

## **SPECIFICATION**

### **ARTIFICIAL STONE WALL MATERIAL**

#### **5 Technical Field**

The invention of this application relates to an artificial stone wall material, having extremely high possibility in designing, having a natural feeling, and capable of providing brightness always changeable in company with movement of and a change in intensity of natural light or artificial light. More particularly, the invention of this application relates to a novel artificial stone wall material, useful as a wall finishing material for use in architecture and civil engineering, and having high superiority in designing.

#### **Background Art**

Conventionally, coating with a paint, and application of tiles, bricks, glass, stones and other materials have been applied to finishing of outer wall of buildings and houses. Such a finishing material are classified into two groups, glossy one and matte one, and have generally used alone or combination of two kinds or more in consideration of designing. A combined design of a glossy finishing material and matte one is also adopted.

For example, in the coating, various kinds of glossy finish or matte finish have been achieved by contrivance in selection of raw materials or composite manner of those. In case of natural stone, a glossy surface thereof is achieved by polishing, or alternatively, a matte concavo-convex surface is finished by tapping, burner jet, hammering and the like.

In small scale constructions such as houses, it is difficult in keeping a balance with surroundings (environment) to use a finishing material, such as stone, with gross like a planar polishing for entire outer wall surface. Therefore, such a glossy finishing material is hardly adopted by itself and the mainstream of designing tends to combine

both finishing materials of gloss and matte.

A use in combination of a glossy finishing material and matte one, just as a conventional adoption, has great trouble in terms of application, takes time and labor in preparing several finishing materials for the use and in addition has a great problem of  
5 difficulty in projection of a design effect on a wall surface.

Therefore, there is high latent need for a wall finishing material, with a so-called third superiority in designing, having both functions of gloss and matte by itself, different from a designing in combination of a glossy material and matte one, and easy to design a wall surface and to project an effect of the design without causing any problem in the  
10 prior art. It is accordingly an object of the invention of the application to provide a novel means for finishing a wall surface capable of satisfying such a need.

#### Disclosure of the Invention

The invention of this application has been made in order to solve the problem  
15 described above. The first aspect thereof is directed to an artificial stone wall material comprising an inorganic fine particle component having a size in the range of 180  $\mu\text{m}$  to 9.5 mm and an inorganic finer particle component having a size in the range of less than 180  $\mu\text{m}$  and a resin component, containing 5 wt % or more of a transparent inorganic fine particle component as said inorganic fine particle component, having a concavo-convex  
20 surface wherein a maximum height between concavity and convexity ranges 1 mm to 100 mm, being molded and solidified into a shape of plate or a deformed shape, and wherein both the transparent inorganic fine particle component, which is exposed on the surface thereof, and a shape of the concavo-convex surface are studded with sparkling points which change with irradiation manner and movement of natural light or artificial light.

25 The second aspect of the invention is directed to the artificial stone wall material described above, wherein the inorganic fine particle component is particles of one or more kinds, obtained by crushing and screening natural stones such as granite and marble, an a molded product such as a tile; or by screening sands such as a river sand and a sea sand, and the transparent inorganic fine particle component contained in  
30 content of 5 wt % or more in the inorganic fine particle component is particles made of

one or more kinds each with achromatic transparency or chromatic transparency such as quartz stone, glass, garnet, amethyst and the like; and the third aspect of the invention is directed to the artificial stone wall material, wherein at least part of the inorganic finer particle component is a luminescent material or a fluorescent material; and the fourth  
5 aspect of the invention is directed to the artificial stone wall material, wherein the luminescent material or the fluorescent material is sintered into a surface of particle of the transparent inorganic fine particle component or covered thereon together with a resin.

The fifth aspect of the invention is directed to the artificial stone wall material  
10 according to anyone described above, wherein at least part of the inorganic fine particle component includes particles having a size in the range of 180  $\mu\text{m}$  to 9.5 mm, obtained by crushing an artificial stone manufactured by molding and solidifying a mixture of an inorganic fine particle component having a size in the range of 180  $\mu\text{m}$  to 9.5 mm, an inorganic finer particle component having a size in the range of less than 180  $\mu\text{m}$  and the  
15 resin component. The sixth aspect of the invention is directed to the artificial stone wall, wherein the artificial stone crushed into particles having a size in the range of 180  $\mu\text{m}$  to 9.5 mm includes a transparent inorganic fine particle component as the inorganic fine particle component; and the seventh aspect of the invention is directed to the artificial stone wall material, wherein the artificial stone crushed into particles having a size in the  
20 range of 180  $\mu\text{m}$  to 9.5 mm includes a luminescent material or a fluorescent material as the inorganic fine particle component.

The eighth aspect of the invention of this application is directed to an artificial stone wall material, wherein the artificial stone wall material according to anyone described above constitutes entirely the surface layer thereof.

25 The ninth aspect of the invention is directed to the artificial stone wall material according to anyone described above, wherein the resin component in the surface portion thereof is removed by dissolution with a solvent or by pressured water or water jet and the transparent inorganic fine particle component is exposed on the surface portion thereof.

30 The tenth aspect of the invention is directed to the artificial stone wall material,

wherein the concavo-convex surface having a maximum height in the range of 1 mm to 100 mm is formed by method of casting with a reverse decoration molding followed by hot pressing, hot extrusion or hot centrifugal molding.

5 The eleventh aspect of the invention is directed to the artificial stone wall material, wherein a metal fitting for attaching the wall material onto a wall surface is molded and embedded integrally at least in any of the rear surface or a lateral side of the molded material having a concavo-convex surface.

#### Brief Description of Drawing

10 Fig. 1 is sectional views showing three types of profiles of wall materials as examples.

#### Best Mode for Carrying out the Invention

15 Description will be given of embodiments of the invention of this application, which has a feature as described above.

The invention of this application has an essential feature of the artificial stone wall material that provides, as described above, sparkling points which change accompanied with irradiation manner and movement of natural light or artificial light, namely with a change in intensity and incidence angle of those lights or the like. The  
20 feature originates from a composition thereof indispensably including:

<A-1> inorganic fine particle component having a size in the range of 180  $\mu$ m to 9.5 mm,

<A-2> inorganic finer particle component having a size in the range of less than 180  $\mu$ m and

25 <B> resin component.

In addition, the <A-1> inorganic fine particle component contains 5 wt% or more of the transparent inorganic fine particle component.

Herein, the <A-1> inorganic fine particle component and the <A-2> inorganic finer particle component realize, as an inorganic aggregate constituting the artificial  
30 stone wall material, physical properties such as a desired degree of strength and a

hardness by being mixed with the <B> resin component. In realization of such a physical property, it is important to combine the two groups of the <A-1> and <A-2> inorganic components different in size of particles. This is because by mixing the <A-1> and <A-2> inorganic components different in size of particles, there is realized the artificial stone wall material high in density as a result of the highest densification in screening filling property. Adjustment in mixing proportion of the <B> resin component achieves the artificial stone wall material having such a native stone-like or a natural appearance that it is impossible to be recognized as a resin molded product at a glance.

A composition in this case preferably contains less than 93 wt% of the <A-1> and <A-2> inorganic components as a total and 7 wt% or more of the <B> resin component, for example on the order in the range of 7 to 70 wt%. Individual percents of combination of the <A-1> and <A-2> inorganic components are generally preferably as follows relative to 100 % of a total amount:

The <A-1> inorganic fine particle component is in the range of 20 to 80 % and the <A-2> inorganic finer component is in the range of 80 to 20 %.

While the <A-1> inorganic fine particle component at a content in the above range includes 5 wt% or more of the transparent inorganic particle component relative to the total of a weight of the <A-1> inorganic fine particle component, the total of the <A-1> inorganic fine particle component may be transparent and a content of the transparent inorganic particle component therein is generally in the range of 5 to 95 wt% and preferably in the range of 10 to 70 wt%.

There may be various kinds of the <A-1> and <A-2> inorganic components and examples thereof include: natural stone particles, mineral particles, ceramic particles, glass particles, particles of a metal or a metal alloy, and others, which can be used alone or two or more kinds. The <A-1> inorganic fine particle component, one of above <A-1> and <A-2> inorganic components, contains 5 wt% or more of the transparent inorganic fine particle component, in which examples of transparent inorganic fine particle components preferably include particles of quartz stone, glass, garnet, amethyst and others with achromatic transparency or chromatic transparency, which are

preferably used alone or two or more kinds in mixture. The other inorganic fine particle component except for the transparent inorganic fine particle component is exemplified as particles obtained by crushing and screening natural stones such as granite and marble and molded products such as a tile, and by screening sands such as a river sand and a sea sand. Advantageous points in the use of a river sand, a sea sand or a dam sedimentation sand as a component in composition are considered that those sands are of energy saving materials because of no crushing, that those sands have rounded corners of particles leading to good fluidity in a mixture prior to solidification and that those sands have a natural feeling to be revealed, and others.

The other inorganic fine particle component may be a particle, on the surfaces of which a luminescent pigment or a fluorescent pigment is coated by means of sintering, or as having a coat layer in mixture with a resin thereon. Such a coated particle can characteristically exert luminescence or fluorescence with a content of 5 wt% or more relative to the total weight thereof.

Such a luminescent pigment or a fluorescent pigment may be contained at least as part of the <A-2> inorganic finer particle component.

The <B> resin component, as a component of a composition of the artificial stone wall material of the invention of this application, may be one of various kinds of polymers and copolymers such as addition polymer or condensation polymer, and may be selected in consideration of a strength, weather resistance, water resistance, oil resistance and the like in connection with a particular application as a wall material. For examples of those, methacrylate resin, acrylate resin, polyester resin, epoxy resin or a composite resin including one or more kinds thereof may be generally preferable.

In the artificial stone wall material of the invention of this application, a recycled material from artificial stone may be used as at least one of the <A-1> and <A-2> fine particle components and the <B> resin component. Examples of the recycled material may include various kinds of materials such as a building material including a floor board or furniture wood; a civil engineering material used in a road or the like; a material manufactured for use in a disaster prevention or the like; and a material discharged in a manufacturing process thereof. The recycled material may be a

particles manufactured in a procedure in which an artificial stone obtained by molding and solidification of a mixture of an inorganic fine particle component having a size in the range of 180  $\mu$ m to 9.5 mm, an inorganic finer particle component having a size in the range of less than 180  $\mu$ m and a resin component is crushed and screened into particles  
5 having a size in the range of 180  $\mu$ m to 9.5 mm. The recycled materials are used at least as part of the <A-1> inorganic fine particle component.

With such use of the recycled material, resource saving and cost saving are achieved.

In a case where a transparent inorganic fine particle component and a  
10 luminescent material or a fluorescent material are mixed into an artificial stone crushed so as to having a size in the range of 180  $\mu$ m to 9.5 mm, a good light emitting performance can be expected.

Note that while it is defined as sizes of the inorganic particle components that the fine particle are in the range of 180  $\mu$ m to 9.5 mm, and finer particles are in the range  
15 of less than 180  $\mu$ m in the above description, for example, actually this classification can be carried out easily by sieves with the nominal openings described in JIS Z 8801-1:2000 corresponding to ISO. The fine particle component having a size in the range of 180  $\mu$ m to 9.5 mm can be classified as a particle remaining by the sieve with 180  $\mu$ m opening and passing through the sieve with 9.5 mm opening. Besides the inorganic finer particles  
20 component having a size in the range of less than 180  $\mu$ m can be classified as a particle passing through the sieve with 180  $\mu$ m opening.

In the invention of this application, the artificial stone wall material as described above may constitute only a surface layer of a wall material for actual application. For example, the above artificial stone wall material may constitute only a  
25 surface layer of a molded product which made from a mixture of a resin and a base material, such as cement-based inorganic material or an inorganic material; or a laminate product or an integrally molded product with other materials. With such a construction, an artificial stone wall material can be provided at a lower cost.

In the artificial stone wall material of the invention of this application, in  
30 addition to the feature of the compositions as described above, it is necessary that the

artificial stone wall material has a concave-convex surface having a maximum height in the range of 1 mm to 100 mm in concavity and convexity and that at least part of the transparent inorganic fine particle component is exposed on the surface thereof. That the concavo-convex surface has a maximum height in the range of 1 mm to 100 mm in  
5 concavity and convexity is an indispensable requirement for being studded with sparkling points which change with irradiation manner and movement of natural or artificial light. If the height in concavity and convexity on a surface is less than 1 mm, it is not sufficient for realizing such sparkling points. In case of exceeding 100 mm, a thickness of a wall finish material is excessively thick to thereby render a cost higher and  
10 enhance constraint on application of the artificial stone wall material to buildings, moreover achieving such points is interfered to the contrary. On the other hand, it is indispensable to expose a transparent inorganic fine particle component. Such an exposure is realized by mixing a transparent component in content of 5 wt% or more relative to a total amount of the <A-1> inorganic fine particle component. If the content  
15 is less than 5 wt%, exposure of the transparent inorganic fine particle component is not sufficient, which makes it difficult to expect for being studded with such sparkling points.

The artificial stone wall material of the invention accompanying concavity and convexity on the surface and exposure of a transparent inorganic fine particle component can be a product obtained by a molding and solidification into a plate or a deformed  
20 shape. Means for the molding and solidification may be of various kinds. Preferable examples to be adopted for molding and solidification include a method of casting with a reverse decoration molding followed by hot pressing, hot extrusion or hot centrifugal molding.

The exposure of a transparent inorganic fine particle component is also realized  
25 effectively by removal of a resin component on the surface portion with a solvent capable of dissolving a resin component on the surface portion and by removal of a resin component on the surface portion by jetting pressured water or water jet onto the surface portion.

With such means, the artificial stone wall material of the invention of this  
30 application makes it possible to be studded with sparkling points which change with

irradiation manner and movement of natural or artificial light. Such an artificial stone wall material has never been known thus far and unrestricted designing can be realized easily by combination of a wall surface portion having a desired gloss with one having less gloss or with one having no gloss (matte).

- 5 A metal fitting for attaching the wall material onto a wall surface may also be embedded and molded integrally at least in any of the rear surface or lateral sides of the molded material having a concavo-convex surface.

In the artificial wall materials provided by the invention of this application, the features as described above are realized, for example, on the basis of physical properties  
10 as a wall material shown in Table 1.

Table 1

|                                                                                                            |             |
|------------------------------------------------------------------------------------------------------------|-------------|
| bending strength                                                                                           | 270~300N/cm |
| Vickers hardness                                                                                           | 950~1150    |
| water absorption coefficient                                                                               | 0.05~0.2    |
| accelerated weather resistance<br>S.W.O.M                                                                  | no anomaly  |
| SUV                                                                                                        | no anomaly  |
| acid/alkali resistance                                                                                     | no anomaly  |
| freezing and thawing test B method<br>over 200 cycles<br>(JIS A 5422 "Fiber reinforced cement sidings")    | no anomaly  |
| impact resistance test<br>500g.....2000mm<br>after falling weight<br>(plate thickness of 18, 21 and 24 mm) | no anomaly  |
| embedded metal fitting pull-up breaking load<br>(mounting strength per each site)                          | 420~1060kgf |

Then, examples are shown below and detailed description will be given of the invention of this application. It is natural that the invention is not intended to be limited by the following examples.

5

#### Examples

##### <Example>

Compositions in the next table were prepared. Herein, MMA indicates methylmethacrylate resin component and as an additive agents, a peroxide type curing catalyst and a light stabilizer were employed.

10

**Table 2**

| compositions                                              | composition 1 | composition 2 | composition 3 | comparative composition |
|-----------------------------------------------------------|---------------|---------------|---------------|-------------------------|
| granite-based river sand inorganic fine particles         | 30w %         | 54w %         |               | 60w %                   |
| andesite-based crushed stone inorganic fine particles     |               |               | 30w %         |                         |
| transparent inorganic fine particles (quartz stone)       | 30w %         | 6w %          | 30w %         |                         |
| inorganic finer particles (aluminum hydroxide)            | 25w %         | 25w %         | 25w %         | 25w %                   |
| MMA                                                       | 14w %         | 14w %         | 14w %         | 14w %                   |
| additive agent and others                                 | 1w %          | 1w %          | 1w %          | 1w %                    |
| transparent inorganic fine particle ratio C/(A + B + C) % | 50            | 10            | 50            | 0                       |

15

The above compositions were subjected to casting followed by hot pressing to thereby form wall materials, respectively. As the surface portions, selected were three types of profiles of wall materials shown in Fig. 1, that is (1) a flat surface, (2) a relief 1 (a design of stacked cut stone with a maximum height in concavity and convexity of 15 mm)

and (3) a relief 2 (a design of small cut stone tile with a maximum height in concavity and convexity of 5 mm). In a case of the relief 1, concavity and convexity are formed with a molding die and in a case of the relief 2, a flat surface is molded and thereafter the surface is processed with water jet thereby into a concave and convex surface.

5            Obtained artificial stone wall materials were visually sensory-evaluated by monitors on a feeling of above described sparkling changing points wherewith a wall surface is studded. The evaluation was performed at 8 a.m., at noon and at 4 p.m. in fine weather using 50 persons as monitors (the number of male persons equal to that of female persons with an even hierarchization over the age ranges of 20 to 30; 31 to 40; 41  
10 to 50; 51 to 60; and 61 to 70) and results were further subjected to on-average comprehensive evaluation.

The criteria of this evaluation are as follows:

A: such sparkling changing points as described above are excellent as wall surface appearance,

15 B: such points are good as wall surface appearance,

C: such points are weak, to the contrary, giving a strange feeling, and

D: no such points were recognized.

Table 3 shows results of the evaluation.

**Table 3**

20

| Compositions             | composition 1 |   |   | composition 2 |   |   | composition 3 |   |   | comparative composition |   |   |
|--------------------------|---------------|---|---|---------------|---|---|---------------|---|---|-------------------------|---|---|
| surface profiles         | ①             | ② | ③ | ①             | ② | ③ | ①             | ② | ③ | ①                       | ② | ③ |
| comprehensive evaluation | B             | A | A | C             | B | A | C             | A | A | D                       | D | D |

It was also confirmed from the results of Table 3 that the wall material of the invention of this application, which gave the comprehensive evaluation A or B observing a wall to be studded with sparkling changing points, provided a preferable superiority in  
25 designing, which has never been known conventionally.

### **Industrial Applicability**

As described in detail above, the invention of this application provides a novel means for finishing a wall surface which is not a conventional design in combination of a  
5 glossy material and matte one but essentially has both functions by itself, but allows easily designing of a wall surface and projecting the effect of the design.

## CLAIMS

1. An artificial stone wall material comprising an inorganic fine particle component having a size in the range of 180  $\mu\text{m}$  to 9.5 mm and an inorganic finer particle component having a size in the range of less than 180  $\mu\text{m}$  and a resin component,  
5 containing 5 wt% or more of a transparent inorganic fine particle component as said inorganic fine particle component, having a concavo-convex surface wherein a maximum height between concavity and convexity ranges 1 mm to 100 mm, being molded and solidified into a shape of plate or a deformed shape, and wherein both the transparent inorganic fine particle component, which is exposed on the surface thereof, and a shape  
10 of the concavo-convex surface are studded with sparkling points which change with irradiation manner and movement of natural light or artificial light.
2. The artificial stone wall material according to claim 1, wherein the inorganic fine particle component except for the transparent inorganic fine particle component is  
15 particles of one or more kinds, obtained by crushing and screening natural stones such as granite and marble, an a molded product such as a tile; or by screening sands such as a river sand and a sea sand, and the transparent inorganic fine particle component contained in content of 5 wt% or more in the inorganic fine particle component is particles made of one or more kinds each with achromatic transparency or chromatic  
20 transparency such as quartz stone, glass, garnet, amethyst and the like.
3. The artificial stone wall material according to claim 1 or 2, wherein at least part of the inorganic finer particle component is a luminescent material or a fluorescent material.  
25
4. The artificial stone wall material according to claim 3, wherein the luminescent material or the fluorescent material is sintered into a surface of particle of the transparent inorganic fine particle component or covered thereon together with a resin.
- 30 5. The artificial stone wall material according to any of claims 1 to 4, wherein at

least part of the inorganic fine particle component includes particles having a size in the range of 180  $\mu\text{m}$  to 9.5 mm, obtained by crushing an artificial stone manufactured by molding and solidifying a mixture of an inorganic fine particle component having a size in the range of 180  $\mu\text{m}$  to 9.5 mm, an inorganic finer particle component having a size in the range of less than 180  $\mu\text{m}$  and the resin component.

6. The artificial stone wall material according to claim 5, wherein the artificial stone crushed into particles having a size in the range of 180  $\mu\text{m}$  to 9.5 mm includes a transparent inorganic fine particle component as the inorganic fine particle component.

7. The artificial stone wall material according to claim 5 or 6, wherein the artificial stone crushed into particles having a size in the range of 180  $\mu\text{m}$  to 9.5 mm includes a luminescent material or a fluorescent material as the inorganic fine particle component.

8. An artificial stone wall material, wherein the artificial stone wall material according to any of claims 1 to 7 constitutes the surface layer thereof.

9. The artificial stone wall material according to any of claims 1 to 8, wherein the resin component in the surface portion thereof is removed by dissolution with a solvent or by pressured water of water jet and the transparent inorganic fine particle component is exposed on the surface portion thereof.

10. The artificial stone wall material according to any of claims 1 to 9, wherein the concavo-convex surface having a maximum height in the range of 1 mm to 100 mm is formed by method of casting with a reverse decoration molding followed by hot pressing, hot extrusion or hot centrifugal molding.

11. The artificial stone wall material according to any of claims 1 to 10, wherein a metal fitting for attaching the wall material onto a wall surface is molded and embedded integrally at least in any of the rear surface or a lateral side of the molded material

**having a concavo-convex surface.**