

DESCRIPTION

AUTOMOTIVE INTERIOR MATERIAL

Technical Field

The present invention relates to an automotive interior material which has excellent ability to capture volatile organic compounds such as aldehydes, does not deteriorate surface material design, and is non-toxic to human bodies.

Background Art

In recent years, generation of sublimated substances that might be harmful to human bodies such as remaining monomers, formaldehyde, organic solvents, plasticizers, hormone-disrupting substances, and other volatile substances from materials of interior components used inside cars has been problematic. Therefore, the development of methods for removing such substances has been addressed.

For instance, as binders for nonwoven fabric fibers used for an automotive interior material for seats, floors, trunks, and other parts, water-based acrylic copolymer emulsion and water-based latex are often used. In such cases, as a means for crosslinking of binder resins used to improve hardness, heat resistance, and durability of a compact, a heat-crosslinking binder obtained via copolymerization of functional copolymerizable monomers such as N-methylol acrylamide is often used. Nonwoven fabric obtained with the use of such a heat-crosslinking binder has improved mechanical properties such as tensile strength, stretching properties, tearing strength, and hardness, and furthermore, it has improved practical durability,

including dimensional stability, water resistance, chemical resistance, and heat resistance.

However, when a condensation reaction of methylol groups is used, such condensation reaction proceeds in the step of heating to dry a sheet applied to fibers and in the subsequent step of laminating the surface of the coated nonwoven fabric with polyethylene. Along with the progression of the condensation reaction, formaldehyde is generated according to the reaction mechanism. Most formaldehyde generated during the above processing steps is sublimated outside the system in the step of drying and heating. However, it is difficult to completely remove formaldehyde from the nonwoven fabric fiber material. Accordingly, formaldehyde remains in a product such that it is sublimated inside a car over time, resulting in deterioration of an environment that surrounds human bodies.

In addition, for a ceiling portion made of an automotive interior material, a laminate compact obtained by bonding nonwoven fabric used as a surface material to a base comprising a PP/glass mat, cotton felt, cardboard, hard urethane foam, or the like is used. Among materials used for automotive parts, a roof material is located at the position that is most affected by summer heat. In such case, a laminate is required to have heat deformation resistance. To form the above structure, thermosetting resin type binders are often used in view of heat resistance, high rigidity, forming properties, and the like. As binders for thermosetting resins, phenol resin or a melamine resin in the form of an aqueous solution type or powder type resin and a system obtained by mixing the above thermosetting powder or thermosetting aqueous solution into an aqueous dispersion of a thermoplastic resin such as acrylic resin emulsion or latex are often used.

The forming of a roof material with the use of such a thermosetting

resin binder is carried out as in the case of the above interior material in a manner such that each binder is allowed to impregnate or is applied to the relevant structure, followed by drying and forming, or in a manner such that a binder in a powder form is uniformly dispersed on fibers, followed by heat forming. Accordingly, a fiber compact is obtained. Nonwoven fabric used for a surface material is bonded thereto with a hot-melt resin powder, a hot-melt film, a hot-melt web, or the like during heat forming of a sheet, or it is bonded thereto with an adhesive after the forming of a sheet. Thus, a laminate is formed.

Formalin-based condensates are used for many of phenol resin compositions and melamine resin compositions contained in such thermosetting resin binders. When such resins are heated, a condensation reaction is induced, resulting in intermolecular three-dimensional cross linking. Thus, robust compacts are obtained. During the process, formaldehyde is generated, even if only in a small amount. In recent years, some manufacturers have been providing products with low formaldehyde content, which result in reduction of the amounts of generated formaldehyde, as well as products containing different formalin catchers for reducing the release of formaldehyde from formed members. However, complete removal of formaldehyde has not been achieved.

As described above, not a small number of binder resins used for members of an automotive interior material comprising fibers have been found to sublimate formaldehyde, which is toxic to human bodies. Therefore, prevention of sublimation of organic substances such as formaldehyde contained in binder resins has been addressed.

For instance, Patent Document 1 described below discloses a decorative sheet comprising a base sheet and a decoration layer, which

contains a formaldehyde scavenger in either or both of the base sheet and the decoration layer so as to provide the function of capturing formaldehyde.

Patent Document 1 discloses specific examples of a formaldehyde scavenger, including: amides such as dicyandiamide and urea; cyclic alkylene ureas such as ethylene urea, propylene urea, 5-hydroxypropylene urea, 5-methoxypropylene urea, 5-methylpropylene urea, parabanic acid (glyoxal monoureine), and 4,5-dimethoxyethylene urea; organic amino compounds such as acid imides and amines.

In addition, Patent Document 2 described below discloses a decorative sheet that is obtained by providing a picture-printed layer and a single resin layer or two or more resin layers to a sheet-type base and contains a formaldehyde scavenger in at least a single resin layer or in two or more resin layers, and particularly in the top resin layer. This invention is intended to capture and remove formaldehyde released from a construction material into the air inside a room of a building, etc. so as to prevent unpleasant odor, effects that are harmful to health, and the like.

Patent Document 2 describes specific examples of agents capable of capturing formaldehyde that are amino compounds such as dicyandiamide and melamine, urea, amides such as barbituric acid and semicarbazide hydrochloride, and nitrogen-containing compounds such as amino acids (e.g., glutamate, glycine, and alanine).

These organic amino compounds disclosed in Patent Documents 1 and 2 react with formaldehyde. Since the resulting reaction product does not release formaldehyde, such compounds have certain effects as agents capable of capturing formaldehyde. However, when such compounds are used for a surface material for an automotive interior material, they might cause surface material coloration or discoloration, which would probably

result in damage to the original design of such a surface material.

Patent Document 1: JP Patent Publication (Kokai) No. 10-180949 A (1998)

Patent Document 2: JP Patent Publication (Kokai) No. 10-100333 A (1998)

Disclosure of the Invention

Hitherto, functions of adsorbents for aldehydes are imparted to fiber products and plastic products by, for example, the kneading, coating, or dipping of such agents. However, all such adsorbents have large particle sizes and opaque appearances. Therefore, such adsorbents can be applied only to a portion located on the back surface of a surface material, such that the portion is not seen by persons and thus visual quality is not impaired. Alternatively, they can be used in the cases of certain limited colors. The fact that such adsorbents can be applied only to a back surface indicates that they can adsorb generated volatile organic compounds that are diffused in a single direction but cannot capture volatile organic compounds diffused inside an interior space.

Therefore, embodiments of the present invention seek to provide an automotive interior material which has excellent ability to capture volatile organic compounds such as aldehydes, does not deteriorate surface material design, and is non-toxic to human bodies.

The present inventors have found it advantageous to allow a certain volatile organic compound scavenger (VOC catcher) to be present in a specific portion of an automotive interior material.

Specifically, an aspect of the present invention relates to an automotive interior material comprising at least a base and a surface material, which is

characterized in that the surface and/or back surface of the surface material contains a volatile organic compound scavenger, and in that the volatile organic compound scavenger is an silicon dioxide-aminosilane reactant having a mean particle size of 1 to 200 nm. Herein, the term "aminosilane" refers to a silicone compound represented by the following general formula: $Y_nSiX_{(4-n)}$ wherein X represents an alkoxy group, acetyl group, or halogen, Y represents an amino group or an alkyl group substituted with at least one amino group, and n represents an integer of 1 to 3. In addition, when X represents an alkoxy group, it is particularly preferable for X to be a methoxy group, ethoxy group, propoxy group, or butoxy group. Further, when Y is an alkyl group substituted with at least one amino group, it is particularly preferable for Y to be an aminomethyl group, aminoethyl group, aminopropyl group, or aminobutyl group. The volatile organic compound scavenger used in the present invention has a nano-order mean particle size, which is extremely small. Therefore, transparency thereof can be secured. In this regard, the agent is superior to a conventional volatile organic compound scavenger having a large average particle size, which is turbid.

The volatile organic compound scavenger used in the present invention can capture volatile organic compounds (VOCs) including aldehydes such as formaldehyde and acetaldehyde, trichloroethylene, tetrachloroethylene, toluene, benzene, and xylene.

Basically, the automotive interior material of the present invention comprises a base and a surface material. If desired, it may be a laminate structure comprising a spacer, nonwoven fabric for the back surface, an aeration-preventing film, a glass mat, or the like. Among the above, a known nonwoven fabric is used as a preferred example of a surface material for a conventional automotive interior material.

A volatile organic compound scavenger is applied to, sprayed over, or allowed to impregnate the surface and/or back surface of a surface material in the automotive interior material of the present invention by various methods such that the scavenger is attached to the surface material. For instance, the volatile organic compound scavenger is attached to the surface material by foam-coating of resin emulsion containing a volatile organic compound scavenger. In such case, a volatile organic compound scavenger is attached to the surface and/or back surface of nonwoven fabric while the nonwoven fabric mesh remains unobstructed. Accordingly, nonwoven fabric maintains its original design in terms of color, grain, and tactile sensation, which is preferable.

The portion of a car to which the automotive interior material of the present invention is applied are not limited. However, it is particularly preferable to apply the automotive interior material as a roof material to the ceiling portion, in which volatilization of volatile organic compounds due to exposure to heat is feared.

The surface and/or back surface of a surface material used for automotive interior material is allowed to contain a silicon dioxide-aminosilane reactant with a mean particle size 1 to 200 nm used as a volatile organic compound scavenger. Thus, transparency of the surface material is secured and volatile organic compounds such as aldehydes can be efficiently removed/reduced while the surface material maintains its design without any damage.

In addition, in contrast with a case in which a volatile organic compound scavenger is comprised inside of an automotive interior material, in the case of the present invention in which the surface material of the automotive interior material comprises a volatile organic compound

scavenger, the surface material is allowed to capture not only volatile organic compounds released from the automotive interior material but also volatile organic compounds released from other parts located inside a car. In particular, since the ceiling surface has a relatively large surface area in car interior, significant effects of removing/reducing volatile organic compounds can be obtained by allowing the roof material having a large surface area to capture volatile organic compounds.

Further, it has been confirmed that a silicon dioxide-aminosilane reactant with a mean particle size 1 to 200 nm used as a volatile organic compound scavenger in the present invention has a low level of oral toxicity and causes little skin irritation. Therefore, the agent is excellent in terms of safety, even when located on the surface facing the interior side of a car, such surface having a high probability of coming into contact with persons.

Brief Description of the Drawings

Fig. 1 shows an example of the cross-sectional structure of a roof material (ceiling material).

Fig. 2 shows the amounts of aldehydes removed by each cut sample.

[Explanation of Reference Numerals]

1: Roof portion of car body; 2: Spacer; 3: Nonwoven fabric; 4: Aeration-preventing film; 5: Glass mat; 6: Base; 7: Glass mat; 8: Surface material back surface; 9: Surface material; 10: Surface material surface; 11: Entirety of the surface material

This description includes part or all of the contents as disclosed in

the description and/or drawings of Japanese Patent Application No. 2008-005980, which is a priority document of the present application.

Best Mode for Carrying Out the Invention

Product parts for which the automotive interior material of the present invention can be used are not particularly limited. However, examples of such parts include pillar trim, door trim, instrument panels, meter hoods, consoles, and ceiling materials. In addition, with the use of a material having shock-absorbing properties for a base or surface material, the automotive interior material can also function as an automotive shock-absorbing material.

Fig. 1 shows an example of a cross-sectional view of a roof material (ceiling material) selected from among automotive interior materials. Note that the present invention is not limited to such structure. A nonwoven fabric 3, an aeration-preventing film 4, a glass mat 5, a base 6 such as a rigid urethane layer, a glass mat 7, and a surface material 9 such as nonwoven fabric are laminated on a car body roof 1 via a spacer 2, in the order from the outside to the inside of a car. In the present invention, a surface 10 and/or a back surface 8 of the surface material 9 contain(s) a volatile organic compound scavenger. The entirety of the surface material 11 comprises a surface material 9, a surface material surface 10, and a surface material back surface 8.

A roof surface material is allowed to contain the volatile organic compound scavenger of the present invention such that aldehydes generated in the roof can be captured by the surface material before being diffused from the inside of the roof to the inside of a car. In addition, volatile organic compounds such as aldehydes generated from other parts located

inside a car can be efficiently captured by the surface material.

1. Volatile organic compound scavenger

The volatile organic compound scavenger used in the present invention is a silicon dioxide-aminosilane reactant with a mean particle size of 1 to 200 nm and having a slightly white and transparent appearance.

2. Base

As a base used for the automotive interior material, a base made of a synthetic resin formed into the shape of a corresponding part of a product is used. The type of synthetic resin is not particularly limited. Preferred examples of synthetic resin include polyethylene, polypropylene, polyester, polystyrene, polyethylene terephthalate (PET), polyvinyl chloride, nylon, and polyurethane. Such synthetic resin may be in a form similar to that of a rigid body or may have shock-absorbing properties. Examples of a synthetic resin having shock-absorbing properties include a foamed synthetic resin and a solid synthetic resin having rubber-like elasticity. In addition, the base may have a single layer structure or multiple layer (laminated) structure. The method for forming a base is not particularly limited. However, preferred examples thereof include injection forming, injection press forming, RIM forming, blow forming, stamping forming, slush forming, and vacuum forming.

3. Surface material

A material having flexibility used as a surface material of the automotive interior material is not particularly limited. Examples thereof include woven fabric, nonwoven fabric, raised fabric, flock-finished fabric, synthetic resin sheet, rubber sheet, leather, and paper. In addition, the surface material may have a single layer structure or a multiple layer

(laminated) structure. In the latter case, the same type of material may be used for lamination or different types of materials may be used for lamination. Further, a material having shock-absorbing properties or a sound-proof material may be used for a single layer in the case of the single layer structure or it may be used for any layer in the case of a multiple layer structure. Such material having shock-absorbing properties is not particularly limited. However, examples thereof include a sheet of a foamed resin, elastomer, or rubber and a sheet of a solid resin having rubber-like elasticity, elastomer, or rubber. Such sound-proof material is not particularly limited. However, the sheet exemplified above as the material having shock-absorbing properties can also function as a sound-proof material. In addition, nonwoven fabric or the like can be used.

The steps of application of the automotive interior material of the present invention are summarized below.

- (1) Production of a roof lining surface material
- (2) Coating of the surface of the roof lining surface material with a volatile organic compound scavenger, drying, and fixation
- (3) Forming and bonding of a roof base such as a thermoplastic base or a thermosetting base together with the roof lining surface material
- (4) Assembly of the material to a car body

Examples

Examples of the present invention are described below.

A coating agent was prepared in accordance with the composition described below.

Acrylic emulsion (Mitsui Special Chemical Co., Ltd., TTC07; solid content: 50%): 50 parts

Volatile organic compound scavenger (Nicca Chemical Co., Ltd.; KIRAKURU AL-00GT; solid content: 20%): 7.5 parts

Water: 42.5 parts

The above components were sufficiently agitated and mixed, followed by foaming via air blowing. The surface (facing the interior side of a car) of a roof lining surface material was uniformly coated with foam in an amount corresponding to a solid content of 20 g/m². The resulting sample was pre-dried on a heating cylinder at 40°C and heated in a drying oven at 150°C for 55 seconds.

The volatile organic compound scavenger used in the present invention is a transparent silicon dioxide-aminosilane reactant with a mean particle size of 1 to 200 nm. It has been confirmed that the oral toxicity thereof is LD50 > 200 mg/kg and the skin irritation level corresponds to P.C.I. = 0.00.

As in the case of the above Example, a cut sample not containing a volatile organic compound scavenger, a cut sample having a surface material surface coated with foam containing the volatile organic compound scavenger (1.9%), a cut sample having a surface material surface coated with foam containing the volatile organic compound scavenger (0.7%), and a cut sample having the surface material surface coated with foam containing the volatile organic compound scavenger (2.5%) were prepared. The above cut samples were evaluated regarding aldehyde adsorption performance in accordance with the test procedures described below.

(1) Each cut sample ($8 \times 10 = 80 \text{ cm}^2$) is placed in a 10-L tetra bag and the

tetra bag is filled with a nitrogen gas (4 L), followed by sealing.

(2) The tetra bag is heated at 65°C for 2 hours.

(3) After heat treatment, the gas (3 L) in the tetra bag is introduced into an aldehyde adsorption column such that aldehydes are adsorbed by the column.

(4) The aldehydes adsorbed by the column are eluted with a solvent. The eluate is quantitatively analyzed by liquid chromatography (measurement wavelength: 360 nm; solvent: acetonitrile/water = 55/45 vol; injection amount: 10 μ L; ODS column).

Fig. 2 shows the remained volumes of aldehydes in the above cut samples. Based on the results shown in fig. 2, it is understood that cut samples of the present invention exhibit excellent aldehyde removal performance.

The color difference between the cut sample not containing a volatile organic compound scavenger and each cut sample having a surface material surface coated with the volatile organic compound scavenger was not more than $\Delta E = 0.5$.

Industrial Applicability

According to the present invention, the presence of volatile organic compounds inside cars can be efficiently reduced, and therefore the present invention is useful in terms of health.

All publications, patents, and patent applications cited herein are incorporated herein by reference in their entirety.

CLAIMS

1. An automotive interior material comprising at least a base and a surface material, wherein the surface and/or back surface of the surface material contains a volatile organic compound scavenger which is an silicon dioxide-aminosilane reactant having a mean particle size of 1 to 200 nm.
2. The automotive interior material according to claim 1, wherein the surface material is nonwoven fabric.
3. The automotive interior material according to claim 1 or 2, wherein the volatile organic compound scavenger is attached to the surface and/or back surface of the surface material by foam-coating of resin emulsion containing the volatile organic compound scavenger.
4. The automotive interior material according to any one of claims 1 to 3, which is a roof material applied to car interior ceiling.