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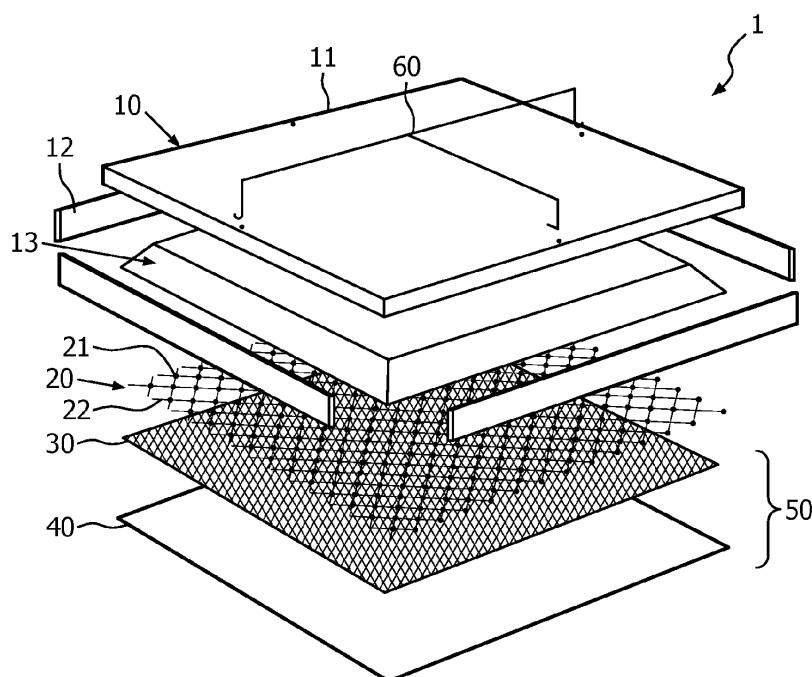
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(72) Inventor: **The designation of the inventor has not yet been filed**

(54) **Acoustical lighting assembly**

(57) The invention relates to an acoustic lighting assembly comprising:  
- a substrate (10) having acoustically absorbing properties and an open cavity (14) having sides surfaces (15, 16) and an opening, the open cavity (14) being provided with optically reflective properties;  
- solid state lighting-based components (21) and circuitry

(22) located in the cavity (14);  
- a rigid cover (50, 50') of the open cavity (14), the cover (50, 50') being transparent to at least one range of wavelengths emitted by the solid state lighting-based components (21) and arranged to be acoustically non-reflective.  
The invention further proposes a method of manufacturing said acoustic lighting assembly.



**FIG. 1**

## Description

### FIELD OF THE INVENTION

**[0001]** The present invention relates to an acoustic lighting assembly, which comprises both sound-absorbing and lighting functionalities. Such acoustic lighting assemblies may be used as a panel in a modular panel system such as a suspended ceilings.

### BACKGROUND OF THE INVENTION

**[0002]** In construction, such acoustic lighting assemblies (or modular panel systems) are commonly used to reduce build cost and construction time. Modular panel systems typically allow for the rapid construction of floors, walls and ceilings, albeit often at the compromise of reduced aesthetic appearance. A prime example of such a modular panel system is a suspended ceiling, which can be found in most professional environments, such as for example office spaces. A suspended ceiling typically comprises a metal or plastic grid defining rectangular or square recesses, which are filled with tiles to form a continuous ceiling.

**[0003]** In such modular systems, e.g. a suspended ceiling, lighting may be integrated into the system, typically by replacing one or more tiles with a lighting unit such as a luminaire. Most suspended ceilings comprise luminaires in which a number of fluorescent light tubes are present. For a number of reasons, such luminaires are not ideal, need additional installation efforts and are considered aesthetically displeasing, i.e. obtrusive.

**[0004]** Now, known solutions consist in integrating lighting functionalities in acoustic tiles to solve these problems, such as the ceiling tile disclosed in US7766511 which comprises a frame having a honeycomb structure to absorb the sound and a hollow central portion provided with LED-based components. Top and bottom skin layers are further used on each side of the hollow central portion to support and cool the LED-based components on one hand and to define a light-exit window on the other hand. These acoustic lighting tiles are usually made for a limited number of LEDs.

### SUMMARY OF THE INVENTION

**[0005]** An object of the invention is to provide an acoustic lighting assembly capable of containing a large number of light sources, while being aesthetically pleasing.

**[0006]** Another object of the invention is to provide such an acoustic lighting assembly with a limited thickness, so as to be an acoustic lighting tile to be included in a ceiling, wall or floor system.

**[0007]** Another object of the invention is to manufacture cost-efficiently such an acoustic lighting assembly.

**[0008]** The invention proposes, according to a first aspect, to solve said problem and reach said objects by

providing an acoustic lighting assembly according to claim 1.

**[0009]** "Acoustically non-reflective", as mentioned in claim 1, means a property of the cover which is essentially acoustically non-reflective, meaning that 60%, 70% or 80% or greater of the sound is not-reflected by the cover - it is absorbed by and/or transmitted through the cover - for the sounds commonly found in buildings: i.e. sounds below 4 kHz, and especially speaking range typically extending between 1kHz and 2 kHz.

**[0010]** This assembly allows the full integration of the lighting components within the acoustic substrate, in a non-cumbersome manner.

**[0011]** Moreover, this full integration permits to properly close the open cavity with a cover enhancing the pleasant aspect of the assembly by an external viewer, while not preventing sound-absorption and light emission.

**[0012]** Indeed, (semi-)transparent and acoustic properties of the cover facilitate both the sound absorption and do not prevent light extraction.

**[0013]** Furthermore, rigidity of the cover allows the cover not being deformed by its own weight and/or by the weight of the solid state-based components and circuitry which may be borne by it. This rigidity is particularly advantageous for large-size cover provided over or across a large open cavity (i.e. open cavity having a large opening surface area). Such a large open cavity is especially needed if a significant number of solid state-based components have to be provided in the open cavity to improve or increase the illumination.

**[0014]** Rigidity of the cover further allows its use as a substrate for the solid state lighting-based components and circuitry, which might be advantageous for the manufacturing. Moreover, this construction creates an air gap between the solid state lighting-based components and circuitry on one hand and the inner surfaces of the open cavity on the other hand, which may facilitate a cooling of these solid state lighting-based components and circuitry.

**[0015]** Rigidity of the cover is also useful for installation of the assembly and for removal of the assemblies during lifetime for access to space above ceiling (handling and installation).

**[0016]** Furthermore, if the open cavity is large, more sound can go through (and be absorbed thereafter at the back and/or side of the open cavity by acoustic elements), and the sound permeability of and/or sound absorption by the cover may have an impact on the sound isolation.

**[0017]** Especially for such large-scale open cavity (typically needed if a significant number of solid state lighting-based components is provided within), inventors found that the light and acoustic performances of the assembly are improved by providing a cover with sound-permeability and/or sound-absorbing properties and mechanical rigidity, while still allowing light transmission.

**[0018]** Optionally, the assembly is according to claim 2.

**[0019]** This feature allows the cover to be fully integrat-

ed in the open cavity, and particularly to have the cover external surface (i.e. the surface opposite to the open cavity) extending in continuation with the surface of the substrate extending around the opening of the cavity, i.e. without any steps between these two surfaces.

**[0020]** Aesthetical aspect of the assembly by an external viewer is therefore improved.

**[0021]** Optionally, the assembly is according to claim 3.

**[0022]** This feature allows the cover to be fully integrated in the open cavity, and particularly to have the cover external surface (i.e. the surface opposite to the open cavity) extending over a plane parallel to the surface of the substrate extending around the opening of the cavity. In particular, at least a part of the cover may extend onto latter surface of the substrate, hiding accordingly this surface.

**[0023]** Aesthetical aspect of the assembly by an external viewer is therefore improved.

**[0024]** Optionally, the assembly is according to claim 4.

**[0025]** Spreading these through holes over the surface of the cover optimizes the sound permeability of the cover.

**[0026]** Moreover, the rigidity of this member allows its use as a substrate for the solid state lighting-based components and circuitry as aforementioned.

**[0027]** Optionally, the assembly is according to claim 5.

**[0028]** This structure allows to provide a determined and constant pitch between the through holes, homogenizing the sound permeability of the cover.

**[0029]** Optionally, the assembly is according to claim 6.

**[0030]** This corrugated structure has a "waves" design, which gives a good stiffness to mass ratio and can be used as a very cheap and light weight construction.

**[0031]** Optionally, the assembly is according to claim 7.

**[0032]** This assembly is particularly advantageous since it is simple and does not necessarily involve use of tools. E.g. gluing may be sufficient. Moreover this assembly allows the cover to be fully integrated with the substrate, giving a nice and smooth design of the overall assembly which might be the design of a conventional acoustic tile. This might be particularly useful if the assembly has to be part of a system (e.g. a ceiling system) comprising a plurality of tiles having each one standardized dimensions.

**[0033]** Optionally, the assembly is according to claim 8.

**[0034]** The superficial smoothness of the cover improves the aesthetical pleasant aspect of the assembly and its integration in an environment (e.g. a ceiling system as aforementioned).

**[0035]** Optionally, the assembly is according to claim 9.

**[0036]** The superficial smoothness of the sheet improves the aesthetical pleasant aspect of the assembly and its integration in an environment (e.g. a ceiling system as aforementioned). Moreover the sheet could more or less hide the rigid member (which may not have an aesthetical nice aspect due to its through holes) for an external viewer.

**[0037]** Moreover, the small thickness of the sheet does

not hamper sound absorption since it allows most of the sound to go through it.

**[0038]** The rigid member is used here as a substrate to the sheet, rigidifying the latter.

5 **[0039]** Without the rigid member, the sheet would have been deformed and would have brought some mechanical weaknesses to the assembly, especially if those sheet would have been extended over a large surface -this is typically the case if the open cavity is large.

10 **[0040]** Optionally, the assembly is according to claim 10.

**[0041]** Said hiding function of the cover and cavity by the sheet is therefore improved by these optical properties.

15 **[0042]** Alternatively, the sheet may be arranged to become transparent only when the solid state lighting-based components emit light, e.g. by using phase-changing or state-changing materials whereby light transmission in the material is changing with the phase or with the internal or structural state of the material, and which phase or state is changing when the material is exposed to a temperature or a light above a determined temperature or light threshold.

20 **[0043]** Optionally, the assembly is according to claim 11.

**[0044]** Acoustic properties of the cover is therefore improved.

**[0045]** Optionally, the assembly is according to claim 12.

30 **[0046]** Providing this acoustic property in the whole substrate optimizes sound absorption, especially when the sound goes through the open cavity. This improved acoustic property is all the more important than the open cavity is large - and therefore a large part of the substrate is provided with a hole (cavity) which would decrease the acoustic properties of the assembly if the other parts are not acoustically improved according to this option of the invention.

35 **[0047]** Optionally, the assembly is according to claim 13.

40 **[0048]** Providing this acoustic property at the back side of the open cavity optimizes sound absorption, especially when the absorption of the sound goes through the open cavity to its back side. This improved acoustic property is all the more important than the open cavity is large - indeed the back side is larger accordingly and the rate of the sound absorbing by the back side over the overall sound going through the cavity, or over the overall sound absorbed by the substrate, is accordingly greater.

45 **[0049]** Optionally, the assembly is according to claim 14.

50 **[0050]** As aforementioned, the non-contact of the solid state lighting-based components with the surfaces of the cavity allows alternative heat dissipative mechanism of these components to the typical heat dissipation directly performed at the back part of such kind of assembly, the back part being thermally conductive in such a typical heat dissipation. For example, heat can be at least par-

tially dissipated in the air of the cavity (i.e. the air gap separating the solid state lighting-based components from the surfaces of the open cavity), via the circuitry.

[0051] Furthermore, this alternative heat dissipation allows to provide the substrate not necessarily with thermally conductive materials and/or thermal configuration, giving more opportunities for other materials and configurations for the substrate. In this kind of assembly, and as aforementioned, it can be advantageous to provide the back side of the substrate (which closes the open cavity at the opposite of the opening of the latter) with sound-absorbing properties, by providing it with a sound-absorbing material and/or sound absorbing configuration. This feature may therefore allow better acoustical properties of the assembly, all the more important than the open cavity is large as aforementioned.

[0052] Optionally, the assembly is according to claim 15.

[0053] This feature allows to ease the manufacturing of the assembly and to separate the solid state lighting-based components and circuitry from the substrate (as aforementioned).

[0054] Moreover, the cover is further used as a substrate of the lighting components, which may facilitate the final assembly.

[0055] According to a second aspect, the invention proposes to solve said problem and reach said objects by providing a method of manufacturing an acoustic lighting assembly, according to claim 16.

[0056] This method of manufacturing necessitates only one major step of fixation, which should limit significantly the costs of fabrication.

[0057] Moreover, the cover and the solid state lighting-based components can be assembled separately from the substrate, which could be convenient in the manufacturing process and reduce costs. In particular, the solid state lighting-based components and circuitry can be positioned accurately on the cover before the fixation with the substrate, which may increase the reliability and ease of the assembly.

[0058] Optionally, the method is according to claim 17.

[0059] The open cavity can be made from panels (e.g. five panels: one for the back side and four for the sides, to have an open cavity having a rectangular cross-section area) which can be cost-effective.

[0060] Alternatively, the open cavity may be made in a thick acoustic panel, by material removal (e.g. mechanical machining or milling), and/or by shaping methods (e.g. pressing locally at the open cavity position to form letter, moulding, forming).

[0061] Optionally, the method is according to claim 18.

[0062] This step of fixing the sheet may be implemented before or after step (d). It might be advantageous to implement this step after step (d) - i.e. to finish the assembly by the fixation of this sheet - in order to prevent the sheet from damages during previous steps and manipulations of the assembly.

[0063] Optionally, the method is according to claim 19.

[0064] According to a third aspect, the invention proposes to solve said problem and reach said objects by providing another acoustic lighting assembly comprising:

- 5 - an acoustically absorbing substrate comprising an open cavity bounded by a bottom acoustically absorbing wall and by sides, the open cavity being provided with optically reflective properties;
- 10 - solid state lighting-based components and circuitry positioned in the cavity;
- a cover of the open cavity, the cover being transparent to at least one range of wavelengths emitted by the solid state lighting-based components.

15 [0065] Providing this acoustic property to the whole substrate optimizes sound absorption, especially the sound going through the open cavity. This improved acoustic property is all the more important than the open cavity is large - indeed, in such a case, a large part of the substrate is provided with a hole (i.e. the open cavity) which would decrease the acoustic properties of the assembly if the other parts of the substrate would not have been acoustically improved according to this third embodiment of the invention.

20 [0066] Especially, providing this acoustic property to the back side of the open cavity optimizes sound absorption, in particular the absorption of the sound going through the open cavity to this back side. This improved acoustic property is all the more important than the open cavity is large - indeed the back side is larger accordingly and the rate of sound absorption by the back side over the overall sound absorbed by the substrate is accordingly greater.

25 [0067] Optionally said sides are acoustically absorbing, which improves acoustic properties of the assembly.

30 [0068] Optionally, the cover is a rigid cover, arranged to be acoustically non-reflective, and especially may be arranged to leave at least a part of the sound passing there through.

35 [0069] Optionally and alternatively, the cover is a sheet or exit window extending over the opening of the open cavity.

40 [0070] Claims 1-12 and claims 13-15 are applicable to this other acoustic lighting assembly, as options, and the aforementioned corresponding advantages can also be found for this other acoustic lighting assembly.

45 [0071] According to a fourth aspect, the invention proposes to solve said problem and reach said objects by proposing another method of manufacturing another acoustic lighting assembly comprising:

- 50 (a) providing an acoustically absorbing substrate comprising an open cavity limiting by a bottom acoustically absorbing wall and by acoustically absorbing sides, the open cavity being provided with optically reflective properties;
- 55 (b) providing a cover transparent to at least one

range of wavelengths emitted by solid state lighting-based components;  
 (c) positioning solid state lighting-based components and circuitry on the cover;  
 (d) fixing the cover to the substrate such that the cover closes the open cavity with the solid state lighting-based components and circuitry located in the open cavity.

**[0072]** Optionally, the cover is a rigid member arranged to leave the sound going there through.

**[0073]** Claims 16-19 are applicable to this other method, as options, and the aforementioned corresponding advantages can also be found for this other method.

**[0074]** According to a fifth aspect, the invention proposes to solve said problem and reach said objects by providing a third acoustic lighting assembly comprising:

- a substrate having acoustically absorbing properties and an open cavity having side surfaces and an opening, the open cavity being provided with optically reflective properties;
- solid state lighting-based components and circuitry located in the cavity;
- a cover of the open cavity, the cover being transparent to at least one range of wavelengths emitted by the solid state lighting-based components;

wherein the cover supports the solid state lighting-based components and circuitry.

**[0075]** Claims 1-15 are applicable to this third acoustic lighting assembly, as options, and the aforementioned corresponding advantages can also be found for this third acoustic lighting assembly.

**[0076]** According to a sixth aspect, the invention proposes to solve said problem and reach said objects by providing a fourth acoustic lighting assembly comprising:

- a substrate having acoustically absorbing properties and an open cavity having side surfaces and an opening, the open cavity being provided with optically reflective properties;
- solid state lighting-based components and circuitry located in the cavity;
- a cover of the open cavity, the cover being transparent to at least one range of wavelengths emitted by the solid state lighting-based components;

wherein the cover comprises a rigid member which comprises a corrugated structure and/or a honeycomb structure.

**[0077]** Claims 1-15 are applicable to this fourth acoustic lighting assembly, as options, and the aforementioned corresponding advantages can also be found for this fourth acoustic lighting assembly.

## BRIEF DESCRIPTION OF THE FIGURES

**[0078]** Other features and advantages of the invention appear from the following detailed description of one of its embodiments, given by way of non-limiting example, and with reference to the following drawings:

FIG. 1 shows an exploded perspective top view of a lighting acoustic assembly according to the invention.

FIG. 2 shows a perspective bottom view of a part of the lighting acoustic assembly of FIG. 1.

FIG. 3 shows a transversal cross-section view of the lighting acoustic assembly of FIG. 1.

FIG. 4 shows a transversal cross-section view of another lighting acoustic assembly according to the invention.

FIG. 5 shows an exploded perspective top view of another lighting acoustic assembly according to the invention.

FIG. 6 shows a perspective top view of a part of the lighting acoustic assembly of FIG. 5.

## DETAILED DESCRIPTION OF THE INVENTION

**[0079]** FIG. 1, FIG. 2 and FIG. 3 depict an example of a lighting acoustic assembly 1 according to the invention.

**[0080]** This assembly 1 comprises:

- a substrate 10 having acoustic properties and reflective optical properties, the substrate 10 exhibiting an open cavity 14;
- LED-based components 21 and circuitry 22 positioned in the cavity 14;
- a rigid cover 50, transparent to at least one range of wavelengths emitted by the LED-based components 11 and arranged for being acoustically non-reflective;
- electrical connection (e.g. electrical wires and/or connectors) 60 to power supply and optionally drive the LED-based components 11, via the circuitry 22, from a power supply and optional drivers or controllers (not shown).

**[0081]** Thus, the light emitted by the LED-based components 11 is extracted from the assembly 1 through the cover 50 and the sound (generated in the environment of the assembly) can go through the cover 50 and the cavity 14 and be absorbed by the substrate 10.

**[0082]** The substrate 10 comprises, in this example, a back element 11 and side elements 12. One, several or all of these elements 11, 12 have acoustic properties, i.e. are made of a material and/or are configured to absorb sounds.

**[0083]** The back element 11 may be made from an acoustic tile, commonly known in the market, e.g. made of mineral filbers or glass wool.

**[0084]** The side elements 12 may be made from an

acoustic material, such as mineral filbers, glass wool,

**[0085]** Alternatively, each one of some of the side elements 12 may be made of strips of metal sheet (which gives better stiffness and small width to the assembly 1) and/or may comprise honeycomb structure.

**[0086]** Side elements 12 can be fixed to the back element 11 by any means of fixation, e.g. screwing, gluing, clamping, or a combination thereof.

**[0087]** Once side elements 12 are fixed to the back element 11, the cavity 14 is then defined by the inner surfaces 15, 16 and 17 of these elements 11, 12.

**[0088]** Alternatively, and as depicted in FIG. 4, this cavity 14 may be integrally made from a block of acoustically absorbing material by techniques and methods of material removal (e.g. mechanical machining or milling) and/or shaping methods (e.g. pressing locally at the open cavity position to form letter, moulding, forming). The resulting part of the block being the substrate 10.

**[0089]** Advantageously, the substrate 10 further comprises optically reflective properties provided within or on faces of the cavity 14, so as to reflect some light resulting from the emission of the LED-based components 21.

**[0090]** These optical properties may be provided at the inner surfaces 15, 16, 17 of the cavity 14, as depicted in FIG. 4.

**[0091]** These reflective properties may be obtained by using a reflective bulk material for the back element 11 and/or side elements 12.

**[0092]** Alternatively or in combination, these optically reflective properties may be obtained by providing optically reflective material on inner surfaces 15, 16 and/or 17 of the cavity 14, e.g. by coating with a reflective paint and/or by providing a reflective element 13 (e.g. a reflective foil or a more rigid reflective element). This reflective element 13 may be flat or corrugated (like the reflective element shown in FIG. 5 and 6) or have any other shape.

**[0093]** As depicted by FIG. 1, 2 and 3, the reflective element 13 may be shaped in order to influence, together with the optical properties of the cover 50, the shape and homogeneity of the light output and therefore to lead to a specific illumination effect after light reflection. In this specific example, the reflective element 13 is tapered so as illuminate homogeneously a large area.

**[0094]** The material used for the optically reflective surface may be a diffusing reflective white material in order to have a better light homogeneity, or any other reflective material.

**[0095]** Each LED-based component 21 comprises at least one LED and optionally a primary optics and optionally a secondary optics. Optionally each LED-based component 21 may further comprise a own circuitry and/or own electronic components.

**[0096]** In case the LED-based components 21 emit light to a preferred direction, the LED-based components 21 can be positioned in the cavity 14 such that this direction points either towards the cavity 14 or outwards the cavity 14. In the first case, it is an indirect lighting and the optical reflective surface 13 is essential. In the second

case, this is a direct lighting.

**[0097]** LED-based components 21 are supplied and optionally driven via a circuitry 22 which comprises electrical paths for power supplying the LEDs and optionally for transporting control signals to the LED-based components 21. Optionally the circuitry 22 may also comprise electronic component(s) to process the power and/or control signals, driver(s) to control the power and/or other components.

**[0098]** Circuitry 22 and LED-based components 21 may be fixed to a transparent or semitransparent board (especially needed in case of indirect lighting) which does not reflect the sound. To reach this acoustic property, the board may be made of an acoustic absorbing material and/or be provided with through hole to leave the sound going therethrough (and therefore to transmit the sound to the cavity 14).

**[0099]** Alternatively, circuitry 22 and LED-based components 21 may be fixed directly to the side of the cover 50 facing the cavity 14.

**[0100]** Advantageously, circuitry 22 is configured to limit the disturbing or absorption of the light emitted or shined by the LED-based components 21 and/or the light reflected by the reflective surface 13. To this purpose, circuitry 22 may comprise transparent electrical paths (e.g. made of ITO). Alternatively or in combination, the circuitry 22 may consist essentially in wires linking the LED-based components 21 one to the other according to a grid configuration, as depicted in FIG. 1 and as disclosed in US2009/0091932. Furthermore this wire-grid configuration of the circuitry 22 improves the dissipation of the heat generated by the LED-based components 21, due to its good thermal conductivity (especially if those wires comprise copper) and its great surface in contact with the air of the cavity 14.

**[0101]** Connection of the circuitry 22 to the electrical supports 60 may be performed via wires extending through or adjacent to the side elements 12, as depicted by FIG. 2.

**[0102]** Alternatively, at least a part of the LED-based components may be provided on the side elements 12 of the assembly 1.

**[0103]** The rigid cover 50 is configured such that acoustic waves, generated outside the assembly 1 and directed towards the cover 50, are not reflected onto the cover 50 or, at least, have limited reflection onto the cover 50.

**[0104]** Particularly the cover 50 may be configured to transmit therethrough a major part of the received acoustic waves and/or to absorb some acoustic waves.

**[0105]** According to the configuration of this example, the cover 50 comprises a rigid panel 30 provided with an array of through holes 31, such as a honeycomb structure, to leave the sound going therethrough. This rigid panel 30 is made of a material transparent to at least a range of wavelengths emitted by the LED-based components 21, such as e.g. polycarbonate, PMMA, PET, transparent plastic, and a material sufficiently rigid to prevent

from deformation due to its own weight and the weight of the LED-based components 21 and circuitry 22 once the rigid panel 30 is fixed at its edge to the side elements 12.

**[0106]** Moreover, the rigid panel 30 bears the LED-based components 21 and circuitry 22 on the side facing the cavity 14. LED-based components 21 and circuitry 22 may be fixed by known techniques such as e.g. clamping, gluing, riveting.

**[0107]** The rigid panel 30 may be fixed to the side elements 12 by different techniques, which may comprise gluing, screwing, riveting.

**[0108]** The cover 50 further comprises a sheet 40 extending over the side of the rigid panel 30 opposite to the cavity 14. The sheet 40 is made of at least one material transparent to at least a range of wavelengths emitted by the LED-based components 21, e.g. glass fiber. The sheet 40 may be provided with optical properties such that said transparency is not the same for the light coming from the cavity 14 (i.e. light issued from the LED-based components 21) as to the light generated outside the assembly 1: accordingly, the light transmittance may be higher for light beams coming from the cavity 14 than for light beams pointing to an opposite direction, and light reflectance may be lower for light beams coming from the cavity 14 than for light beams pointing to an opposite direction.

**[0109]** Alternatively, the sheet 40 may be painted by a thin white paint so as to reflect a part of the light (e.g. 30%) and to transmit another part of the light (e.g. 70%). Therefore the reflection found can be sufficiently reflective for the light incident from outside the assembly 1 to hide the rigid panel and sufficiently optically transmissive to transmit a significant portion of the light emitted by the LED-based components 21 out of the assembly 1. The non-transmitted portion of said emitted light is reflected by the paint back to the cavity 14 and is mainly reflected onto the reflective element 13 back to the sheet 40. This portion of the emitted light is therefore "recycled" and reaches the sheet 40 again and again.

**[0110]** Alternatively, the sheet 40 may also be transparent only when the LED-based components 21 emits light. This property may be found with materials having wavelength specific reflection properties, e.g. phase-changing or state-changing materials whereby light transmission in the material is changing with the phase or with the internal or structural state of the material, and which phase or state is changing when the material is exposed to a temperature or a light above a determined temperature or light threshold

**[0111]** The sheet 40 may be sufficiently thin for a sufficiently small surface density (typically around 0.05 to 0.2 mm of thickness, preferably lower than 0.15 mm or around 0.10 mm, for a surface density lower than 200 g/m<sup>2</sup>, but preferably lower than 150 g/m<sup>2</sup> or than 100 g/m<sup>2</sup>) to prevent a significant reflectivity of the sound thereon.

**[0112]** Alternatively or in combination with said sound

transmittance, the sheet 40 may be provided with acoustically absorbing properties. To this purpose, the sheet 40 may be made of one layer or several layers stacked one to the other. Additionally, the sheet 40 may be further provided with small through micro holes (e.g. micro perforations) which acoustically absorb by viscous losses, whose sub-millimeter diameter (e.g. between 0.05 and 0.3 mm) is similar to the thickness of a boundary layer of air. Spacing between holes (e.g. a few mm) can also be adapted to tune the rate of sound absorption. Clear-sorber® foils may be used for the sheet 40.

**[0113]** Optionally, the sheet 40 may further extend onto the side elements 12 of the substrate 10, as shown in FIG. 2 and FIG. 3.

**[0114]** The sheet 40 may be fixed to the rigid panel 30 by different techniques, which may comprise gluing, riveting, screwing, stitching.

**[0115]** The assembly 1 may be used as a tile in a ceiling, wall or floor system.

**[0116]** Alternatively to the lighting assembly 1 of FIGS 1-4, FIG 5 and 6 show a lighting assembly 1' with a cover 50' comprising a corrugated rigid panel 30' made of a material optically transparent to at least one range of wavelengths emitted by the LED-based components 21.

Accordingly, this rigid panel 30' comprises successively top waves 35' and bottom waves 36'. This rigid panel 30' may be made of polycarbonate, PMMA, PET, transparent plastic. The corrugated shape may be found by either thermoforming, or by forcing the rigid panel 30' to be corrugated by applying compression forces at opposite edges of the rigid panel 30' and thereafter fixing this constrained rigid panel 30' at its edges to the sheet 40 and/or the side elements 12 in order to maintain this constraint.

**[0117]** The sheet 40, e.g. of glass fiber, may be glued or stitched to the portions of the rigid panel 30' located close to the apexes 38' of the bottom waves 36' and/or to bottom edges of the side elements 12.

**[0118]** As shown in FIG. 5 and 6, the LED-based components 21 may be embedded in and/or supported by the rigid panel 30', via the circuitry 22 which may be made rigid. In particular, LED-based components 21 may be positioned within the cavities formed by the waves 35' and 36' of the rigid panel 30', and the circuitry 22 (electrically connecting the LED-based components 21 one to the other) is arranged to come through the sections of the rigid panel 30' located between apexes 37' and 38' of the waves 35' and 36'. Accordingly the electrical assembly (i.e. LED-based components 21 and the circuitry 22) is held by these sections, and thanks to the rigidity of the circuitry 22 and of the rigid panel 30'.

**[0119]** In particular, waves 35', 36' of the corrugated rigid panel 30' may be periodic and/or the pitch between the waves may be chosen to be roughly n times (n being an integer equal or greater than 1) the distances separating LED-based components 21.

**[0120]** Reflective element 13' may be any reflective element aforementioned. In this specific example, it is provided a corrugated reflective element 13' (e.g. made of

an optically reflective foil or solid material). But this corrugated shape of the reflective element may also be advantageous to have a higher stiffness along one direction (the direction of the waves), to prevent that the shape of the reflective element 13' changes significantly over lifetime. Alternatively this reflective element 13' can be flat.

**[0121]** While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive; the invention is not limited to the disclosed embodiments, and the person skilled in the art can clearly adapt the teaching of the invention, especially relating to size, shape and application of the acoustic lighting assembly 1.

**[0122]** Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality.

## Claims

### 1. Acoustic lighting assembly comprising:

- a substrate (10) having acoustically absorbing properties and an open cavity (14) having sides surfaces (15, 16) and an opening, the open cavity (14) being provided with optically reflective properties;
- solid state lighting-based components (21) and circuitry (22) located in the cavity (14);
- a rigid cover (50, 50') of the open cavity (14), the cover (50, 50') being transparent to at least one range of wavelengths emitted by the solid state lighting-based components (21) and arranged to be acoustically non-reflective.

2. Acoustic lighting assembly of claim 1, wherein at least a part of the cover (50, 50') extends across the opening of the open cavity (14).

3. Acoustic lighting assembly of claim 1 or 2, wherein the cover (50, 50') is generally extending over a surface parallel to the opening area of the open cavity (14).

4. Acoustic lighting assembly of one of claims 1-3, wherein the cover (50) comprises a rigid member (30) provided with an array of through holes (31) leaving the sound going there through.

5. Acoustic lighting assembly of claim 4, wherein the cover (50) comprises a honeycomb structure (40).

6. Acoustic lighting assembly of one of claims 1-3,

wherein the cover (50') comprises a rigid member (30') comprising a corrugated structure.

7. Acoustic lighting assembly of any one of claims 4-6, wherein the acoustic panel comprises side elements (12) surrounding the open cavity (14), and wherein the rigid member (30, 30') is fixed to the side elements (12).

8. Acoustic lighting assembly of one of claims 1, wherein the surface of the cover (50, 50') opposite to the open cavity (14) is smooth.

9. Acoustic lighting assembly of one of claims 4-7, wherein the cover (50, 50') comprises a sheet (40) covering the side of the rigid member (30, 30') opposite to the open cavity (14).

10. Acoustic lighting assembly of claim 9, wherein the sheet (30) is provided with high reflectivity for light incident from outside the assembly (1, 1') and high transmittance for light incident from the open cavity (14), for at least one common range of wavelengths.

11. Acoustic lighting assembly of claim 9 or 10, wherein the sheet (30) is further configured to exhibit acoustically absorbing properties.

12. Acoustic lighting assembly of claim 1, wherein the substrate (10) is made of an acoustically absorbing material.

13. Acoustic lighting assembly of claim 12, wherein the substrate (10) comprises a back acoustically absorbing panel (11) and side elements (12), optionally acoustically absorbing, fixed to the back acoustically absorbing panel (11) to form said open cavity (14), each side element (12) having a surface being one of said side surfaces (15, 16) of the open cavity (14).

14. Acoustic lighting assembly of claim 1, wherein the solid state lighting-based components (21) do not contact the surfaces (15, 16, 17) of the open cavity (14).

15. Acoustic lighting assembly of one of claims 1-14, wherein the solid state lighting-based components (21) and circuitry (22) are fixed to the surface of the cover (50) facing the open cavity (14).

16. Method of manufacturing an acoustic lighting assembly (1, 1') comprising:

- (a) providing a substrate (10) having acoustically absorbing properties and comprising an open cavity (14) having side surfaces (15, 16) and an opening, the open cavity (14) being provided with optically reflective properties;



(b) providing a rigid member (30, 30') transparent to at least one range of wavelengths emitted by solid state lighting-based components (21), the rigid member (30, 30') being arranged to be acoustically non-reflective; 5

(c) fixing solid state lighting-based components (21) and circuitry (22) to the rigid member (30, 30'); 10

(d) fixing the rigid member (30, 30') to the substrate (10) such that the rigid member (30, 30') closes the open cavity (14) with at least a part of the solid state lighting-based components (21) and circuitry (22) located in the open cavity (14). 15

**17.** Method of claim 16, wherein the substrate (10) comprises a back acoustically absorbing panel (11) and side elements (12), and wherein step (a) comprises the fixation of the side elements (12) to the back acoustically absorbing panel (11) to form said open cavity (14), each side elements (12) having a surface being one of said side surfaces (15, 16) of the open cavity (14). 20

**18.** Method of claim 16 or 17, further comprising a step of providing a sheet (40) transparent to at least one range of wavelengths emitted by the solid state lighting-based components (21), the method further comprising a step of fixing the sheet (40) to the face of the rigid member (30, 30') opposite to the open cavity (14). 25 30

**19.** Method of claim 16, wherein step (a) comprises the provision of an optically reflective element (13, 13') within or on surfaces of the open cavity (14), e.g. by coating with a reflective paint or applying a reflective foil or providing a reflector in the open cavity (14). 35 40

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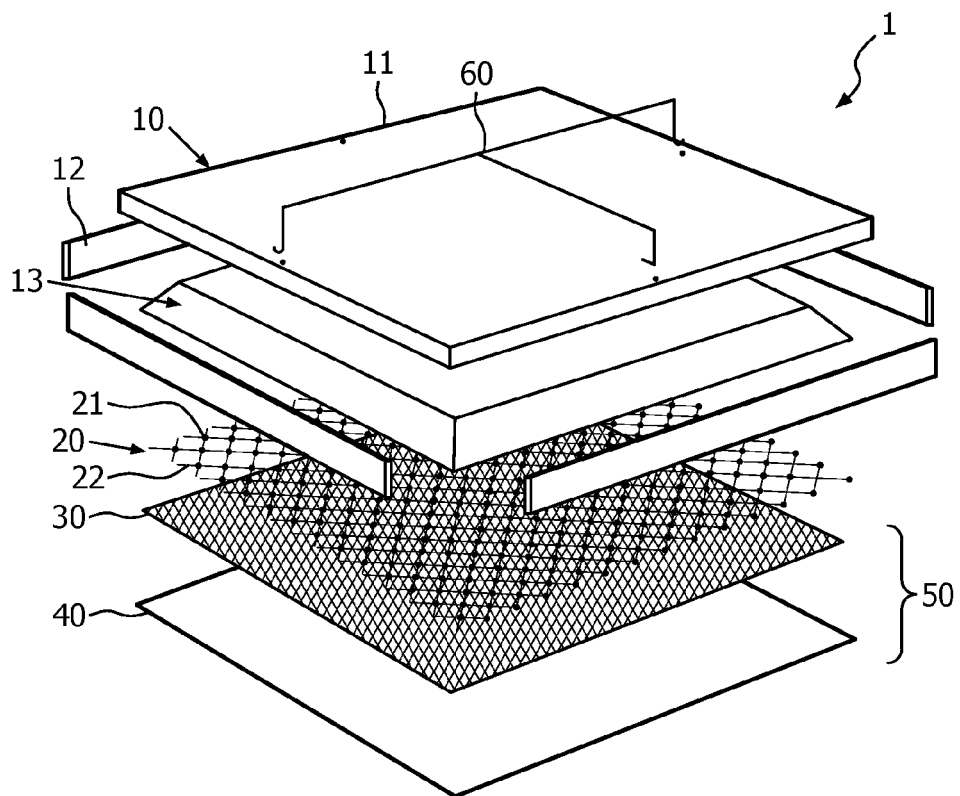


FIG. 1

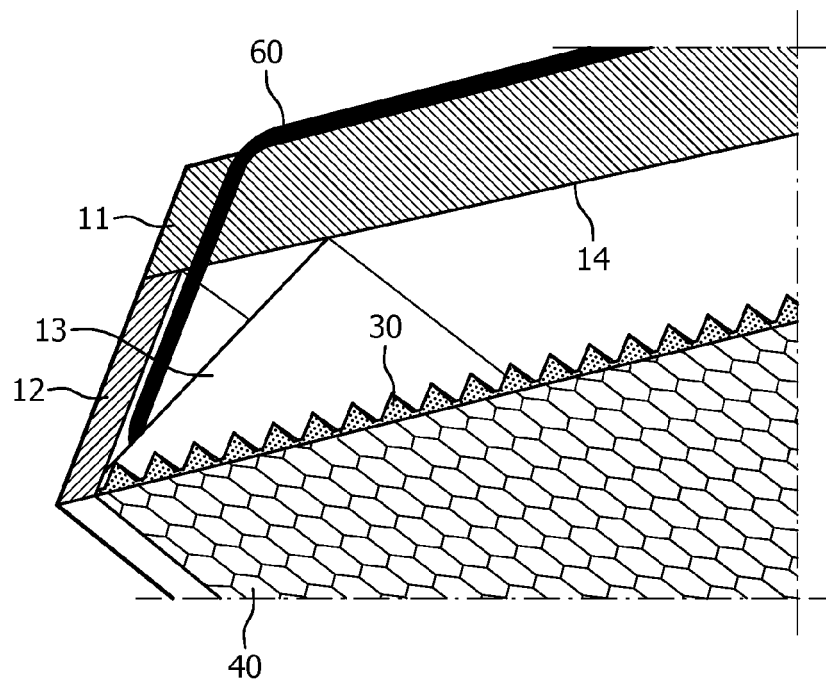


FIG. 2

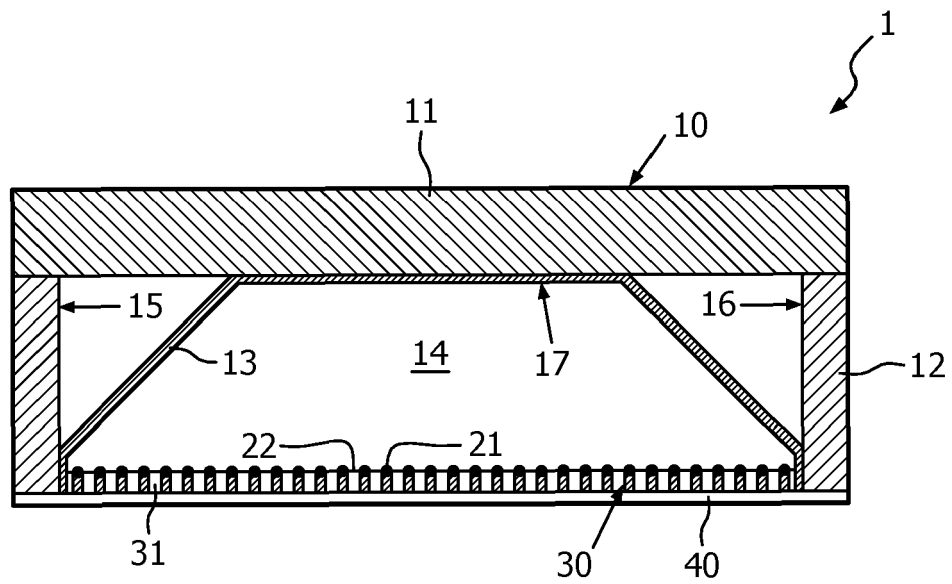


FIG. 3

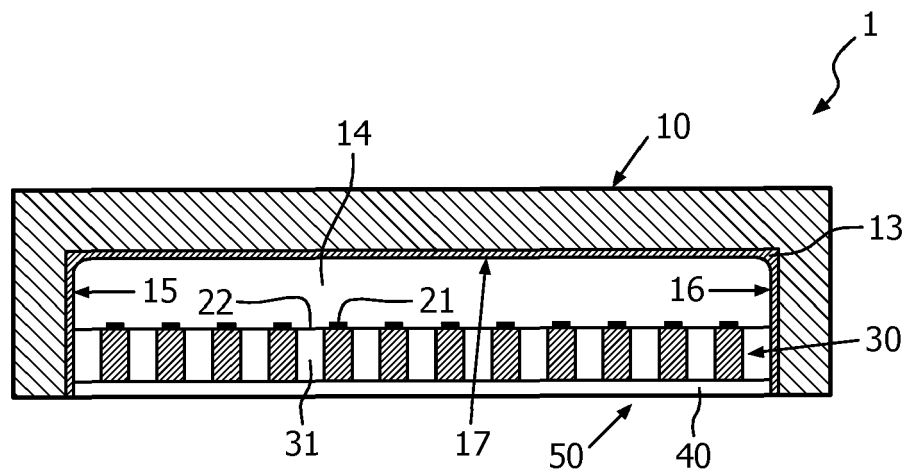


FIG. 4

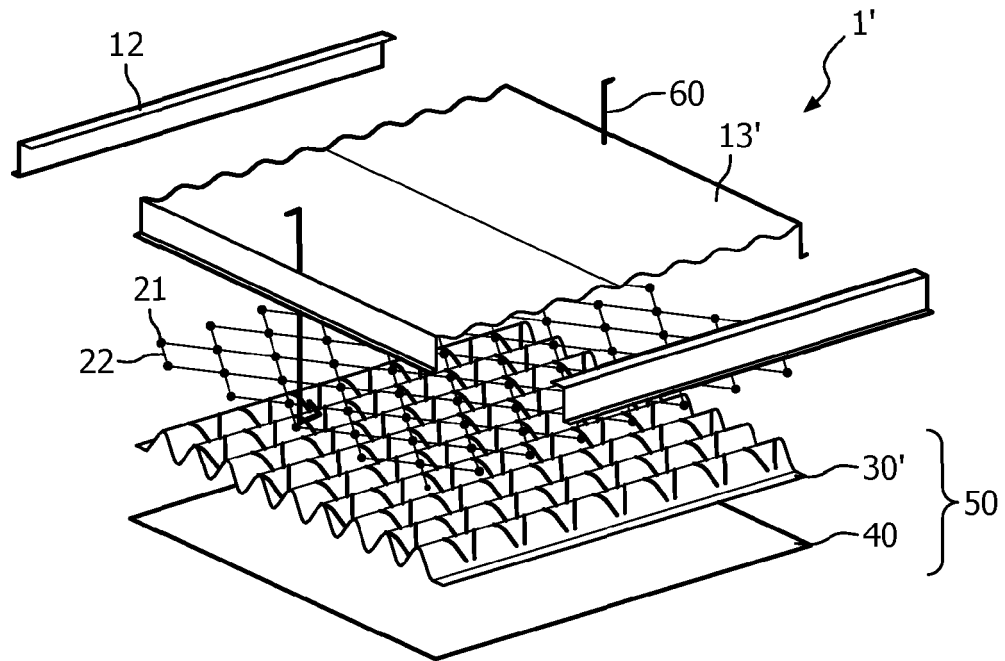


FIG. 5

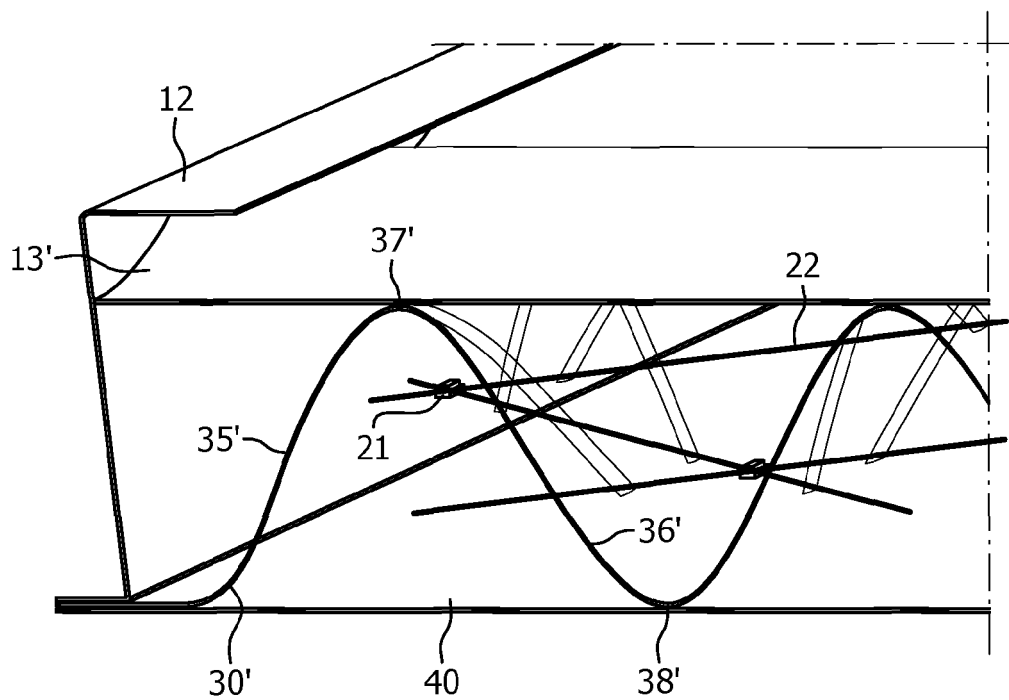


FIG. 6



## EUROPEAN SEARCH REPORT

Application Number  
EP 11 30 6199

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Place of search <b>Munich</b>		Date of completion of the search <b>20 June 2012</b>	Examiner <b>Berthommé, Emmanuel</b>
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20-06-2012

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