ACOUSTIC ABSORBER AND METHOD OF MANUFACTURING THEREOF

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of priority to the Singapore application no. 10202302624R filed September 19, 2023, the contents of which are hereby incorporated by reference in their entirety for all purposes.

TECHNICAL FIELD

[0002] This application relates to the field of acoustics, and more particularly to an acoustic absorber and a method of manufacturing an acoustic absorber.

BACKGROUND

[0003] Various challenges are present in the field of noise isolation or noise shielding. Acoustic absorbers are often used in an enclosed space or in an open setting for the shielding of noise source or the mitigation of environmental noise. Conventional acoustic absorbers are typically effective in the higher frequency, for example above 1000 Hz, with the efficiency increasing with an increase in the frequency of the noise. However, some environmental or machine noise tends to be lower in frequency, for example below 1000 Hz or even below 500 Hz. Challenges remains in mitigating these lower frequency noise with current conventional solutions.

SUMMARY

[0004] According to an aspect, disclosed herein an acoustic absorber. The acoustic absorber, comprising: a barrier layer defining a first barrier surface and a second barrier surface opposing the first barrier surface, the first barrier surface and the second barrier

surface defining a thickness axis; a first foam layer attached to the first barrier surface, the first foam layer defining a first thickness along the thickness axis, wherein the first foam layer defines a receiving surface for facing towards a noise source; and a second foam layer attached to the second barrier surface, the second foam layer defining a second thickness along the thickness axis, wherein the barrier layer has a higher acoustic impedance than each of the first foam layer and second foam layer, wherein a thickness ratio of the second thickness relative to the first thickness is at least one.

[0005] According to another aspect, disclosed herein a method of manufacturing an acoustic absorber. The method comprising: providing a barrier layer defining a first barrier surface and a second barrier surface opposing the first barrier surface, the first barrier surface and the second barrier surface defining a thickness axis; attaching a first foam layer to the first barrier surface, the first foam layer defining a first thickness along the thickness axis, wherein the first foam layer defines a receiving surface for facing towards a noise source; and attaching a second foam layer to the second barrier surface, the second foam layer defining a second thickness along the thickness axis, wherein the barrier layer has a higher acoustic impedance than each of the first foam layer and second foam layer, wherein a thickness ratio of the second thickness relative to the first thickness is at least one.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Various embodiments of the present disclosure are described below with reference to the following drawings:

[0007] FIG. 1 is a schematic diagram of an acoustic absorber according to embodiments of the present disclosure;

[0008] FIG. 2 shows an `absorption performance of a two-foam layers structure;

[0009] FIG.3 shows an experimentally measured absorption performance of the acoustic absorber of FIG. 1;

[0010] FIG. 4 shows a perspective exploded view of an acoustic absorber according to various embodiments;

[0011] FIG. 5 shows a perspective exploded view of an acoustic absorber according to various embodiments;

[0012] FIG. 6 shows an exemplary barrier layer of an aluminium sheet backed with a polyethylene sheet (mA);

[0013] FIG. 7 shows an exemplary barrier layer of a micro-perforated aluminium sheet (pA)

[0014] FIG. 8 shows an exemplary barrier layer of various high-density polymeric sheets;

[0015] FIG. 9 shows an experimentally measured absorption performance of the acoustic absorber of FIG. 4;

[0016] FIG. 10 shows an experimentally measured absorption performance of the acoustic absorber of FIG. 5;

[0017] FIG. 11 shows a sectional side view of an acoustic absorber in a "forward one-third thickness" configuration according to various embodiments;

[0018] FIGs. 12 and 13 show respective absorption performances of the acoustic absorber of FIG. 11;

[0019] FIG. 14 shows a sectional side view of another acoustic absorber in a "forward two-third thickness" according to various embodiments;

[0020] FIGs. 15 and 16 show respective absorption performances of the acoustic absorber of FIG. 14;

[0021] FIG. 17 shows a sectional side view of another acoustic absorber in a "multi-barrier" configuration according to various embodiments;

[0022] FIGs. 18 and 19 show respective absorption performances of the acoustic absorber of FIG. 17;

[0023] FIG. 20 shows a sectional side view of another acoustic absorber in a "forward cover" configuration according to various embodiments;

[0024] FIGs. 21 to 23 show respective absorption performances of the acoustic absorber of FIG. 20;

[0025] FIG. 24 shows a sectional side view of another acoustic absorber in a “forward cover one-third thickness” configuration according to various embodiments;

[0026] FIGs. 25 and 26 show respective absorption performances of the acoustic absorber of FIG. 24; and

[0027] FIG. 27 is a schematic diagram illustrating a method of manufacturing an acoustic absorber according to various embodiments of the present disclosure.

DETAILED DESCRIPTION

[0028] The following detailed description is made with reference to the accompanying drawings, showing details and embodiments of the present disclosure for the purposes of illustration. Features that are described in the context of an embodiment may correspondingly be applicable to the same or similar features in the other embodiments, even if not explicitly described in these other embodiments. Additions and/or combinations and/or alternatives as described for a feature in the context of an embodiment may correspondingly be applicable to the same or similar feature in the other embodiments.

[0029] In the context of various embodiments, the articles “a”, “an” and “the” as used with regard to a feature or element include a reference to one or more of the features or elements.

[0030] In the context of various embodiments, the term “about” or “approximately” as applied to a numeric value encompasses the exact value and a reasonable variance as generally understood in the relevant technical field, e.g., within 10% of the specified value.

[0031] As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items.

[0032] The term “position” or “pose” may refer to a location and an orientation of an object, for example an acoustic absorber. The term “location” may refer to a coordinate (for example, X-coordinate, Y coordinate, Z coordinate) of an object or part of an object in a space or a frame. The term “orientation” may refer to a facing or angle (for example, a X-direction vector, a Y-direction vector, a Z-direction vector) of an object or part of an object in a space or a frame. Each of the terms “pose”, “position”, “location” and “orientation” may be defined by a coordinate system, such as a cartesian coordinate.

[0033] The term “layer” may generally refer to a continuous planar material or sheet material. The “layer” may be a generally homogenous layer. In some instances, the “layer” may include one or more homogeneous material layers in a stacked configuration. Multiple homogeneous material layers may be adhesively attached to form a layer.

[0034] The present disclosure is related to an acoustic absorber and a method of manufacturing an acoustic absorber. In addressing the various problems posed by existing solutions, where either low frequency noise absorption is inefficient or an increase in low frequency noise absorption is at the cost of higher frequencies, the proposed acoustic absorber lowers the frequency for effective noise absorption while maintaining the acoustic absorption at higher frequency range with minimal reduction in high frequency performance.

[0035] The acoustic absorber may be in a lightweight multilayer planar structure or a multilayer sheet. Due to its low weight, the acoustic absorber may be inserted into existing soft acoustic absorption blanket or acoustic absorption fabrics. In other instances, existing acoustic absorption blanket may be modified into the structure of the proposed acoustic absorber.

[0036] According to various embodiments, the proposed acoustic absorber comprises a multilayer structure, wherein a barrier layer is sandwiched between two foam layers. The barrier layer may be made of a higher acoustic impedance material in comparison to the foam layers. For example, the barrier may be a metallic sheet, or a rigid polymer sheet. The multilayered

structure with intermediate placement of thin metallic or polymeric sheet (barrier layer) may tune the noise absorption of the original foam layers for lower frequency while maintaining the noise absorption for the original polymeric foam for higher frequency.

[0037] Departing from conventional knowledge, it was found that an improvement in low frequency (<500Hz) sound absorption performance as well as a balance between low frequency and high frequency acoustic absorption performance may be achieved with the variation of a relative thickness of the two foam layers. In addition, a relative position between a thicker foam layer and a thinner foam layer also plays a part in improving the acoustic absorption performance. It was found that in the multilayer structure as described previously, a thinner foam layer facing a noise source and a thicker foam layer facing away from the noise source achieves a surprising technical effect of an improved acoustic absorption performance. According to various embodiments, it was also found that with the provision of an additional cover layer over the foam layer (facing the noise source) further improves the acoustic absorption performance.

[0038] FIG. 1 illustrates an acoustic absorber 100 according to various embodiments. The acoustic absorber 100 may define a front side 102 facing a noise source 80, and a rear side 104 facing away from the noise source 80. The acoustic absorber 100 may include a barrier layer 110 disposed between a first foam layer 120 and a second foam layer 130. The barrier layer 110 may be attached to each of the first foam layer 120 and the second foam layer 130. The barrier layer 110 may have a higher acoustic impedance in comparison to each of the first foam layer 120 and the second foam layer 130. In addition, the barrier layer 110 may have a higher acoustic impedance, stiffness and/or modulus of elasticity, in comparison to each of the first foam layer 120 and the second foam layer 130.

[0039] The barrier layer 110 may define a thickness axis 90 orthogonal or substantially orthogonal to the barrier layer. The first foam layer 120 may include a first thickness T1 along

the thickness axis 90. The first foam layer 120 may further define a receiving surface 122 for facing the noise source 80. Similarly, the second foam layer 130 may define a second thickness T2 along the thickness axis 80.

[0040] FIG. 2 shows an experimentally measured absorption performance of a two-foam layers structure (without incorporation of a barrier layer). FIG. 3 shows an experimentally measured absorption performance of the proposed acoustic absorber of FIG. 1. All measurements were performed with Impedance tube (B&K Type 4206 for all the acoustic barriers as described in the present disclosure. It may be seen from FIGs. 2 and 3 that sound absorption coefficient, and hence noise absorption performance, improves at the lower frequency (~500 Hz, dotted line) from 0.4 to 0.7 with the addition of the barrier layer. However, the improve at lower frequency comes at a cost of noise absorption performance at higher frequency (>1000Hz) from above 0.8 in FIG. 2 to below 0.8 in FIG. 3.

[0041] FIG. 4 illustrates another acoustic absorber 100 according to various embodiments of the present disclose. The acoustic absorber 100 may define a front side 102 facing a noise source 80, and a rear side 104 facing away from the noise source 80. The acoustic absorber 100 may include a barrier layer 110. The barrier layer 110 may define a first barrier surface 112 and a second barrier surface 114 opposing the first barrier surface 112. The first barrier surface 112 and the second barrier surface 114 may define a thickness axis 80.

[0042] A first foam layer 120 may be attached to the first barrier surface 112. In some embodiments, the first foam layer 120 may be adhesively attached to the first barrier surface 112 or attached via adhesive. The first foam layer 120 may define a first thickness T1 along the thickness axis 80. The first foam layer 120 may define a receiving surface 122 for facing towards the noise source 80.

[0043] A second foam layer 130 may be attached to the second barrier surface 114. In some embodiments, the second foam layer 130 may be adhesively attached to the second barrier

surface 114 or attached via adhesive. The second foam layer 130 may define a second thickness T2 along the thickness axis 80.

[0044] In various embodiments, a barrier thickness of the barrier layer 110 may be substantially thinner than the first thickness T1 and the second thickness T2. This enables the mass of the denser barrier layer 110 to be minimal, allowing the acoustic absorber 100 to be a light weight apparatus.

[0045] In various embodiments, the barrier layer 110 may have a higher acoustic impedance than each of the first foam layer 120 and second foam layer 130. In various embodiments, the barrier layer 110 may have a higher density, stiffness and/or modulus of elasticity, in comparison to each of the first foam layer 120 and the second foam layer 130.

[0046] In some embodiments, the barrier layer 110 may be an aluminium sheet backed with a polyethylene sheet (mA). In an example shown in FIG. 6, the aluminium sheet backed with a polyethylene sheet (mA) may have a weight of 0.385g for a 10 cm diameter circular sample. As examples, the first foam layer 120 and the second foam layer 130 may have a density in a range of 1.885g/mm^2 to 2.456g/mm^2.

[0047] In some embodiments as shown in FIG. 5, the barrier layer 110 may be a micro-perforated aluminium sheet (pA). In an example shown in FIG. 7, the micro-perforated aluminium sheet (pA) may have a weight of 2.462g for a 10 cm diameter circular sample. In addition, the micro-perforated aluminium sheet may include multiple 0.39 mm diameter perforations.

[0048] In some embodiments, the barrier layer 110 may be a high-density polymeric sheet (cover 1 and cover 2, see FIG. 10). In examples shown in FIG. 8, the high-density polymeric sheet may include: high-density polymeric sheet (cover 1) with a weight of 3.071g for a 10 cm diameter circular sample, and high-density polymeric sheet (cover 2) with a weight of 3.582g for a 10 cm diameter circular sample.

[0049] FIG. 9 shows an experimentally measured absorption performance of a barrier layer 110 of an aluminium sheet backed with a polyethylene sheet (mA) which is sandwiched between two foam layers (Basotect G+ foam). FIG. 10 shows an experimentally measured absorption performance of a barrier layer 110 of a micro-perforated aluminium sheet (pA) which is sandwiched between two foam layers (Basotect G+ foam). It may be seen that improvement to the lower frequency (~500Hz) may be achieved with the incorporation of the barrier layer 110 in comparison to FIG. 2. In addition, the use of the micro-perfroated aluminium sheet (FIG. 10) as the barrier layer 110 also improves the higher frequency (>1000Hz) performance in comparison to aluminium sheet backed with a polyethylene sheet (FIG. 9).

[0050] In various embodiments, a thickness ratio (T2/T1) of the second thickness T2 relative to the first thickness T1 may be equal to or approximately equal to one. In other words, the second foam layer 130 may be equal to or thicker than the first foam layer 120. In some embodiments, the second thickness T2 may equal to first thickness T1, such that the barrier layer 110 may be disposed at a mid-plane position in the acoustic absorber 100. The acoustic absorber 100 may be said to be in a “half thickness” configuration (e.g. FIGs. 4 and 5).

[0051] According to various embodiments, the thickness ratio (T2/T1) may be more than one. In other words, the provision of a thinner forward foam layer (first foam layer 120) and a thicker backward foam layer (second foam layer 130) sandwiching a barrier layer 110. In some exemplary embodiments, the thickness ratio (T2/T1) may be in a range of 1 to 5; 1 to 4; and 1 to 3. In some exemplary embodiments, the thickness ratio (T2/T1) may be in a range of 1.1 to 2.9; 1.2 to 2.8; 1.3 to 2.7; 1.4 to 2.6; 1.5 to 2.5; 1.6 to 2.4; 1.7 to 2.3; 1.8 to 2.3; 1.9 to 2.1.

[0052] According to various embodiments as shown in FIG. 11, the acoustic absorber 100 may define a front side 102 facing a noise source 80. The acoustic absorber 100 may include a barrier layer 110 defining a thickness axis 90. A first foam layer 120 and a second foam layer

130 may be disposed on opposing sides of and attached to the barrier layer 110. The first foam layer 120 may define a receiving surface 122 for facing towards the noise source 80. The first foam layer 120 may define a first thickness T1 along the thickness axis 90. The second foam layer 130 may define a second thickness T2 along the thickness axis 90. The second thickness T2 may be thicker than first thickness T1, such that the barrier layer 110 may be disposed away from a mid-plane 106 of the acoustic absorber 100. The mid-plane 106 may be define as a centre plane of the acoustic absorber 100 along the thickness axis 90. Therefore, the barrier layer 110 may be disposed ahead or in front of the mid-plane 106 facing the noise source 80. It was found that relative to the noise source 80, by attaching the barrier layer 110 between a thinner foam layer (first foam layer 120) facing the noise source 80 and a thicker foam layer (second foam layer 130) facing away from the noise source 90, provides an improved absorption performance at the low frequency region (< 500Hz).

[0053] In various embodiments, the thickness ratio (T2/T1) between the second foam layer 130 and the first foam layer 120 may be equal to 2 or approximately equal to 2. When the thickness ratio (T2/T1) is equal to 2, the acoustic absorber 100 may be said to be in a "forward one-third thickness" configuration, wherein the barrier layer 110 is at a forward one-third position along the thickness axis 90. In various embodiments, the second thickness T2 of the second foam layer 130 may be achieved by stacking two homogeneous foam layers each with thickness T1. In various embodiments, multiple homogeneous foam layers may be adhesively attached to form the second foam layer 130.

[0054] FIG. 12 shows an experimentally measured absorption performance of the "forward one-third thickness" configuration of FIG. 11 using high-density polymeric sheet (cover 1) as the barrier layer. Similarly, FIG. 13 shows an experimentally measured absorption performance of the "forward one-third thickness" configuration of FIG. 11 using high-density polymeric sheet (cover 2) as the barrier layer. It is evident that in comparison to FIG. 3 which is in the

“half thickness” configuration, a surprising technical effect of a significant improvement in sound absorption performance at the low frequency (< 500Hz) is achieved. This may be done by a change in relative thickness between the foam layers, significantly improving the low frequency (<500Hz) sound absorption. This may be seen in the shifting of peak of the sound absorption coefficient to a frequency of around 350Hz (as shown in FIGs. 12 and 13), which points to an increased ability (sound absorption coefficient at almost 0.9) to absorb low frequency noise below 500Hz.

[0055] It is worth noting that such improvement in sound absorption performance at the low frequency (< 500Hz) is not present when the barrier layer 110 is positioned behind the mid-plane 106 of the acoustic absorber 100, as shown in FIG. 14. FIG. 14 illustrates an acoustic absorber 100 wherein the first foam layer 120 is thicker than the second foam layer 130. The first thickness T1 may be double that of the second thickness T2, and hence the barrier layer 110 is at a forward two-third position along the thickness axis 90. In such configuration, the acoustic absorber 100 may be said to be in a “forward two-third thickness” configuration.

[0056] FIG. 15 shows an experimentally measured absorption performance of the “forward two-third thickness” configuration of FIG. 14 using high-density polymeric sheet (cover 1) as the barrier layer. Similarly, FIG. 16 shows an experimentally measured absorption performance of the “forward two-third thickness” configuration of FIG. 14 using high-density polymeric sheet (cover 2) as the barrier layer. It is evident that the sound absorption performance at low frequency (<500Hz) for the “forward two-third thickness” configuration is inferior in comparison to the “forward one-third thickness” configuration (FIGs. 12 and 13). This confirms the surprising technical benefit of the provision of a thinner forward foam layer and a thicker backward foam layer sandwiching a barrier layer, such as the “forward one-third thickness” configuration.

[0057] In various embodiments, the acoustic absorber 100 may include multiple barrier layers and corresponding foam layers forming a “multi-barrier” configuration. For example, the acoustic absorber 100 may include 10 foam layers and corresponding barrier layers disposed between each adjacent pair of foam layers.

[0058] FIG. 17 illustrates a “multi-barrier” configuration comprising three foam layers and two barrier layers. Similar to previous embodiments, the acoustic absorber 100 may define a front side 102 facing a noise source 80. The acoustic absorber 110 may include a barrier layer 110 may define a thickness axis 90. A first foam layer 120 and a second foam layer 130 may be disposed on opposing sides of and attached to the barrier layer 110. The acoustic absorber 100 may further include a second barrier layer 150 attached to the second foam layer 130, wherein the second barrier layer 150 and the barrier layer 110 are disposed on opposing sides of the second foam layer 130 along thickness axis 80. In addition, the acoustic absorber 100 may also include a third foam layer 160 attached to the second barrier layer 150. In various embodiments, each of the first foam layer 120, second foam layer 130 and third foam layer 160 may have equal thickness along the thickness axis 90.

[0059] FIG. 18 shows an experimentally measured absorption performance of the “multi-barrier” configuration of FIG. 17 using high-density polymeric sheet (cover 1 and cover 2) as the barrier layers. Similarly, FIG. 16 shows an experimentally measured absorption performance of the “multi-barrier” configuration of FIG. 17 using high-density polymeric sheet (cover 2 and cover 1) as the barrier layers. It was found that the sound absorption performance in low frequency (<500 Hz) for “multi-barrier” configuration is comparable to the “forward one-third thickness” configuration (FIGs. 12 and 13) despite the provision of an additional barrier layer 150. This again confirms the technical benefit of the provision of a thinner forward foam layer and a thicker backward foam layer sandwiching a barrier layer, such as the “forward one-third thickness” configuration.

[0060] In various embodiments, the acoustic absorber 100 may also include a cover layer disposed on the multilayer structure, the cover layer facing the noise source to form a “forward cover” configuration. As shown in FIG. 20, similar to previous embodiments, the acoustic absorber 100 may define a front side 102 facing a noise source 80. The acoustic absorber 110 may include a barrier layer 110 may define a thickness axis 90. A first foam layer 120 and a second foam layer 130 may be disposed on opposing sides of and attached to the barrier layer 110. In addition, the acoustic absorber 100 may also include a cover layer 140 attached to the first foam layer 120. A surface of the cover layer 140 may correspond to the front side 102. The cover layer 140 and the barrier layer 110 may be disposed on opposing sides of the first foam layer 120 along the thickness axis 90.

[0061] In various embodiments, the cover layer 140 and the barrier layer 120 may be made of same material, for example an aluminium sheet backed with a polyethylene sheet (mA) or a micro-perforated aluminium sheet (pA). In other embodiments,

[0062] In various embodiments, the cover layer 140 and the barrier layer 120 may be made of different material. For example, the cover layer 140 may be made of an aluminium sheet backed with a polyethylene sheet (mA) and the barrier layer 120 may be made of a micro-perforated aluminium sheet (pA), or vice versa.

[0063] FIG. 21 shows an experimentally measured absorption performance of the “forward cover” configuration of FIG. 20 using micro-perforated aluminium sheet (pA) as both the barrier layer and cover layer. Similarly, FIG. 22 shows an experimentally measured absorption performance of the “forward cover” configuration of FIG. 20 using aluminium sheet backed with a polyethylene sheet (mA) as both the barrier layer and cover layer. In addition, FIG. 23 shows an experimentally measured absorption performance of the “forward cover” configuration of FIG. 20 using micro-perforated aluminium sheet (pA) as the cover layer and aluminium sheet backed with a polyethylene sheet (mA) as the barrier layer.

[0064] It was found that for the “forward cover” configuration, the lower frequency (~500Hz) performance is significantly improved with the sound absorption coefficient reaching almost 1 as shown in FIGs. 22 and 23. In addition, higher frequency (>1000Hz) performance was also maintained with sound absorption coefficient above 0.8. However, the low frequency (<500Hz) performance was not comparable to the “forward one-third thickness” configuration (FIGs. 12 and 13).

[0065] In various embodiments, a cover member was provided to the “forward one-third thickness” configuration to obtain a “forward cover one-third thickness” configuration. As shown in FIG. 24, in the “forward cover one-third thickness” configuration, the acoustic absorber 100 may define a front side 102 facing a noise source 80. The acoustic absorber 100 may include a barrier layer 110 defining a thickness axis 90. A first foam layer 120 and a second foam layer 130 may be disposed on opposing sides of and attached to the barrier layer 110. The first foam layer 120 may define a first thickness T1 along the thickness axis 90. The second foam layer 130 may define a second thickness T2 along the thickness axis 90. The thickness ratio (T2/T1) between the second foam layer 130 and the first foam layer 120 may be equal to 2 or approximately equal to 2. Hence, the barrier layer 110 may be disposed away from a mid-plane 106 of the acoustic absorber 100. The second thickness T2 of the second foam layer 130 may be achieved by stacking two homogeneous foam layers each with thickness T1. In various embodiments, multiple homogeneous foam layers may be adhesively attached to form the second foam layer 130.

[0066] In various embodiments, the acoustic absorber 100 may further include a cover layer 140 attached to the first foam layer 120. The cover layer 140 and the barrier layer 110 may be disposed on opposing sides of the first foam layer 120 along the thickness axis 90. A surface of the cover layer 140 may correspond to the front side 102.

[0067] In various embodiments, the cover layer 140 and the barrier layer 120 may be made of same material, for example an aluminium sheet backed with a polyethylene sheet (mA) or a micro-perforated aluminium sheet (pA).

[0068] In various embodiments, the cover layer 140 and the barrier layer 120 may be made of different material. For example, the cover layer 140 may be made of an aluminium sheet backed with a polyethylene sheet (mA) and the barrier layer 120 may be made of a micro-perforated aluminium sheet (pA), or vice versa.

[0069] FIG. 25 shows an experimentally measured absorption performance of the "forward cover one-third thickness" configuration of FIG. 24 using micro-perforated aluminium sheet (pA) as both the barrier layer and cover layer. Similarly, FIG. 26 shows an experimentally measured absorption performance of the "forward cover one-third thickness" configuration of FIG. 24 using aluminium sheet backed with a polyethylene sheet (mA) as both the barrier layer and cover layer.

[0070] It was found that the low frequency (<500Hz) performance for the "forward cover one-third thickness" configuration is an improvement in comparison to the "forward cover" configuration, the middle frequency (between 500Hz to 1000Hz) performance includes a peak at 0.9, and the higher frequency (>1000Hz) performance is an improvement in comparison to the "forward one-third thickness" configuration.

[0071] According to another aspect of the disclosure, a method 700 of manufacturing an acoustic absorber is presented according to various embodiments. Referring to FIG. 27, the method 700 may include in 710, providing a barrier layer defining a first barrier surface and a second barrier surface opposing the first barrier surface, the first barrier surface and the second barrier surface defining a thickness axis; in 720, attaching a first foam layer to the first barrier surface, the first foam layer defining a first thickness along the thickness axis, wherein the first foam layer defines a receiving surface for facing towards a noise source; and in 730, attaching

a second foam layer to the second barrier surface, the second foam layer defining a second thickness along the thickness axis. The barrier layer may have a higher acoustic impedance than each of the first foam layer and second foam layer, and a thickness ratio of the second thickness relative to the first thickness may be at least one.

[0072] In various embodiments, the method 700 may also include, in 740, attaching a cover layer to the first foam layer, the cover layer and the barrier layer disposed on opposing sides of the first foam layer along the thickness axis. Further, the method may also include, in 750, attaching a second barrier layer to the second foam layer, wherein the second barrier layer and the barrier layer disposed on opposing sides of the second foam layer along thickness axis; and attaching a third foam layer to the second barrier layer.

[0073] In various embodiments, an existing foam layer of an acoustic absorbance panel/barrier may be split or cut into two to form the first foam layer and the second foam layer. These may be followed by the method of manufacturing as described above to obtain the proposed acoustic absorber.

[0074] All examples described herein, whether of methods, materials, or products, are presented for the purpose of illustration and to aid understanding and are not intended to be limiting or exhaustive. Modifications may be made by one of ordinary skill in the art without departing from the scope of the invention as claimed.

CLAIMS

1. An acoustic absorber, comprising:

a barrier layer defining a first barrier surface and a second barrier surface opposing the first barrier surface, the first barrier surface and the second barrier surface defining a thickness axis;

a first foam layer attached to the first barrier surface, the first foam layer defining a first thickness along the thickness axis, wherein the first foam layer defines a receiving surface for facing towards a noise source; and

a second foam layer attached to the second barrier surface, the second foam layer defining a second thickness along the thickness axis,

wherein the barrier layer has a higher acoustic impedance than each of the first foam layer and second foam layer,

wherein a thickness ratio of the second thickness relative to the first thickness is at least one.

2. The acoustic absorber as recited in claim 1, wherein the barrier layer is a high-density polymeric sheet.

3. The acoustic absorber as recited in claim 1, wherein the barrier layer is an aluminium sheet backed with a polyethylene sheet.

4. The acoustic absorber as recited in claim 1, wherein the barrier layer is a micro-perforated aluminium sheet.

5. The acoustic absorber as recited in any of the above claims, wherein at least one of the first foam layer and the second foam layer, has a density in a range of 1.885g/mm^2 to 2.456g/mm^2.

6. The acoustic absorber as recited in any of the above claims, wherein the first foam layer is adhesively attached to the barrier layer, and the second foam layer is adhesively attached to the barrier layer.

7. The acoustic absorber as recited in any one of claims 1 to 6, wherein the thickness ratio is in a range from 1.9 to 2.1.

8. The acoustic absorber as recited in claim 7, further comprising: a cover layer attached to the first foam layer, the cover layer and the barrier layer disposed on opposing sides of the first foam layer along the thickness axis.

9. The acoustic absorber as recited in any one of claims 1 to 6, further comprising: a cover layer attached to the first foam layer, the cover layer and the barrier layer disposed on opposing sides of the first foam layer the thickness axis.

10. The acoustic absorber as recited in any one of claims 7 to 9, wherein the cover layer and the barrier layer are made of same material.

11. The acoustic absorber as recited in any one of claims 7 to 9, wherein the cover layer and the barrier layer are made of different material.

12. The acoustic absorber as recited in any one of claims 1 to 6, further comprising: a second barrier layer attached to the second foam layer, wherein the second barrier layer and the barrier layer disposed on opposing sides of the second foam layer along thickness axis; and a third foam layer attached to the second barrier layer.

13. The acoustic absorber as recited in claim 12, wherein each of the first foam layer, second foam layer and third foam layer has equal thickness.

14. A method of manufacturing an acoustic absorber, the method comprising:

providing a barrier layer defining a first barrier surface and a second barrier surface opposing the first barrier surface, the first barrier surface and the second barrier surface defining a thickness axis;

attaching a first foam layer to the first barrier surface, the first foam layer defining a first thickness along the thickness axis, wherein the first foam layer defines a receiving surface for facing towards a noise source; and

attaching a second foam layer to the second barrier surface, the second foam layer defining a second thickness along the thickness axis,

wherein the barrier layer has a higher acoustic impedance than each of the first foam layer and second foam layer,

wherein a thickness ratio of the second thickness relative to the first thickness is at least one.

15. The method as recited in claim 14, wherein the thickness ratio is in a range from 1.9 to 2.1.

16. The method as recited in claim 15, further comprising attaching a cover layer to the first foam layer, the cover layer and the barrier layer disposed on opposing sides of the first foam layer along the thickness axis.

17. The method as recited in claim 14, further comprising attaching a cover layer to the first foam layer, the cover layer and the barrier layer disposed on opposing sides of the first foam layer along the thickness axis.

18. The method as recited in claim 14, further comprising: attaching a second barrier layer to the second foam layer, wherein the second barrier layer and the barrier layer disposed on opposing sides of the second foam layer along thickness axis; and attaching a third foam layer to the second barrier layer.

19. The method as recited in claim 18, wherein each of the first foam layer, second foam layer and third foam layer has equal thickness.

20. The method as recited in any one of claims 14 to 19, wherein the first foam layer is adhesively attached to the barrier layer, and the second foam layer is adhesively attached to the barrier layer.