

DESCRIPTION

AUTOMOTIVE CARPET

Technical Field

The present invention relates to an automotive carpet having excellent ability to capture volatile organic compounds (VOCs) such as aldehydes.

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 discussed.

For instance, a carpet such as a tufted carpet or a needle punched carpet that can be industrially mass-produced is placed or fixed on a base composed of felt or the like on the floor inside a car.

A tufted carpet can be produced by needling a ground fabric (primary ground fabric) with a number of piles with the use of a tufting machine so as to produce a surface layer material, applying a coating material containing a polymer such as synthetic rubber to fix seams appearing on the back surface of the primary ground fabric of the surface layer material, and, if necessary, laminating and adhering coarse woven fabric as a secondary ground fabric (backing material) to the back surface of the fabric with the use of the coating material as an adhesive.

A needle punched carpet is a felt carpet with a flat surface, which is

produced by piercing fiber webs with many needles so as to intertwine the fiber webs with each other in order to form felt, applying a coating material containing a polymer such as synthetic rubber to the back surface of the thus formed surface layer material with a certain thickness, and finishing the material in a manner such that it has a smooth surface.

In the cases of the aforementioned different carpets, the generation of volatile organic compounds (VOCs) from coating materials has been reported. It has been desired to quickly solve the problem.

Further, a felt layer and a sound absorbing (SA) layer used for the base for an automotive carpet are produced by passing polyester fibers and the like through a heating roller. In such case, pressurization and heating cause deterioration of polyester. There is a concern about the generation of aldehydes from carboxyl groups, which are terminal groups. In particular, a felt layer accounts for a large amount of the total volume of a carpet. Accordingly, it is thought that large amounts of volatile organic compounds are generated from a felt layer. In many cases, a sound absorbing (SA) layer is also composed of a felt material. Therefore, as in the case of a felt layer, there is a concern about the generation of volatile organic compounds.

As described above, there are not a small number of existing automotive carpets that cause sublimation of aldehydes which are toxic to human bodies. Therefore, prevention of sublimation of organic compounds such as aldehydes from automotive carpets has been addressed.

Patent Document 1 described below discloses coating of the back surface of a surface layer material that constitutes the surface of a carpet with a coating material in which a carbon powder obtained by finely pulverizing carbon is dispersed. This invention is intended to prevent generation of readily volatile organic compounds (VOCs) such as

formaldehyde from flooring carpets (but not from automotive carpets) used where pedestrian traffic volume is high.

Patent Document 2 described below discloses a carpet body constituting a carpet (but not from automotive materials), which comprises at least an adsorbent that adsorbs aldehydes. This invention is intended to efficiently remove odor components such as formaldehyde and acetaldehyde dispersed inside a room from flooring so as to remove odors of aldehydes such as formaldehyde from the room.

The carpets disclosed in Patent Documents 1 and 2 are not used for cars. Therefore, it cannot be expected that they have sufficient effects of capturing volatile organic compounds such as aldehydes contained in a specific automotive carpet which comprise a base having a felt layer and a surface layer placed or immobilized on the base.

Patent Document 1: JP Patent Publication (Kokai) No. 2000-287819 A

Patent Document 2: JP Patent Publication (Kokai) No. 11-046965 A (1999)

Disclosure of the Invention

It is an object of the present invention to provide an automotive carpet having excellent ability to capture volatile organic compounds such as aldehydes.

The present inventors have found that the above object can be achieved by allowing a volatile organic compound scavenger (VOC catcher) to be present in a specific portion of an automotive carpet. This has led to the completion of the present invention.

According to an aspect of the present invention there is provided an automotive carpet

comprising at least a base composed of a felt layer and an air-impervious or poorly air-permeable resin layer placed or immobilized on the felt layer and a surface layer placed or immobilized on the base, which is characterized in that a volatile organic compound scavenger is incorporated in, applied to, or sprayed over the bottom surface of the felt layer constituting the base, and the felt layer is substantially covered by the resin layer and a floor panel. In the case of the automotive carpet of the present invention, emanation of volatile organic compounds from the upper surface of a felt layer from which volatile organic compounds emanate (interior side) is prevented using an air-impervious or poorly air-permeable resin layer placed or immobilized on the felt layer. In addition, a volatile organic compound scavenger is incorporated into, applied to, or sprayed over the bottom surface (car body side) of the felt layer such that emanation of volatile organic compounds from the bottom surface (car body side) of the felt layer is prevented. Synergy of such effects takes place, allowing the efficient capturing of substantially all volatile organic compounds emanating from the felt layer.

It is thought that the application of a volatile organic compound scavenger to the upper surface of a felt layer would be effective for a conventional automotive carpet having no air-impervious or poorly air-permeable resin layer. However, as in the case of the present invention, for an automotive carpet comprising a base composed of an air-impervious or poorly air-permeable resin layer placed or immobilized on a felt layer, a volatile organic compound scavenger is incorporated in, applied to, or sprayed over the bottom surface (car body side) of the felt layer. In particular, this is significantly effective for prevention of emanation of volatile organic compounds from the felt layer.

According to the present invention, the base further comprises a sound absorbing layer. The base can be composed of a felt layer, an air-impervious or poorly air-permeable resin layer, and a sound absorbing

layer, which are laminated in such order from the bottom portion.

Also, a sound absorbing layer (SA layer) is usually composed of felt, which causes emanation of volatile organic compounds. Therefore, it is also preferable that a volatile organic compound scavenger be incorporated in, applied to, or sprayed over the sound absorbing layer (SA layer). Accordingly, the automotive carpet of the present invention can efficiently capture volatile organic compounds such as aldehydes emanating from a felt layer and a sound absorbing layer constituting a base.

A typical example of the automotive carpet of the present invention is characterized in that: an air-impervious or poorly air-permeable resin layer is provided between the felt layer and the sound absorbing layer that constitute a base; the sound absorbing layer is composed of a material with a lower volatile organic substance content than that of the felt layer; and the felt layer is substantially covered by the poorly air-permeable resin layer and a floor panel. Substantially all volatile organic compounds can be captured by substantially covering the upper surface of a felt layer with a high volatile organic substance content and the bottom surface of such felt layer with an air-impervious or poorly air-permeable resin layer and a floor panel, respectively. Further, a volatile organic compound scavenger is also incorporated in, applied to, or sprayed over a sound absorbing layer located closed to the interior side of a car such that volatile organic compounds generated from other parts and diffused inside the car can also be efficiently captured.

Conventionally known agents can be used as agents capable of capturing volatile organic compounds used for the automotive carpet of the present invention. Among such agents, a silicon dioxide-aminosilane reactant with a mean particle size of 1 to 200 nm is preferable because it has

high ability to capture volatile organic compounds. In particular, such silicon dioxide-aminosilane reactant with a mean particle size of 1 to 200 nm is excellent in terms of transparency and nontoxicity. In addition, it can be applied by spray dispersion. Therefore, it is recommended that such reactant be used in a case in which a volatile organic compound scavenger is incorporated in, applied to, or sprayed over filaments of a surface layer facing the interior space of a car.

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 can capture volatile organic compounds (VOCs) including aldehydes such as formaldehyde and acetaldehyde, trichloroethylene, tetrachloroethylene, toluene, benzene, and xylene.

The automotive carpet of the present invention has excellent ability to capture volatile organic compounds (VOCs) such as aldehydes mainly generated from a felt layer and a sound absorbing layer that constitute a carpet base, and therefore it contributes to the improvement of the in-car environment. In addition, incorporation, application, or spraying of a volatile organic compound scavenger in a step of production of a felt layer or

a sound absorbing layer contributes to simplification of production steps, compared with a case in which a volatile organic compound scavenger is incorporated in, applied to, or sprayed over a produced felt layer or a sound absorbing layer.

In addition, application of the present invention to a carpet surface layer is also effective for capturing volatile organic compounds (VOCs) such as aldehydes generated from other parts used inside a car, in addition to volatile organic compounds (VOCs) such as aldehydes generated from a felt layer and a sound absorbing layer that constitute a carpet base.

Further, particularly when a silicon dioxide-aminosilane reactant with a mean particle size 1 to 200 nm is used as a volatile organic compound scavenger in the present invention, it has been confirmed that such volatile organic compound scavenger has a high degree of ability to capture volatile organic compounds (VOCs) such as aldehydes, and furthermore, it 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 the automotive carpet.

Fig. 2 shows the volumes of aldehydes removed by the different cut samples.

This description includes part or all of the contents as disclosed in the description and/or drawings of Japanese Patent Application Nos.

2008-005926 and 2008-009770, which are priority documents of the present application.

Best Mode for Carrying Out the Invention

Fig. 1 shows an example of the cross-sectional structure of the automotive carpet. However, the present invention is not limited to such structure. In general, the base of the automotive carpet has a felt layer and a sound absorbing (SA) layer mainly consisting of a felt material in such order from the bottom portion and it further has an air-imperious or poorly air-permeable resin layer composed of low density polyethylene (LDPE) and the like between the felt layer and the sound absorbing (SA) layer. A surface layer that constitutes the carpet is placed or immobilized on the upper portion of the base. Such surface layer is the one that is generally known to be used for a tufted carpet or a needle punched carpet used as automotive carpet. Note that the felt layer and the sound absorbing (SA) layer are produced by heating and pressurization of polyester fibers and the like with a roller. Therefore, volatile organic compounds (VOCs) such as aldehydes are generated due to deterioration or degeneration of polyester fibers and the like during the production steps.

A felt layer or a sound absorbing (SA) layer is allowed to contain a volatile organic compound scavenger. Accordingly, aldehydes generated from an automotive carpet are captured inside the automotive carpet before they can be diffused into the interior of a car from the automotive carpet. In addition, volatile organic compounds such as aldehydes generated from other parts located inside a car are efficiently captured by the surface layer.

Further, according to the present invention, diffusion of a volatile organic compound scavenger sublimated from the felt layer to the interior

space of a car can be prevented not only by capturing volatile organic compounds (VOCs) such as aldehydes with the use of a volatile organic compound scavenger but also by substantially covering the felt layer with an air-impervious or poorly air-permeable resin layer and a floor panel.

In the present invention, a wide range of known agents capable of capturing volatile organic compounds can be used. For instance, specific examples thereof include: 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; amino compounds such as melamine; amides such as barbituric acid and semicarbazide hydrochloride; and nitrogen-containing compounds such as amino acids (e.g., glutamate, glycine, and alanine), which have been known as formaldehyde-capturing agents.

In the present invention, a silicon dioxide-aminosilane reactant with a mean particle size of 1 to 200 nm is particularly preferably used as a volatile organic compound scavenger. Such silicon dioxide-aminosilane reactant has a slightly white and transparent appearance. In addition, it causes no oral toxicity or no skin irritation, and thus it is excellent in terms of safety.

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 (Nippon Chemical Co., Ltd.; KIRAKURU AL-00GT; solid content: 20%): 7.5 parts

Water: 42.5 parts

The above components were sufficiently agitated and mixed. The resultant was sprayed over the bottom surface of a felt layer with a thickness of 5 to 20 μm .

A base was obtained by introducing a resin layer composed of LDPE with a thickness of 1 to 2 mm between the felt layer and a sound absorbing (SA) layer composed of felt with a thickness of approximately 5 mm. A carpet surface layer was placed on the base. Then, a cut sample was obtained.

Similarly, a mixture of the volatile organic compound scavenger and natural rubber latex was directly applied to the surface of a sound absorbing (SA) layer composed of felt with a thickness of approximately 5 mm.

A base was obtained by introducing a resin layer comprising LDPE with a thickness of 1 to 2 mm between a felt layer with a thickness of 5 to 20 μm and the sound absorbing (SA) layer. A carpet surface layer was placed on the base. Then, a cut sample was obtained.

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 $\text{LD}_{50} > 200 \text{ mg/kg}$ and the skin irritation level corresponds to $\text{P.C.I.} = 0.00$.

As in the case of the above Example, a cut sample not containing a volatile organic compound scavenger was prepared. Specifically, a base was obtained by introducing a resin layer composed of LDPE with a thickness of 1 to 2 mm between a felt layer with a thickness of 5 to 20 μm and a sound absorbing (SA) layer composed of felt with a thickness of approximately 5 mm. A carpet surface layer was placed on the base. Then, a cut sample was obtained.

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 μL ; ODS column).

Fig. 2 shows the volumes of remained 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. In particular, it is understood that samples obtained by applying the volatile organic compound scavenger to the felt layer surface exhibit excellent aldehyde removal performance.

Industrial Applicability

According to the present invention, the presence of volatile organic compounds remaining inside cars can be efficiently reduced, and therefore environmental performance is improved.

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

CLAIMS

1. An automotive carpet comprising at least
a base composed of a felt layer and an air-impervious or poorly air-permeable resin layer placed or immobilized on the felt layer and
a surface layer placed or immobilized on the base,
wherein a volatile organic compound scavenger is incorporated in, applied to, or sprayed over the bottom surface of the felt layer constituting the base, and

the felt layer is substantially covered by the resin layer and a floor panel.
2. The automotive carpet according to claim 1, wherein the base further comprises a sound absorbing layer and the the air-impervious or poorly air-permeable resin layer is provided between the felt layer and the sound absorbing layer.
3. The automotive carpet according to claim 1 or 2, wherein the sound absorbing layer is composed of a material with a lower volatile organic compound content than that of the felt layer.
4. The automotive carpet according to any one of claims 1 to 3, wherein a volatile organic compound scavenger is incorporated in, applied to, or sprayed over the sound absorbing layer.
5. The automotive carpet according to any one of claims 1 to 4, wherein the volatile organic compound scavenger is a silicon dioxide-aminosilane reactant with a mean particle size of 1 to 200 nm.