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(54) **ACOUSTIC TILE**

SCHALLSCHLUCKPLATTE

PLAQUE ACOUSTIQUE

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Description

[0001] The object of the invention is a new perforated acoustic tile that presents the advantage of ensuring air pollution removal under visible and ultraviolet light irradiation, particularly by photocatalysis.

[0002] Acoustic tiles are well known products that are intended to be applied to walls or ceilings. The acoustic tiles related to the invention are perforated acoustic tile supports that are covered on their entire rear surface, that is, their non-visible face, with a nonwoven material. The support may vary and generally is most often in the form of plaster boards, but also, in certain cases, in the form of metal boards, wood boards or PVC boards and, more generally, in any type of material.

[0003] The boards of the invention have numerous applications, particularly in public buildings, train stations, airports, hospitals, nurseries, offices, etc.

[0004] The principle of photocatalysis consisting of destroying various organic pollutants in air is also a well known principle. In practice, the photocatalytic reaction is initiated by activating a semi-conductive solid and particularly TiO_2 by UV radiation with a wavelength of less than 380 nm or visible radiation (depending on the characteristics of the TiO_2), causing electronic changes within the semiconductor and leading to, in the presence of air, the creation of oxygenated radicals at the surface of the semiconductor. These radicals attack the organic compounds adsorbed on the semiconductor and, by a succession of chemical reactions involving water and oxygen from the air, degrade the organic compounds until the carbon from the carbon chains is completely transformed into carbon dioxide.

[0005] The idea of conferring photocatalytic properties to acoustic tiles is already known and, in particular, was described in document WO-A1-99/51345 of the Applicant. In particular, this document describes the possibility of applying a TiO_2 - based paint onto the acoustic tile support. Although it is satisfactory in terms of pollution removal, such a solution prohibits the reworking of the ceiling or wall inasmuch as the application of a new paint layer on the photocatalytic composition will destroy its effects. It is thus necessary in such a case to apply a new layer of photocatalytic paint, which is a particularly costly measure. Considering these major disadvantages, this solution has never been implemented.

[0006] To get around this problem, a second solution could have been to incorporate the photocatalytic agent, particularly TiO_2 directly into the support. However, this solution is not completely satisfactory inasmuch as the photocatalytic effect would only be effective near the perforations and not on the entire tile surface. In addition, such a solution would be likely to only relate to plaster tiles and not to wood or metal tiles.

[0007] Document US-A1-2006/0137276 describes the idea of incorporating zeolite into plaster boards. The zeolite will have the effect of adsorbing the pollutant, but contrary to what has been indicated, the zeolite will not be regenerated since zeolite is not a semiconductor. Thus, it does not act like a photocatalytic agent and does not destroy, in contact with UV or visible radiation, the previously attached pollutant agents. By operating according to an adsorption mechanism, the efficacy of zeolite is thus independent from the radiation to which it is subjected. In other words, even if the zeolite ensures effective pollution removal, this short-term efficiency is limited due to the saturation phenomenon.

[0008] Document DE-U1-20102074 describes an acoustic tile consisting of a perforated support to the reverse face of which a continuous sheet of plastic or aluminum is applied and the front side of which is provided with a waterproof sheet capable of receiving an 'acoustic treatment'. The nature of the treatment or the sheet itself is not discussed. In any case, due to the waterproof character of the sheet, it cannot be a nonwoven support.

[0009] Document US-A1-2003/0082367 describes a support covered with a photocatalytic composition. Different kinds of supports (glass, plastic, textile) can be used for different applications (siding, ceiling, walls). The woven or nonwoven character of the textile is not discussed.

[0010] Document US-A-5 674 594 discloses an acoustic tile comprising a perforated support wherein one of the surfaces is covered on its entire surface with a nonwoven material, wherein the nonwoven material is covered on at least one face by a photocatalytic composition comprising at least one photocatalyst agent.

[0011] For this reason, the Applicant is focused on the development of an acoustic tile that removes pollution by the photocatalysis phenomenon, which does not present the disadvantages of the tiles described in document WO-A1-99/51345. In particular, the aim of the invention is to provide an acoustic tile that can be painted without losing its cleaning capacity.

[0012] The Applicant has observed that in a completely surprising manner, the application of TiO_2 directly onto the nonwoven material of the tile confers a particularly effective pollution removing activity to said tile.

[0013] In other words, the object of the invention is an acoustic tile comprising a perforated support in which one of the faces is covered by a nonwoven material over its entire surface and the face of the nonwoven material facing the perforated support being covered with a photocatalytic composition.

[0014] The tile is characterized in that at least the face of the nonwoven material facing the perforated support is covered by a photocatalytic composition comprising at least one photocatalytic agent.

[0015] In other words, the invention consists of applying the photocatalytic composition not on the front face of the tile, directly on the support, but on the face of the nonwoven material arranged onto the rear face of the tile. Such a configuration avoids the tile reworking problem while ensuring optimal photocatalytic activity, particularly in offices in daylight or artificial light. In fact, in the two cases, the radiation spectrum is comprised of UV

and visible light allowing the photocatalysis phenomenon to be activated. In addition, application of the photocatalytic composition on the sheet material instead of the tile does not affect in any way the acoustic properties of the tile only existing due to presence of the holes.

[0016] As has already been said, the composition based on at least one photocatalytic agent is applied on at least one of the material faces.

[0017] In a first embodiment, the composition is applied to the surface of the nonwoven material facing the support. In practice, the composition is applied at a rate of 2 to 50 g/m^2, advantageously on the order of 4 to 12 g/m^2. Application of the layer is particularly carried out by coating, spraying or an equivalent method.

[0018] In a second embodiment, the composition is applied to the two faces of the nonwoven material, in particular by impregnation or an equivalent method. In this hypothesis, the photocatalytic composition is applied at a rate of 2 to 100 g/m^2, advantageously between 8 and 20 g/m^2.

[0019] As regards the photocatalytic agent-based composition, this contains, in addition to the photocatalytic agent, at least one binding agent, in particular an inorganic binding agent.

[0020] The photocatalytic agent is particularly chosen from the group comprising metallic oxides, alkaline-earth oxides, actinide oxides and rare earth oxides. Advantageously, the photocatalytic agent is titanium dioxide (TiO_2), preferably anatase. In practice, the titanium dioxide particles have a diameter of between 10 and 30 nm.

[0021] In a preferred embodiment, the TiO_2 has a specific surface area greater than 225 m^2/g and a particle size on the order of 15 nm. Advantageously, the TiO_2 is the TiO_2 sold by the Kronos company under the brand KRONOS® VLP 7000.

[0022] In a particular embodiment, the photocatalytic composition contains, in addition, adsorbent particles such as, for example, zeolite. The adsorbent particles such as, for example, zeolite represent in practice between 1 and 50% by weight of the photocatalytic composition, advantageously between 5 and 25%.

[0023] As regards the inorganic binder, it is advantageously present in the form of an aqueous colloidal dispersion of silicon dioxide comprising silica particles able to be bound to one another after having coated the photocatalytic agent.

[0024] More precisely, the phrase "aqueous colloidal dispersion of silicon dioxide SiO_2", refers to a negatively charged dispersion of amorphous silica particles, with a high specific surface area, in water. In practice, the specific surface area of the silica particles is greater than 80 m^2/g, advantageously 100 m^2/g for a particle size of between 25 and 30 nm. Furthermore, it is greater than 300 m^2/g, advantageously 350 m^2/g for a particle size of between 4 and 6 nm. On their surface, the silica particles present OH groups and OH^- ions, which form a double electric layer, conferring self-bonding properties to said particles.

[0025] In an advantageous embodiment, the particles of SiO_2 represent from 20 to 50% by weight of the aqueous colloidal dispersion and have a diameter of between 10 and 50 nm, preferably of between 20 and 30 nm.

[0026] The Applicant has observed that particularly effective results are obtained with a photocatalytic composition containing from 10 to 60 parts (dry), advantageously 50 dry parts of an aqueous colloidal dispersion of SiO_2 containing between 20 and 50% by weight of SiO_2 with a size of between 10 and 50 nm, advantageously of between 20 and 30 nm, the complement to 100% being constituted of TiO_2 and, if necessary, of adsorbent particles.

[0027] In a particular embodiment, the complement to 100% is constituted of 25 to 45 parts of TiO_2 and from 5 to 25 parts of adsorbent particles, such as, in particular, zeolite.

[0028] If necessary and according to demand, the photocatalytic composition may also contain pigments, particularly black pigments.

[0029] According to another characteristic, the perforated support is advantageously a plaster support. It may also, nevertheless, be present in the form of a wooden board, a metal board or a PVC board.

[0030] The nonwoven material designates materials comprising artificial and/or synthetic and/or natural fibers. The expression 'artificial and/or synthetic fibers' designates fibers chosen from a group comprising, among artificial fibers, viscose fibers, and among synthetic fibers, polyester, polypropylene, polyamide, polyacrylic, polyvinyl alcohol, and polyethylene fibers, alone or in mixture. The expression 'natural fibers' designates especially cellulose fibers.

[0031] The invention and its resulting advantages will emerge more clearly from the following embodiments, supported by the attached figures.

Figure 1a and 1b are schematic partial cross sections of two preferred embodiments of the present invention.

Figure 2 is a schematic representation of a photocatalysis loop.

Figure 3 corresponds to the curve giving the concentration of toluene as a function of the air treatment time by different types of tile, including the tile of the invention under UV radiation.

Figure 4 corresponds to the curve giving the concentration of toluene as a function of the air treatment time by different types of tile, including the tile of the invention in the absence of any radiation.

Figure 5 corresponds to the curve giving the concentration of toluene as a function of the air treatment time by different types of tile, including the tile of the invention under visible radiation.

[0032] Figures 1 a is a schematical partial cross section of an acoustic tile in accordance with a preferred embodiment of the present invention. The acoustic tile 10 of Fig.

1 a comprises a tile support 12 with holes 14, and a nonwoven material 16 covering one face of the tile support 12, and being fastened thereon. The surface of the nonwoven material 16 facing the tile support 12 is coated by a photocatalytic composition 18. The acoustic tile is, in accordance with a preferred embodiment of the invention, manufactured such that the tile support 12 is produced, for example from plaster, and holes 14 being arranged in the tile support. The nonwoven material 16 is manufactured separately, and a photocatalytic composition 18 is applied on one face of the nonwoven material 16. The final manufacture of the actual acoustic tile 10 takes place, for instance, such that an appropriate binder is applied on one face of the tile support 12, and the nonwoven material 16 is laid and pressed on the tile support such that the photocatalytic composition layer 18 is positioned against the tile support 12. The acoustic tile of Fig. 1a functions such that the holes 14 of the tile 10 are blinded by the photocatalytic composition layer 18, whereby the pollutants in the air are able to reach the photocatalytic composition at the bottoms of the holes and be photocatalytically degraded such that carbon from the carbon chains is converted into carbon dioxide.

[0033] Fig. 1 b is a schematical partial cross section of an acoustic tile in accordance with another preferred embodiment of the present invention. The only exception compared to the acoustic tile of Fig. 1 a can be seen in the structure of the nonwoven material 16. In this embodiment both surfaces of the nonwoven material 16 are coated with photocatalytic composition 18 and 20. The manufacture of the acoustic tile is similar to the one discussed above. The function of the acoustic tile 10 is substantially the same, but now it is possible to utilize the photocatalytic composition 20 arranged on the upper face (provided that it is a question of an acoustic tile used as a ceiling material) of the acoustic tile provided that polluted air is allowed to enter the space above the acoustic tile 10. One option is to arrange the nonwoven material 16 of the acoustic tile 10 porous such that air is able to pass through the hole 14 and the nonwoven material 16 to the upper side of the acoustic tile 10. Another option would be to arrange specific openings in the acoustic tile 10 via which polluted air could enter the cavity above the acoustic tile, or to arrange corresponding openings to the sides of the ceiling. In any case, if the photocatalytic composition layer is supposed to be used, an appropriate light source should be provided in the cavity facing the photocatalytic composition layer 20 on the upper surface of the acoustic tile.

Example:

[0034] In this example, the pollution removal efficiency of a tile of the invention, in UV or visible light, is compared to that of an acoustic tile sold by the KNAUF company under the CLEANEO brand and to standard tiles.

[0035] Figure 2 represents a photocatalysis loop in which the tests are performed. Mainly, the photocatalysis loop is comprised of a tunnel 1 with a volume equal to 0.1 m^3 in which the pulsed air circulates, coming from the inlet 2 by means of a ventilator 3 with a flow of 150 m^3/h. In addition, the tunnel contains three 24W UV lamps 4 or a lamp emitting in the visible range positioned near the acoustic tile to be tested 5. Injection of a polluting agent, in practice toluene, is done at the inlet 6 while the formed carbon dioxide coming out at end 7 is detected by infrared light by a means 8, the information then being analyzed by a computer 9.

[0036] The following products are tested:

- o CLEANEO Mustev: plaster board sold by KNAUF containing zeolite, according to patent US-A1-2006/0137276,
- o Coated nonwoven 20 g/m^2: perforated tile of the invention, in plaster, covered on its rear face (opposite face of the tile) by a nonwoven material coated with 20 g/m^2 of the following photocatalytic composition: 10 g SiO_2 (SNOWTEX® 50), 8 g TiO_2 of the KRONOS® VLP 7000 brand, 2g of zeolite.
- o Standard acoustic tile without nonwoven: standard acoustic tile without photocatalytic treatment, sold by the LAFARGE company, lacking nonwoven material on the rear face of the tile,
- o Standard acoustic tile with uncoated nonwoven: sold by the LAFARGE company, with a nonwoven material on the rear face of the tile,
- o Coated nonwoven 8 g/m^2 + zeolite: perforated tile in plaster according to the invention covered on its rear face (opposite face of the tile) by a nonwoven material coated with 8 g/m^2 of the following photocatalytic composition: 4 g SiO_2 (SNOWTEX® 50), 3.2 g TiO_2 of the KRONOS® VLP 7000 brand, 0.8 g zeolite.
- o Coated nonwoven 8 g/m^2 + double zeolite: perforated tile in plaster according to the invention covered on its rear face (opposite face of the tile) by a nonwoven material coated with 8 g/m^2 of the following photocatalytic composition: 4 g SiO_2 (SNOWTEX® 50), 2.4 g TiO_2 of the KRONOS® VLP 7000 brand, 1.6 g zeolite.

Figure 3:

[0037] This figure shows that under UV irradiation, the tile of the invention is the tile that degrades toluene most effectively and that generates the most CO_2 by photocatalysis, and that, thanks to the combined action of zeolite, attaches the pollutant near the TiO_2, which acts by photocatalysis.

[0038] The CLEANEO product also attaches the pollutant thanks to the presence of zeolite. On the other hand, there is no regeneration of zeolite due to the absence of photocatalytic agent. The very low generation of CO_2 is probably due to the fact that the plaster boards are not constituted of pure calcium carbonates and that the board produces a carbonation phenomenon with UV

contact. This cannot be a photocatalysis phenomenon under any circumstances.

[0039] The LAFARGE standard boards/tiles with and without nonwoven material and lacking the photocatalyst agent and zeolite have an insignificant pollution removal activity.

Figure 4:

[0040] Figure 4 shows that in the absence of UV light, the efficiency of the tile of the invention is greater than that of the CLEANEO tile. In other words, even in the absence of light, the pollution removal phenomenon subsists.

Figure 5:

[0041] In this experiment, UV radiation was replaced by visible light whose spectrum was between 400 and 700 nm.

[0042] As the figure shows, the tile of the invention presents very good pollution removal efficiency still with the same principle, a combination of the adsorbent effect of zeolite with the photocatalyst effect of TiO_2.

[0043] From all of these results, it may be deduced that the tile of the invention, with or without zeolite, may be used in offices in daylight or artificial light, these two sources comprising both UV (in low proportion) and visible (in high proportion) radiation.

[0044] The invention and the resulting advantages clearly emerge from the previous description. In particular, the development of an acoustic board able to ensure removal of pollution from ambient air, particularly in offices, without any saturation of the pollution removal sites, should be noted.

Claims

1. An acoustic tile (10) comprising a perforated support (12) wherein one of the faces is covered on its entire surface with a nonwoven material (16), wherein the nonwoven material (16) is covered on at least one face by a photocatalytic composition (18) comprising at least one photocatalyst agent,
   characterized in that the photocatalyst composition (18) is applied onto the face of the nonwoven material (16) facing the support (12).

2. The tile (10) according to claim 1, **characterized in that** the photocatalyst composition (18) is applied onto a face at a rate of 2 to 50 g/m^2, advantageously on the order of 4 to 12 g/m^2.

3. The tile (10) according to claim 1, **characterized in that** the photocatalyst composition (18) is applied onto two faces of the material (16).

4. The tile (10) according to claim 3, **characterized in that** the photocatalyst composition (18) is impregnated to the material (16) at a rate of 2 to 100 g/m^2, advantageously 8 to 20 g/m^2.

5. The tile (10) according to any of the previous claims, **characterized in that** the photocatalyst agent (18) is TiO_2 having a specific surface area greater than 225 m^2/g and a particle size on the order of 15 nm.

6. The tile (10) according to any of the previous claims, **characterized in that** the photocatalyst composition (18) furthermore contains adsorbent particles.

7. The tile (10) according to claim 6, **characterized in that** the adsorbent particles represent between 1 and 50% by weight of the photocatalyst composition, (18) advantageously between 5 and 25%.

8. The tile (10) according to any of the previous claims, **characterized in that** the photocatalyst composition (18) contains, as a binding agent, an aqueous colloidal dispersion of SiO_2 containing between 20 and 50% by weight of SiO_2 with a size of between 10 and 50 nm, advantageously between 20 and 30 nm.

9. The tile (10) according to claim 1, **characterized in that** the photocatalyst composition (18) contains from 10 to 60 parts (dry), advantageously 50 dry parts of an aqueous colloidal dispersion of SiO_2 containing between 20 and 50% by weight of SiO_2 with a size of between 10 and 50 nm, advantageously between 20 and 30 nm, the complement to 100% being constituted by TiO_2 and possibly by adsorbent particles.

10. The tile (10) according to claim 9, **characterized in that** the complement to 100% is constituted of 25 to 45 parts of TiO_2 and 5 to 25 parts of adsorbent particles, such as, in particular, zeolite.

11. The tile (10) according to the previous claim, **characterized in that** the support (12) is in plaster, wood, metal or PVC.

Patentansprüche

1. Schallschutzplatte (10), einen perforierten Träger (12) umfassend, wobei eine der Flächen auf ihrer gesamten Oberfläche mit einem Vliesmaterial (16) bedeckt ist, wobei das Vliesmaterial (16) auf mindestens einer Fläche mit einer Photokatalysatorzusammensetzung (18) bedeckt ist, die mindestens einen Photokatalysator umfasst, **dadurch gekennzeichnet, dass** die Photokatalysatorzusammensetzung (18) auf die Fläche des Vliesmaterials (16) aufgebracht wird, die dem Träger (12) zugewandt ist.

2. Platte (10) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Photokatalysatorzusammensetzung (18) mit einer Rate von 2 bis 50 g/m^2 auf eine Fläche aufgebracht wird, vorteilhafterweise in der Größenordnung von 4 bis 12 g/m^2.

3. Platte (10) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Photokatalysatorzusammensetzung (18) auf zwei Flächen des Materials (16) aufgebracht wird.

4. Schallschutzplatte (10) nach Anspruch 3, **dadurch gekennzeichnet, dass** die Photokatalysatorzusammensetzung (18) mit einer Rate von 2 bis 100 g/m^2 auf das Material (16) imprägniert wird, vorteilhafterweise mit 8 bis 20 g/m^2.

5. Platte (10) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Photokatalysator (18) TiO_2 ist, das eine spezifische Oberfläche von mehr als 225 m^2/g und eine Partikelgröße in der Größenordnung von 15 nm aufweist.

6. Platte (10) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Photokatalysatorzusammensetzung (18) des Weiteren adsorbierende Partikeln enthält.

7. Platte (10) nach Anspruch 6, **dadurch gekennzeichnet, dass** die adsorbierenden Partikeln zu 1 bis 50 Gew.-% der Photokatalysatorzusammensetzung (18) vorhanden sind, vorteilhafterweise zu 5 und 25 Gew.-%.

8. Platte (10) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** die Photokatalysatorzusammensetzung (18) als Bindemittel eine wässrige, kolloidale Dispersion von SiO_2 enthält, die zwischen 20 und 50 Gew.-% SiO_2 mit einer Größe zwischen 10 und 50 nm enthält, vorteilhafterweise zwischen 20 und 30 nm.

9. Platte (10) nach Anspruch 1, **dadurch gekennzeichnet, dass** die Photokatalysatorzusammensetzung (18) 10 bis 60 Teile (trocken), vorteilhafterweise 50 Trockenteile, einer wässrigen, kolloidalen Dispersion von SiO_2enthält, die zwischen 20 und 50 Gew.-% SiO_2 mit einer Größe zwischen 10 und 50 nm enthält, vorteilhafterweise zwischen 20 und 30 nm, wobei die Ergänzung bis 100 % von TiO_2 gebildet wird und möglicherweise durch adsorbierende Partikeln.

10. Platte (10) nach Anspruch 9, **dadurch gekennzeichnet, dass** die Ergänzung bis 100 % von 25 bis 45 Teilen TiO_2 und 5 bis 25 Teilen adsorbierender Partikeln, wie beispielsweise Zeolith, gebildet wird.

11. Platte (10) nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** der Träger (12) aus Gips, Holz, Metall oder PVC besteht.

Revendications

1. Dalle acoustique (10) dotées d'un support perforé (12), dans laquelle l'une des faces est couverte sur toute sa surface d'un voile non tissé (16), dans laquelle le voile non tissé (16) est couverte sur au moins une face par une composition photocatalytique (18) comprenant au moins un agent photocatalyseur, **caractérisée en ce que** la composition photocatalytique (18) est appliquée sur la face du voile non tissé (16) faisant face au support (12).

2. Dalle (10) selon la revendication 1, **caractérisée en ce que** la composition photocatalytique (18) est appliquée sur une face à un taux de 2 à 50 g/m^2, de préférence de l'ordre de 4 à 12 g/m^2.

3. Dalle (10) selon la revendication 1, **caractérisée en ce que** la composition photocatalytique (18) est appliquée sur deux faces du voile (16).

4. Dalle (10) selon la revendication 3, **caractérisée en ce que** la composition photocatalytique (18) est imprégnée sur le voile (16) à un taux de 2 à 100 g/m^2, de préférence de l'ordre de 8 à 20 g/m^2.

5. Dalle (10) selon l'une des revendications précédentes, **caractérisée en ce que** l'agent photocatalyseur (18) est du TiO_2 ayant une surface spécifique supérieure à 225 m^2/g et une taille de particule de l'ordre de 15 nm.

6. Dalle (10) selon l'une des précédentes revendications, **caractérisée en ce que** la composition photocatalytique (18) contient en outre des particules adsorbantes.

7. Dalle (10) selon la revendication 6, **caractérisée en ce que** les particules adsorbantes représentent entre 1 et 50 % en poids de la composition photocatalytique, (18) de préférence entre 5 et 25 %.

8. Dalle (10) selon l'une des précédentes revendications, **caractérisée en ce que** la composition photocatalytique (18) contient, comme agent de liaison, une dispersion colloïdale aqueuse de SiO_2 contenant entre 20 et 50 % en poids de SiO_2 avec une taille de l'ordre de 10 à 50 nm, de préférence l'ordre de 20 à 30 nm.

9. Dalle (10) selon la revendication 1, **caractérisée en ce que** la composition photocatalytique (18) contient de 10 à 60 parts (en sec), de préférence 50 parts

sèches d'une dispersion colloïdale aqueuse de SiO_2 contenant entre 20 et 50 % en poids de SiO_2 avec une taille de l'ordre de 10 et 50 nm, de préférence de l'ordre de 20 et 30 nm, le complément à 100 % étant constitué de TiO_2 et éventuellement par des particules adsorbantes.

10. Dalle (10) selon la revendication 9, **caractérisée en ce que** le complément à 100 % est constitué de 25 à 45 parts de TiO_2 et 5 à 25 parts des particules adsorbantes, telles que, en particulier, la zéolithe.

11. Dalle (10) selon la revendication précédente, **caractérisée en ce que** le support (12) est en plâtre, bois, métal ou PVC.

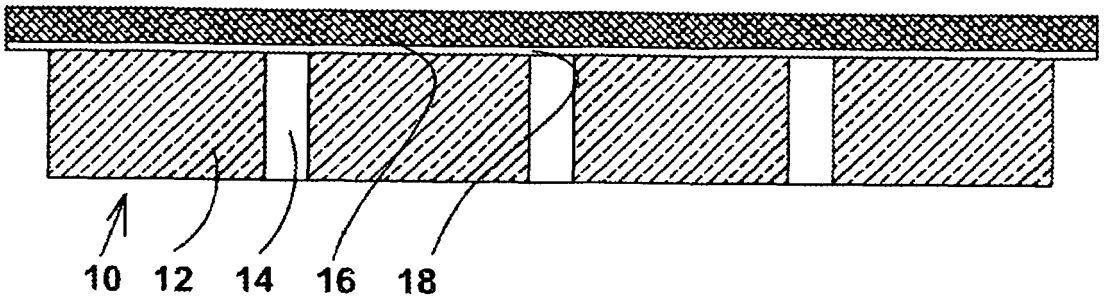


Fig. 1a

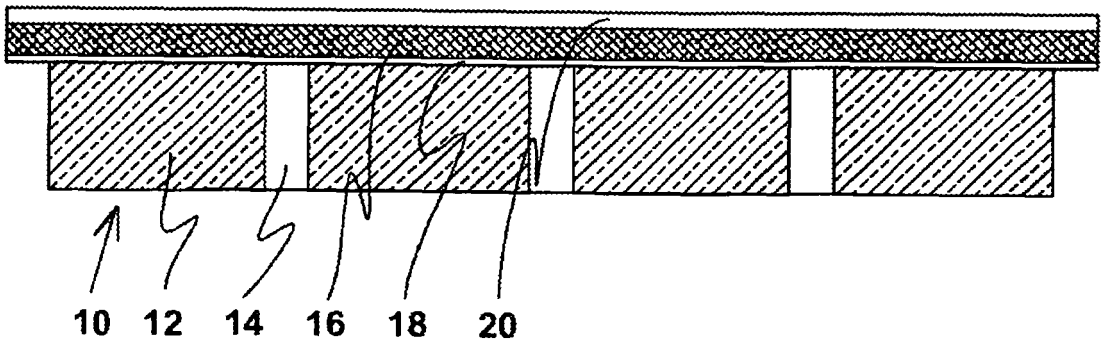


Fig. 1b

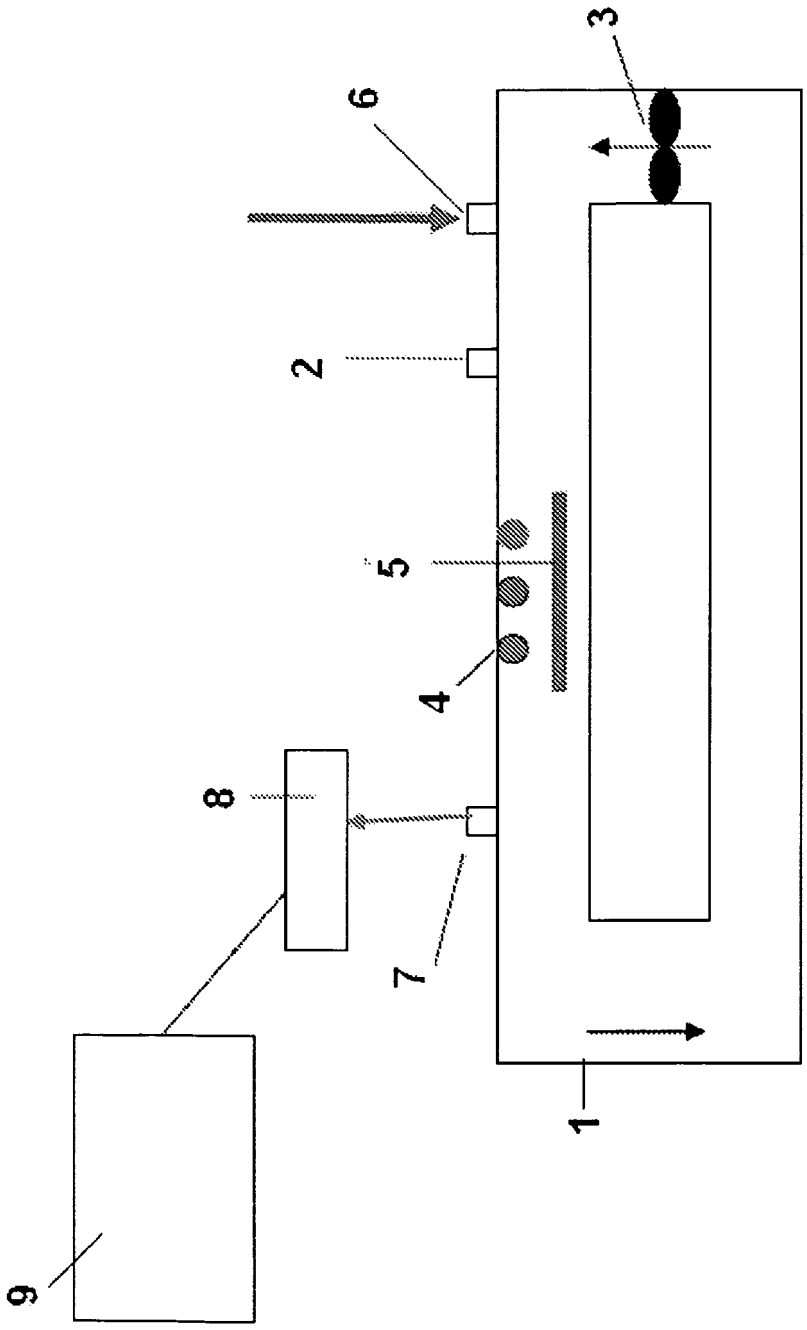


Fig. 2

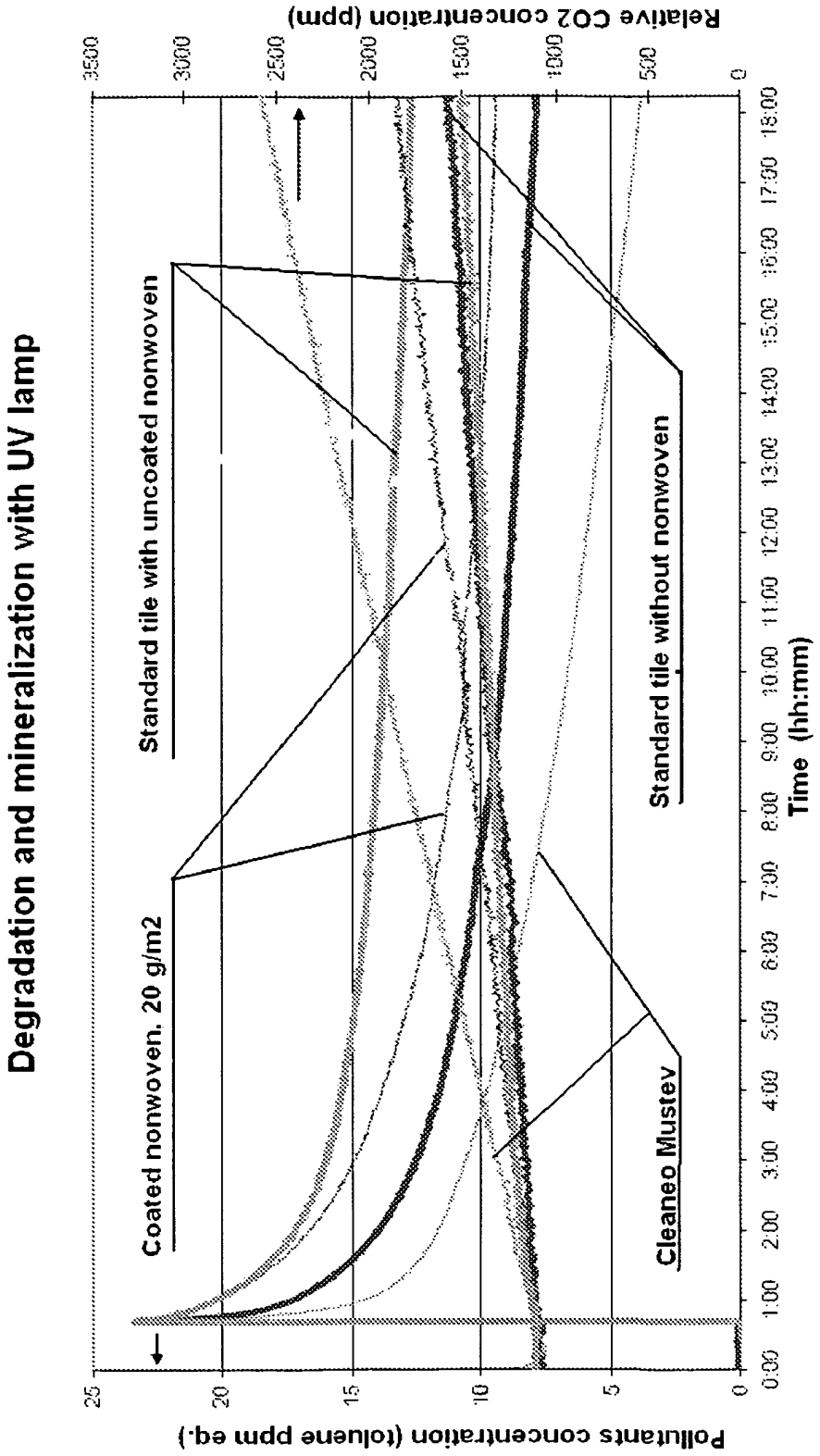

Degradation and mineralization with UV lamp
Pollutants concentration (toluene ppm eq.)
Relative CO2 concentration (ppm)
Time (hh:mm)
Coated nonwoven. 20 g/m2
Standard tile with uncoated nonwoven
Standard tile without nonwoven
Cleaneo Mustev

Fig. 3

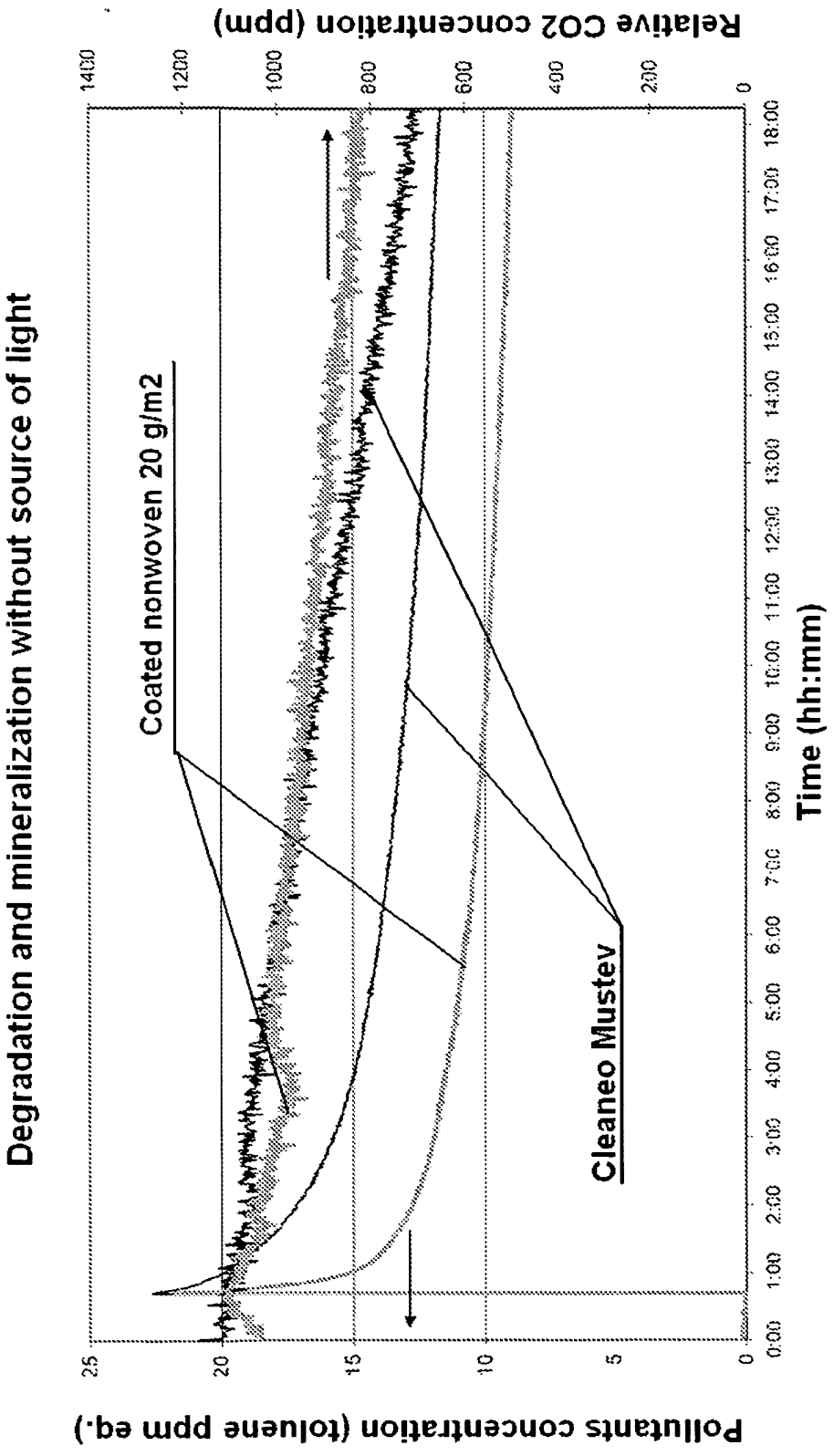

Degradation and mineralization without source of light
Coated nonwoven 20 g/m2
Cleaneo Mustev
Pollutants concentration (toluene ppm eq.)
Relative CO2 concentration (ppm)
Time (hh:mm)
0
5
10
15
20
25
200
400
600
800
1000
1200
1400
0:00
1:00
2:00
3:00
4:00
5:00
6:00
7:00
8:00
9:00
10:00
11:00
12:00
13:00
14:00
15:00
16:00
17:00
18:00

Fig. 4

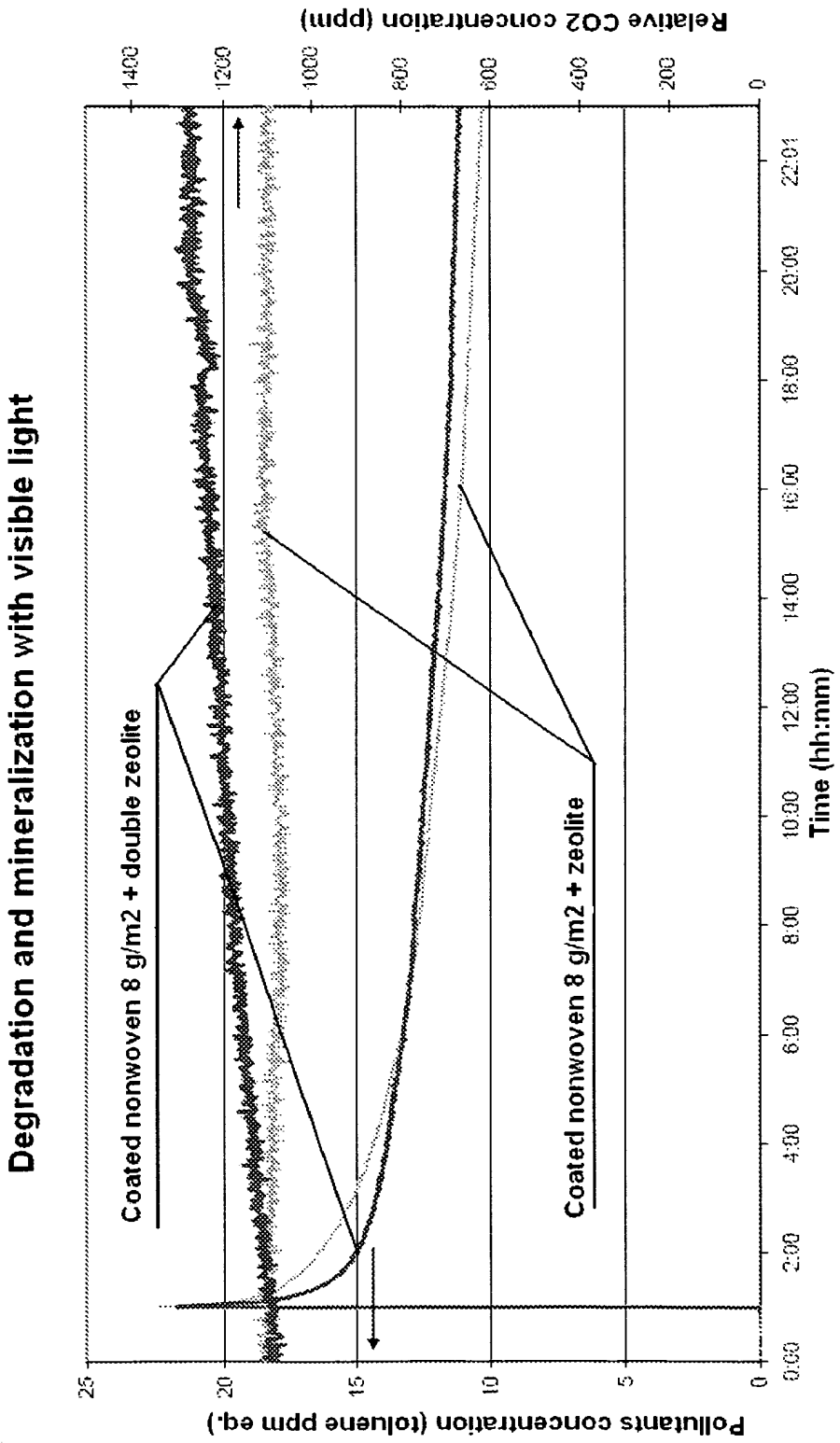

Degradation and mineralization with visible light
Coated nonwoven 8 g/m2 + double zeolite
Coated nonwoven 8 g/m2 + zeolite
Pollutants concentration (toluene ppm eq.)
Relative CO2 concentration (ppm)
Time (hh:mm)
0
5
10
15
20
25
200
400
600
800
1000
1200
1400
0:00
2:00
4:00
6:00
8:00
10:00
12:00
14:00
16:00
18:00
20:00
22:01

Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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