Binder H: vinyl acetate/ethylene copolymer resin (MFR (190°C): 20 5.7 g/10 min, vinyl acetate content: 28% by mass, tensile strain at break: >600%)
- Binder I: vinyl acetate/ethylene copolymer resin (MFR (190°C): 160 g/10 min, vinyl acetate content: 20% by mass, tensile strain at break: >770%)
- 25 • Binder J: vinyl acetate/ethylene copolymer resin (MFR (190°C): 1.5 g/10 min, vinyl acetate content: 20% by mass, tensile strain at break: >590%)
- Binder K: vinyl acetate/ethylene copolymer resin (MFR (190°C): 12 g/10 min, vinyl acetate content: 15% by mass, tensile strain at break: 800%) 30
- Binder L: vinyl acetate/ethylene copolymer resin (MFR (190°C): 2.2 g/10 min, vinyl acetate content: 15% by mass, tensile strain at break: 500%)
- Binder M: vinyl acetate/ethylene copolymer resin (MFR (190°C): 35 1,000 g/10 min, vinyl acetate content: 28% by mass, tensile

strain at break: 310%)

• Binder N: acryl/styrene copolymer resin (MFR (190°C): 88 g/10 min, vinyl acetate content: 0% by mass)

• Foaming agent: melamine

5 • Carbonizing agent: pentaerythritol

• Flame retardant: ammonium polyphosphate

• Filler A: titanium oxide (TiO_2 , rutile type, mean particle diameter: 0.3 μm)

10 • Filler B: wollastonite (CaSiO_2 , longer axis: 200 μm , phase transition temperature: 1000°C or higher (melting point: 1400°C))

• Fiber: glass fiber (fiber length: 6 mm)

• Chlorinated paraffin A: (carbon number: 26, chlorine content: 51%)

15 • Chlorinated paraffin B: (carbon number: 15, chlorine content: 51%)

• Chlorinated paraffin C: (carbon number: 25, chlorine content: 42%)

Experimental Example 1 (flex resistance test)

20 The resulting covering materials 1 to 31 were subjected to a flex resistance test.

[0074]

Specifically, each covering material was subjected to a flex resistance test according to JIS K5400 (mandrel diameter: 2 mm) at 25°C and at 5°C, and the conditions of the covering materials were evaluated by visual observation.

[0075]

The evaluation criteria are shown below. The degree of flexibility during the test (operability) was also considered.

30 Tables 1-1 to 1-3 show the results.

[0076]

A: No defect was observed until 180°

B: No defect was observed until 180° (inferior operability)

C: Cracking observed from 90° to 180°

35 D: Cracking observed below 90°

Experimental Example 2 (Evaluation of foaming ratio and denseness)

Each of the covering materials 1 to 31 was adhered to a
5 hot rolled steel plate (300 mm × 300 mm × 9 mm) with adhesive,
giving test samples of each covering material.
[0077]

The test samples were heated in accordance with the
standard heating curve specified in ISO 834 for a certain period
10 of time (1 hour). After cooling the test samples to room
temperature, the foaming ratio of the carbonized heat-insulating
layer was measured. The denseness of the foaming layer of the
carbonized heat-insulating layer was evaluated by visual
observation. Thereafter, the test samples were made to stand
15 vertically, and the strength of each carbonized heat-insulating
layer was evaluated by visual observation. The criteria for
evaluation are shown below. Tables 1-1 to 1-3 show the results.

Foaming ratio

- 20 A: Foaming ratio of 50x or more
B: Foaming ratio of 30x or more but less than 50x
C: Foaming ratio of 10x or more but less than 30x
D: Foaming ratio of less than 10x

25 Denseness

- A: The inside of the carbonized heat-insulating layer was dense
B: Voids were partially observed inside the carbonized heat-
insulating layer
C: Many voids were observed inside the carbonized heat-insulating
30 layer

Experimental Example 3 (Evaluation of anti-detachment property)

Among the covering materials 1 to 31, those evaluated
as level A in both Experimental Examples 1 and 2 were subjected
35 to the test described in Experimental Example 3.

[0078]

Each of the target covering materials was adhered to a hot rolled steel plate (150 mm × 75 mm × 1.6 mm) with acrylic adhesive to obtain test samples.

5 [0079]

The resulting test samples were placed with the top surface of the covering material facing down. The test samples were allowed to stand still at 250°C for 10 minutes, and the detachment and shifting of the covering materials were evaluated
10 by visual observation (before the formation of the carbonized heat-insulating layer).

[0080]

The criteria for evaluation are shown below. Tables 1-1 to 1-3 show the results.

15 [0081]

A: Detachment was not observed

B: Part of the surface layer was detached

C: The entire covering material was detached

20 Experimental Example 4 (Evaluation of hot-cool cycle)

Among the covering materials that underwent Experimental Example 3, those evaluated as level A in Experimental Example 3 were subjected to the test described in Experimental Example 4.

25 [0082]

Each of the target covering materials was adhered to a base material obtained by bending a hot rolled steel plate (150 mm × 75 mm × 1.6 mm) into an L-shape with acrylic adhesive to obtain test samples.

30 [0083]

Each of the test samples was subjected to 10 hot-cool cycles. In each cycle, a test sample was placed at 50°C (for 3 hours), and then -30°C (for 3 hours). Thereafter, the conditions of the covering materials were evaluated by visual observation.

35 [0084]

The criteria for evaluation are shown below. Tables 1-1 to 1-3 show the results.

[0085]

A: No defect was observed

5 B: Slight cracking was observed in the surface layer

D: Cracking was observed at the edge portion

Table 1-1

		Covering material									
		1	2	3	4	5	6	7	8	9	10
Binder A		100	-	-	-	-	-	-	-	-	-
Binder B		-	100	-	100	100	100	100	100	-	-
Binder C		-	-	100	-	-	-	-	-	-	-
Binder D (Comparative Product)		-	-	-	-	-	-	-	-	100	-
Binder E (Comparative Product)		-	-	-	-	-	-	-	-	-	100
Binder F		-	-	-	-	-	-	-	-	-	-
Binder G		-	-	-	-	-	-	-	-	-	-
Binder H		-	-	-	-	-	-	-	-	-	-
Binder I		-	-	-	-	-	-	-	-	-	-
Binder J		-	-	-	-	-	-	-	-	-	-
Binder K		-	-	-	-	-	-	-	-	-	-
Binder L		-	-	-	-	-	-	-	-	-	-
Binder M (Comparative Product)		-	-	-	-	-	-	-	-	-	-
Binder N (Comparative Product)		-	-	-	-	-	-	-	-	-	-
Foaming agent		60	60	60	60	60	60	60	60	60	60
Carbonizing agent		60	60	60	60	60	60	60	60	60	60
Flame retardant		300	300	300	300	300	300	300	300	300	300
Filler A		75	75	75	60	50	70	75	75	75	75
Filler B		-	-	-	15	25	5	-	-	-	-
Fiber		6	6	6	6	6	6	6	6	6	6
Chlorinated paraffin A		75	75	75	75	75	75	-	-	75	75
Chlorinated paraffin B		-	-	-	-	-	-	75	-	-	-
Chlorinated paraffin C		-	-	-	-	-	-	-	75	-	-
Evaluation 1	Flexibility (25° C)	A	A	A	A	A	A	A	A	C	A
	Flexibility (5° C)	A	A	A	A	A	A	A	A	D	A
Evaluation 2	Foamability	A	A	A	A	B	A	A	A	C	D
	Denseness	A	A	A	A	A	A	A	A	C	C
Evaluation 3	Anti-detachment property	C	B	C	A	-	B	B	B	-	-
Evaluation 4	Hot-cool cycle	-	-	-	B	-	-	-	-	-	-

Table 1-2

[illegible]

Table 1-3

		Covering material									
		22	23	24	25	26	27	28	29	30	31
Binder A		100	-	-	-	-	-	-	-	-	-
Binder B		-	-	-	-	-	-	-	50	35	91
Binder C		-	100	-	-	-	-	-	-	-	-
Binder D (Comparative Product)		-	-	-	-	-	-	-	-	-	-
Binder E (Comparative Product)		-	-	-	-	-	-	-	-	-	-
Binder F		-	-	100	-	-	-	-	-	-	-
Binder G		-	-	-	100	-	-	-	-	-	-
Binder H		-	-	-	-	100	-	-	50	65	-
Binder I		-	-	-	-	-	100	-	-	-	-
Binder J		-	-	-	-	-	-	100	-	-	-
Binder K		-	-	-	-	-	-	-	-	-	-
Binder L		-	-	-	-	-	-	-	-	-	-
Binder M (Comparative Product)		-	-	-	-	-	-	-	-	-	-
Binder N (Comparative Product)		-	-	-	-	-	-	-	-	-	9
Foaming agent		60	60	60	60	60	60	60	60	60	60
Carbonizing agent		60	60	60	60	60	60	60	60	60	60
Flame retardant		300	300	300	300	300	300	300	300	300	300
Filler A		60	60	60	60	60	60	60	60	60	60
Filler B		15	15	15	15	15	15	15	15	15	15
Fiber		6	6	6	6	6	6	6	6	6	6
Chlorinated paraffin A		75	75	75	75	75	75	75	75	75	75
Evaluation 1	Flexibility (25°C)	A	A	A	A	A	A	A	A	A	A
	Flexibility (5°C)	A	A	A	A	A	A	B	A	A	A
Evaluation 2	Foamability	A	A	B	A	A	B	B	A	A	A
	Denseness	A	A	A	A	A	A	A	A	A	A
Evaluation 3	Anti- detachment property	A	A	-	A	A	-	-	A	A	A
Evaluation 4	Hot-cool cycle	C	C	-	B	A	-	-	A	A	A

CLAIMS

[Claim 1]

A covering material comprising a binder, a flame retardant, a foaming agent, a carbonizing agent, and a filler, wherein the covering material contains,

(1) as the binder, a vinyl acetate/ethylene copolymer resin having a melt mass flow rate of 0.1 to 300 g/10 min at 190°C and having a vinyl acetate content of 15 to 50% by mass,

(2) the foaming agent generates a nonflammable gas in a fire, and

(3) the covering material comprises a fiber material in an amount of 0 to 30 parts by mass relative to 100 parts by mass of the solids content of the binder.

[Claim 2]

The covering material according to claim 1, further comprising a liquid halogenated compound.

[Claim 3]

The covering material according to claim 1 or 2, wherein the filler comprises at least one member selected from the group consisting of titanium dioxides and inorganic powders having a phase transition temperature of 1,000°C or higher.

[Claim 4]

The covering material according to any one of claims 1 to 3, wherein the mass ratio of the titanium dioxide to the inorganic powder is 97:3 to 50:50.

[Claim 5]

The covering material according to any one of claims 1 to 4, wherein the covering material has a foaming ratio of 10 factors or more when heated in accordance with the standard heating curve specified in ISO 834 for 1 hour and cooled to room temperature.