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(54) Title: ELEMENT FOR SOUND INSULATION

(57) Abstract: The invention discloses an element for sound insulation which forms the external completion of a housing-like structure excited to oscillations, in which there is located at least one sound emitter, in which element is formed of a shaped thermoplastic material, which is reinforced by means of a glass fiber component of more than 35 weight percent.
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Element for sound insulation

The present invention relates to an element for sound insulation which forms the external completion of a housing-like structure excited to oscillations, in which at least one sound emitter is located. This element for sound insulation is suited for example in particular as underbody covering for motor vehicles, such as motor cars.

Underbody coverings for motor vehicles serve on the one hand for improving the aerodynamics of the underbody, and on the other hand for sound insulation or sound damping. This sound protection is of significance in particular in the case of diesel motors, since these give rise to strong motor noises, whereby in many cases maximum permissible noise emissions are exceeded.

From DE 199 20 969 A1 there is known a sound insulating component which inter alia is used as floor covering of the engine compartment or also as underbody covering for motor vehicles, and is of a punched or perforated plate, which serves as carrier for a porous cover layer. This cover layer may for example be a foamed plastic. Clearly, the acoustic effect of this component, in particular as underbody covering for motor vehicles, is however not sufficient, because the employment of additional porous cover layers is taught, which must be attached to the component on the inner side.

WO 04/089592 A2 describes a method for the production of a two-part roof covering for vehicles, which distinguishes itself through very good characteristics with regard to the damping of a head impact on the roof covering and through sound damping. The damping material may be glass fiber reinforced polypropylene. The roof covering is of a first part, which forms the side visible to the passenger compartment and a second part, towards
the roof, and serves for mechanical reinforcement. The two parts are formed in different tools and connected with one another in accordance with conventional processes, such as for example by means of the employment of hot melt adhesives. The roof covering is so attached to the bodywork roof that there arises a hollow chamber between the covering and the roof, through which the sound dampening is attained.

It is thus the object of the present invention to improve sound insulating elements in such a manner that they manifest an extraordinarily low deployment weight, are simple to produce and do not need additional airborne sound absorbing supplementary elements, wherein a highest level of airborne sound absorption is ensured.

This object is achieved with an element for sound insulation in accordance with claim 1.

The present invention relates to an element for sound insulation which forms the external completion of a housing-like structure excited to oscillations, in which at least one sound emitter is located, which is characterized in that it is of a shaped thermoplastic material, which is reinforced by means of a glass fiber component of more than 35 weight percent.

The dependent claims relate to preferred embodiments of the element for sound insulation in accordance with the invention.

The Figures serve for explanation of the invention. There is shown:

Fig. 1 a diagram for assessment of the airborne sound damping of a sound insulation element in accordance with the invention and a conventional element;
Fig. 2 an arrangement for measurement of airborne sound damping and

Fig. 3 a diagram for the assessment of the equivalent absorption area of an element in accordance with the invention in comparison with known sound insulation elements.

The element in accordance with the invention has a relatively high proportion of the glass fibers of more than 35 weight percent, whereby the glass fiber proportion may be up to 65 weight percent. As a rule, one employs relatively long cut glass fibers having a length of at least 1 cm, which are surrounded with a thermoplastic plastic material.

By means of the kind of interaction of the glass fibers with the thermoplastic material in the composite, one achieves a high flexural strength with a surprisingly low weight per unit area.

The thermoplastic material of the element for sound insulation in accordance with the invention is normally a polyolefin. In a preferred embodiment of the present invention the polyolefin is selected from the group polyethylene, polypropylene, derivates thereof and/or mixtures thereof, wherein a thermoplastic material of polypropylene is particularly preferred.

The element for sound insulation in accordance with the invention is in one part and is as such airborne sound absorbing without, as is usual in the state of the art, having to be provided with apertures. Surprisingly, the element for sound insulation is also airborne sound damping in such quality that it compensates for the degradation in the degree of sound damping resulting, theoretically, from the difference in weight per unit area referred to conventional sound insulation elements.
The element for sound insulation in accordance with the invention may be present preferably in the form of a plate or shell. For example, an airborne sound absorbing underbody covering is formed by in one piece of a uniform plate of the element for sound insulation in accordance with the invention to thicknesses between 5 and 10 mm. The moulding in the tool is effected under pressure and/or vacuum and heat in accordance with conventional processes in such a manner that on the one hand the structurally required shaping is produced and on the other hand by means of pressing to locally different thicknesses an optimal airborne sound absorption behaviour, adapted to the engine compartment noise, is attained.

In a further embodiment of the present invention, an increase of the values of the airborne sound absorption can be attained by means of lamination of conventionally available foils, in particular by means of foils having a weight per unit area in the range of 100 g/m² to 150 g/m².

In accordance with the invention it has been found that the element for sound insulation has extremely high flexural strength and thus allows a compression at the edges of up to about 2 mm, so that optimal prerequisites for installation at the housing-like structure are provided. Despite this slight thickness, the attachment holes do not tear.

As a rule, the housing-like structure is of a plastic or sheet metal. The minimum spacing of the element forming the external completion to the at least one sound emitter within the housing-like structure, and the maximum spacing, are normally predeterminded by the structure. In a preferred form of exercising the invention the sound emitter may be an engine.
In a particular embodiment of the present invention a plate-like element for sound insulation is formed to a moulded part and at least on one side, preferably on the outside, is provided with a foil lamination, expediently, for reasons of recycling, with a polyolefin non-woven material, in particular polypropylene non-woven material.

In a further particular embodiment of the present invention the element in accordance with the invention is employed as underbody covering for motor vehicles. The shell-like underbody covering formed of a plate has, due to its composite structure, airborne sound absorbing characteristics, whereby the conventionally usual supplementary absorbers on the inner side of the covering can be omitted. With differently strong compression, one can, in dependence upon the structural thicknesses which are permitted by the motor car manufacturer, produce a broadband - in terms of frequency - absorption characteristic.

Due to the airborne sound absorbing characteristics, the underbody covering brings about not only a reduction of the noise in the passenger compartment but also with regard to external noise. The high flexural strength, or the high modulus of elasticity, in the range between $0.8 \times 10^9$ and $2 \times 10^9$ N/m$^2$, allows a compression, brought about by pressing under heat, at the edge zones of up to about 2 mm through which optimal prerequisites for the attachment to the bodywork with only a few points are provided, so that also the holes needed for the attachment do not tear.

The element for sound insulation in accordance with the invention, in particular an underbody covering for example for motor vehicles, distinguishes itself through an extremely high flexural strength with a very slight weight per unit area and favourable airborne sound absorbing characteristics, whereby a supplementary
airborne sound absorber applied on the inside to the shaped part can be omitted.

Due to the two-sided absorption effect of the element for sound insulation in accordance with the invention the exterior noise, to the street side, and at engine compartment side is significantly reduced, whereby at the same time the noise in the passenger compartment is lowered. The reduced airborne sound damping to be expected, in comparison with conventional elements for sound insulation, due to the weight reduction, is compensated by means of the airborne sound absorbing characteristics of the element, without further measures.

In the following, an underbody covering in accordance with the invention is investigated with regard to its sound damping characteristics.

An underbody covering with locally different thicknesses between 6 and 10 mm was produced. The underbody covering is of glass fiber reinforced poly propylene with non-woven material covering to both sides. This underbody covering was compared in a test series for determination of the airborne sound damping, with a mass produced, conventional underbody covering. These measurements were effected in a modified sound damping test station which made possible measurements on original parts, which usually in terms of area are considerably smaller than required in accordance with DIN measurements. Such a device is illustrated in Fig. 2.

In order to simulate installation situations as realistically as possible, the test parts, as shown in Fig. 2, where mounted with 40 mm spacing before a steel sheet, which was fitted into a frame having very high sounds damping (mask). Through this it was attained that airborne sound generated in the transmission chamber can
arrive at the receiving chamber exclusively via the test surface.

The sound damping of an underbody covering in accordance with the invention and of a conventional underbody covering were measured in dB in dependence upon the third octave band middle frequency (Hz). The measurement values and the curves resulting therefrom are shown in Fig. 1. The conventional underbody covering “series”, characterized by curve 1, had a weight of 1170 g compared with a "light underbody covering" in accordance with the invention, designated by curve 2, having a part weight of 881 g. Theoretically, there results therefrom a deterioration of the degree of sound damping of 2.5 dB, whereby however the test results are virtually the same.

Comparative investigations for airborne sound absorption were carried out, wherein the so-called equivalent absorption area was measured in a so-called alpha cabin. This alpha cabin corresponds to a spatially reduced echo chamber and is suitable for measurements from 400 Hz. The measured equivalent absorption area is the (mathematical) product of test area x degree of absorption.

With this test, the following underbody coverings were tested. A light underbody covering A in accordance with the invention (polypropylene-glass fiber reinforced, absorbing on both sides with a mass of 645 g, a mixed fiber non-woven underbody covering B (absorbing on both sides with a mass of 1151 g), an underbody covering "series" C having airborne sound absorbing elements ("non-woven in foil", additional weight approximately 190 g) and an underbody covering "series" D having a weight of 1170 g.

In the test, the parts were mounted at a spacing of 20 cm from the floor in the alpha cabin in order to realistically simulate the installation situation in a
vehicle. The underside corresponds to the carriageway side to the floor.

The series produced parts in conventional configurations (see coverings B to D above), also with inlaid airborne sound absorbing supplementary elements, were compared with an underbody covering (see A) in accordance with the invention. In this respect attention is directed to Fig. 3. The result shows clearly better values for the underbody covering A in accordance with the invention, even in comparison with a conventional covering of mixed fiber non-woven material (B). This had a weight of 1151 g, compared with the light, underbody covering in accordance with the invention having a weight of only 645 g.
CLAIMS:

1. Element for sound insulation, which forms the external completion of a housing-like structure excited to oscillations, in which there is located at least one sound emitter characterized in that, it is formed of a shaped thermoplastic material which is reinforced by means of a glass fiber component of more than 35 weight percent.

2. Element according to claim 1, characterized in that, the glass fiber component is up to 65 weight percent.

3. Element according to claim 1 or 2, characterized in that, the thermoplastic material is selected from the group of polyolefins.

4. Element according to claim 3, characterized in that, the polyolefin is selected from the group: polyethylene, polypropylene, derivates thereof and/or mixtures thereof.

5. Element according to any of claims 1 to 4, characterized in that, it is one piece.

6. Element according to claim 5, characterized in that, the element is present in the form of a plate or shell.

7. Element according to claim 6, characterized in that,
on at least one side there is provided a foil lamination.

8. Element according to claim 7, characterized in that, the foil lamination is a polyolefin non-woven material.

9. Element according to any of claims 1 to 8, characterized in that, it has locally different thicknesses.

10. Element according to claim 8, characterized in that, it has a thickness in the range from 5 to 10 mm.

11. Element according to claim 10, characterized in that, the thickness to the edge reduces to ca. 2 mm.

12. Element according to any of claims 1 to 11, characterized in that, the housing-like structure is of a plastic or sheet metal.

13. Element according to any of claims 1 to 12 as underbody covering for motor vehicles.
Fig. 1

Sound damping (dB) vs. Third octave band middle frequency (Hz)
Fig. 2

"Receiver side"
Measurement of emitted sound power

Underbody covering (possibly with absorber)

Installation mask
Steel sheet 0.88 mm

"Transmission chamber" with airborne noise excitation
Fig. 3