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(72) Inventors:
• **Jopek, Wojciech**
54-072 Wroc aw (PL)
• **Turów, Micha**
50-107 Wroc aw (PL)

(74) Representative: **AOMB Polska Sp. z o.o.**
Ul. Emilii Plater 53
21st Floor
00-113 Warsaw (PL)

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(71) Applicant: **Thermic Shell Sp. z o.o.**
53-009 Wroclaw (PL)

(54) **ILLUMINATED PAVING BRICK MADE OF CERAMIC-POLYMERIC COMPOSITE MATERIAL AND A METHOD FOR MANUFACTURING AN ILLUMINATED PAVING BRICK**

(57) The application relates to an illuminated paving brick (3) made of a ceramic-polymer composite material (4) containing glass granules (1) of variable sizes embedded in a polymer resin matrix (2). The brick at one of its side surfaces or at its bottom surface has an electric

light source (5) embedded in the polymer matrix such that that the electrical contacts thereof protrude outside the brick. The application also relates to the method of manufacturing the illuminated paving brick.

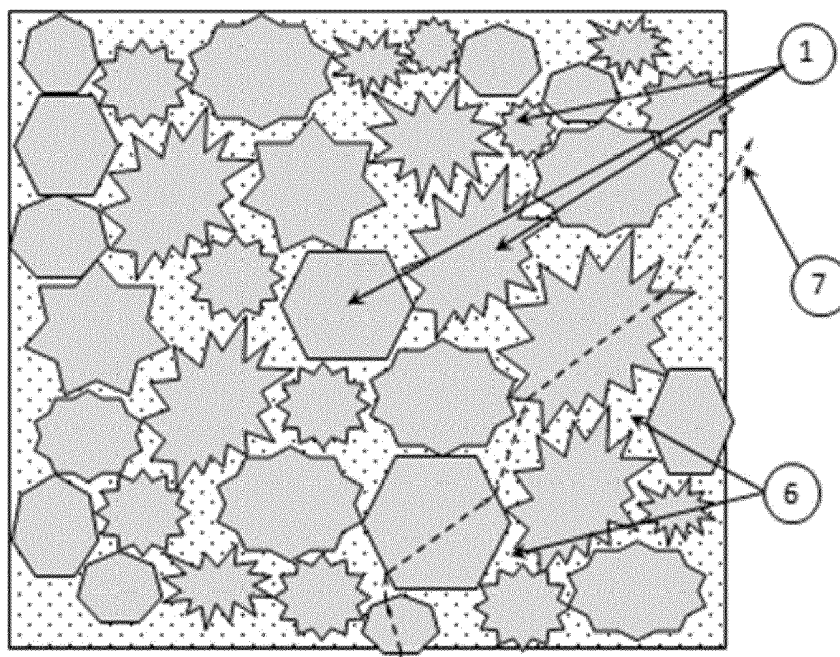


Fig. 3

Description

Technical field

[0001] This invention relates to an illuminated paving brick made of ceramic-polymer composite material having high light scattering capabilities and good strength properties. Additionally, the invention also relates to a method for manufacturing the illuminated paving brick.

Background art

[0002] The Chinese utility model CN204451355 specification discloses an artificial stone such as a paving stone or floor tile containing aluminium hydroxide, calcium carbonate and quartz sand bonded by a high molecular weight polymer binder and coated with a glass layer containing phosphorescent particles. Such solution, however, does not provide a possibility of lighting for more than a couple dozen minutes and does not allow for control (turning on and off) of the backlight function.

[0003] The German patent application DE 10030573 A1 refers to a backlit cassette with the shape and dimensions of a paving brick, consisting of three major elements: a trough made of plastic, a transparent cover and a light source. Such a construction requires all the elements to be produced separately, and subsequently assembled together. In addition, the empty space in which the light source is located, is unable to support loads that may occur during utilization of surface with the built-in cassette, for example when a heavy vehicle is coming onto it. A similar construction is also shown in patent application FR 2718514 A1 with the difference that the illuminated cassette is very narrow, which reduces the risk of its destruction under the pressure of vehicle wheels.

[0004] The German patent application DE 10239360 A1 discloses a solution, wherein a light-emitting element is placed in a hole made in a paving brick. This gives a point source of light, but does not provide the effect of illumination of the entire brick, which in the opinion of the authors of the present invention is desired by end users.

[0005] In turn, a lighting unit for installation in a stone pavement is known from the German patent application DE 102005027381 A1. The unit has a housing containing LED diodes. The housing is covered with a transparent cover, wherein specially designed light diffusion grooves are made from below. The small distance between the diodes and the cover, however, limits the light scattering degree or requires the use of diodes having a illumination large area. In addition, such structure requires three elements to be produced separately and then assembled together, which adversely affects both the time and cost of manufacturing of the final product.

[0006] The German utility model DE 202006001527 U1 specification discloses a solution in the form of a paving brick with an hollow space inside, containing a solar cell, a battery and a light element, covered with a massive glass cover. The described paving brick contains the en-

tire electronic system together with the solar panel, which significantly increases the overall cost of its production, while the massive glass cover does not guarantee sufficient resistance to impact loads and point pressure, which may occur when a stone lying on the glass cover is pressed against the cover by a vehicle wheel. In the Japanese patent application JPH04203109 (A) a system with a solar cell is also disclosed, however, characterized by a much more complex construction, while the multi-stage process of preparing components and their assembly is a time-consuming and laborious operation.

[0007] Another way of scattering light in tiles forming walls or flooring is presented in the Japanese patent application JP2003092008A, the authors of which propose using a glass plate, which on its bottom surface is provided with solar cells. Electricity accumulated in the battery then supplies a series of diodes emitting light to the inside of the plate. The glass plate is provided with a reflecting plate directing light outside the plate. An important drawback of this type of plate, however, is a reduced pressure resistance.

[0008] The European patent application EP 2479485 A2 discloses a solution for embedding a light source in a hole made in a paving brick. This element is suitable for being a lighting element (e.g. for highlighting building facades), but it does not provide the desired aesthetic effect of highlighting the paving brick in its entirety.

[0009] In turn, in the European patent application EP 2587140 (A2), an illuminated paving brick having a reflective element is described for reflecting light emitted by a light source located between the upper and lower surfaces of the brick. The complex internal structure of a brick of this type affects its manufacturing cost, while the scattering surface requires additional space, which adversely affects the brick strength.

[0010] The inventors of U.S. patent 6082886 have proposed a lighting system consisting of substantially solid paving bricks, each of them containing a bundle of optical fibres in its structure. During manufacturing process the brick is cut such that the optical fibres' ends converge to one multiplexer in the bottom part of the brick, and the top side contains on its surface the cut ends of optical fibres that emit point light during the use of the lighting system. Although this solution seems to demonstrate sufficient resistance to pressure, the backlight effect, although covering the entire surface of the cube, is still multi-point rather than uniform.

[0011] Known backlit paving bricks or backlight units intended for use in pavements show at least one of the following drawbacks: low pressure resistance, in particular in case of pressure being applied to certain points only; complex structure leading to significant expenditures associated with producing the components and assembling them; one or at most multi-point surface lighting.

Summary of the invention

[0012] The aim of this solution was to overcome the above-mentioned problems by providing an illuminated paving brick showing sufficient mechanical strength (mainly compressive strength, but also abrasion resistance), having a simple structure, allowing for durability and easy assembly, and at the same time providing the desired effect of uniform illumination of the entire brick surface.

[0013] The present invention relates to an illuminated paving brick made of a ceramic-polymer composite material, wherein the composite material contains glass granules of various particle sizes embedded in a polymer resin matrix, whereas in the brick at one of the side surfaces or at the bottom surface an electric light source is embedded in the polymer matrix such that its electrical contacts protrude outside the brick.

[0014] Preferably, the electric light source is a LED.

[0015] Preferably, the polymer matrix is made of a transparent polymer resin.

[0016] Preferably, the glass granulate contains particles having a diameter of 100 μm , 500 μm and 1 mm in a 1:1:1 weight ratio.

[0017] Preferably, the weight ratio of the polymer resin to the glass granulate is 9:1.

[0018] The present invention relates also to a manufacturing an illuminated paving brick, wherein an electric light source is placed in a mould at one of its walls such that electrical contacts of the light source protrude outside the mould, then a mixture is prepared of glass granules having different particle size together with a polymer resin and a polymerization initiator, and afterwards the mixture is poured over the mould and the resin crosslinking process is carried out until the mixture is completely cured in the mould.

[0019] Preferably, in the method according to the invention a LED is used as the electric light source.

[0020] Preferably, in the method according to the invention a transparent polymer resin is used.

[0021] Preferably, in the method according to the invention the glass granulate is used containing particles having a diameter of 100 μm , 500 μm and 1 mm in a 1:1:1 weight ratio.

[0022] Preferably, in the method according to the invention the weight ratio of the polymer resin to the glass granulate in the mixture for pouring over the mould is 9:1.

[0023] The ceramic-polymer composite material of the paving brick according to the invention, containing glass granules having various particle size embedded in a polymer resin matrix, allows the light beam emitted by a single light source, such as a LED diode, to be scattered only a few centimetres away, i.e. within the thickness of a standard paving brick (usually 6, 8 or 10 cm). This enables uniform illumination of the entire upper surface of the paving brick using a single light source. These properties result mainly from the passage of a light beam through a very large number of polymer-glass phase

boundaries, as well as from repeated refraction and reflection on the surfaces of glass particles. In addition, the paving brick made of a composite comprising glass particles being packed such that they contact each other and are joined together by a polymer matrix occupying the spaces between the glass particles, shows very high compressive strength (the load is then transferred through the glass granules) as well as high resistance to impact loads (transferred through and scattered by the polymer matrix). The compressive strength of the paving bricks according to the invention is more than 10 MPa, which is quite sufficient to transfer the weight of a 3.5-ton vehicle riding over the brick surface.

[0024] A big advantage of the illuminated paving brick is its simple construction, allowing for easy assembly and ensuring a low level of failure of such lighting element.

[0025] An important advantage of the method of manufacturing the illuminated paving brick according to the invention is simplicity. Forming a cube in a form of any shape (cuboid, prism with hexagonal base or other polygonal base, right circular or elliptic cylinder, etc.) in a single casting operation in a mould (e.g. gravity casting), followed by curing of the resin and obtaining a final brick, does not require a complicated apparatus or providing special process conditions, resulting in a small workload and production costs in case of such paving bricks.

[0026] Another element is a possibility of using glass granules obtained from waste glass, which makes the method of the invention beneficial for environmental reasons.

Short description of drawings

[0027] The invention will now be further illustrated in the preferred embodiments, with reference to the accompanying drawings, in which:

Fig. 1 shows the packing structure of a glass granulate and polymer resin mixture in a mould for the production of the paving brick using the method according to the invention;

Fig. 2 shows the schematic structure of the paving block according to the invention in a cross-section;

Fig. 3 shows the beam scattering in the paving brick structure according to the invention.

Detailed description of embodiments of the invention

[0028] An exemplary packing structure of a glass granulate and polymer resin mixture in a mould for producing a paving brick in the method according to the invention is presented in Fig. 1, wherein glass particles **1** of different sizes are tightly packed, in contact with each other, and the space between these particles **1** is completely filled with the resin **2**. Fig. 2 shows the cross-section of a single paving brick **3** cuboid in shape and made of a ceramic-polymer composite **4** according to the invention, wherein a LED **5** is embedded at one of the surfaces, said LED

5 constituting an electric light source illuminating the brick. In turn, Fig. 3 illustrates the process of scattering of a light beam from the LED in the paving brick structure comprising the glass particles **1** embedded in a polymer matrix **6** exemplified by a single light beam **7** passing through a plurality of glass-polymer phase boundaries or being reflected or refracted thereon.

Example 1

[0029] In an open-top silicone mould (MM940 from ACC) having a cuboid shape, a single LED was placed so that the electrical contacts of the diode protruded outside the mould. Further, a mixture of glass granules, a transparent polyester resin and a polymerization initiator was prepared. The glass granules used contained particles having a diameter of 100 μm , 500 μm and 1 mm in 1:1:1 weight ratio. As a polyester resin the SC-22 resin from Prochima was used, and while MEKP [2,2'-peroxydi(butane-2-peroxol)] of the same company was used as the polymerization initiator. The weight ratio of resin to glass granulate in the mixture was 9:1. After thorough mixing (mixing time: 10 min, 120 rpm using an orbital agitator with a screw agitator), the mixture was poured into the mould. The process was carried out at room temperature. After one hour, the polymer matrix was completely cured, and the final paving brick of monolithic structure having dimensions 100 mm x 100 mm x 60 mm was removed from the mould.

[0030] In the compressive strength test performed using a hydraulic press with 100 tons pressure, the obtained paving brick was not destroyed, meaning that it showed compressive strength above approx. 10 MPa.

Example 2

[0031] In an open-top silicone mould (RTV SILIFORM 25 from Jacobson Chemicals Ltd.) cuboid in shape, a single LED was placed so that the electrical contacts of the diode protruded outside the mould. Further, a mixture of glass granules, a transparent polyester resin and a polymerization initiator was prepared. The glass granules used contained particles having a diameter of 500 μm and 1 mm in 2:1 weight ratio. The polyester resin used was Polimal 103-1 resin from Organika Sarzyna S.A., while Luperox® K-1 [MEKP] from Arkema was used as the polymerization initiator together with a cobalt accelerator from the same company. The weight ratio of the resin to glass granulate in the mixture was 8:2. After thorough mixing (mixing time: 10 min, 120 rpm using an orbital agitator with a screw agitator), the mixture was poured into the mould. The process was carried out at room temperature. After 30 minutes, the polymer matrix was completely cured, and the final paving brick of monolithic structure having dimensions 100 mm x 100 mm x 60 mm was removed from the mould.

[0032] In the compressive strength test performed using a hydraulic press with 100 tons pressure, the obtained

paving brick was not destroyed, meaning that it showed compressive strength above approx. 10 MPa.

Claims

1. An illuminated paving brick made of a ceramic-polymer composite material, **characterised in that** the composite material contains glass granules of various particle sizes embedded in a polymer resin matrix, whereas in the brick at one of the side surfaces or at the bottom surface an electric light source is embedded in the polymer matrix such that its electrical contacts protrude outside the brick.
2. The paving brick according to claim 1, **characterised in that** the electric light source is a LED.
3. The paving brick according to claim 1 or 2, **characterised in that** the polymer matrix is made of a transparent polymer resin.
4. The paving brick according to one of the claims 1 to 3, **characterized in that** the glass granulate contains particles having a diameter of 100 μm , 500 μm and 1 mm in a 1:1:1 weight ratio.
5. The paving brick according to one of the claims 1 to 4, **characterized in that** the weight ratio of the polymer resin to the glass granulate is 9:1.
6. A method for manufacturing an illuminated paving brick, **characterized in that** an electric light source is placed in a mould at one of its walls such that electrical contacts of the light source protrude outside the mould, then a mixture is prepared of glass granules having different particle size together with a polymer resin and a polymerization initiator, and afterwards the mixture is poured over the mould and the resin crosslinking process is carried out until the mixture is completely cured in the mould.
7. The method according to claim 6, **characterised in that** a LED is used as the electric light source.
8. The method according to claim 6 or 7, **characterised in that** a transparent polymer resin is used.
9. The method according to one of the claims 6 to 8, **characterised in that** the glass granulate contains particles having a diameter of 100 μm , 500 μm and 1 mm in a 1:1:1 weight ratio.
10. The method according to one of the claims 6 to 9, **characterized in that** the weight ratio of the polymer resin to the glass granulate in the mixture for pouring over the mould is 9:1.

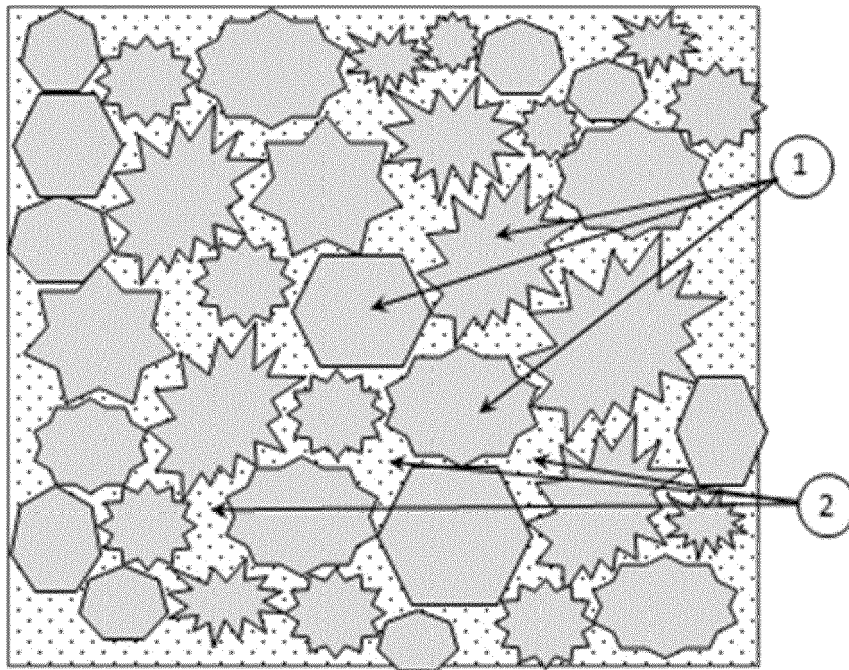


Fig. 1

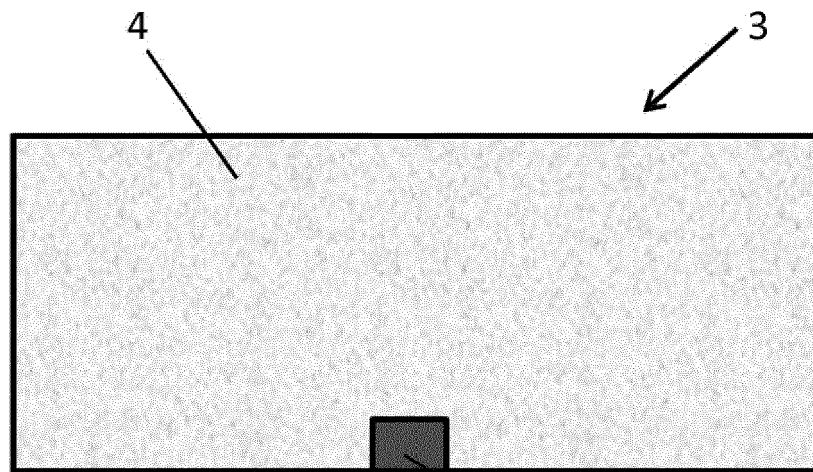


Fig. 2

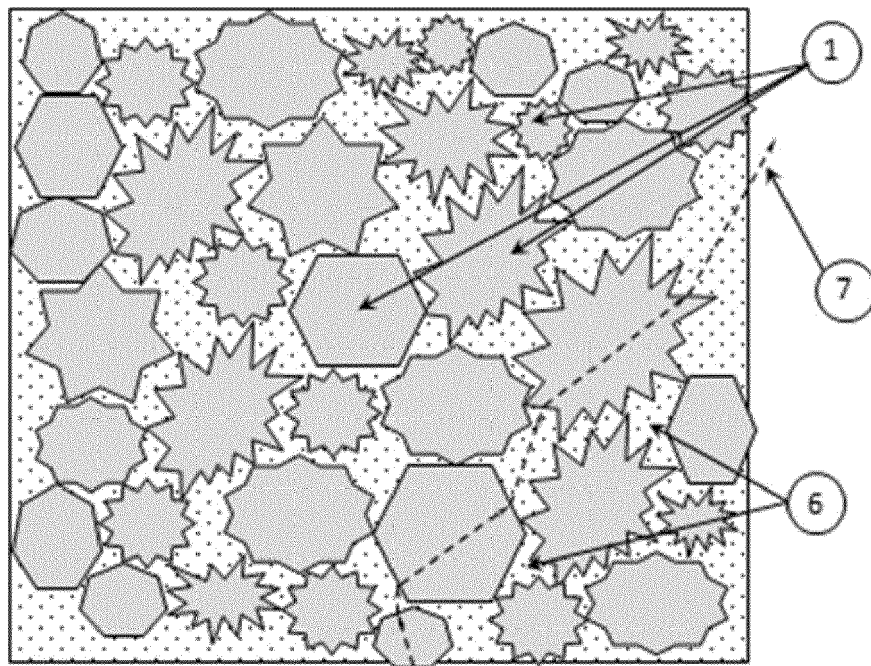


Fig. 3



EUROPEAN SEARCH REPORT

 Application Number
 EP 18 15 7299

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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