

ORGANIC POWDER FILLER USEFUL AS THE REPLACEMENT OF MINERAL FILLER IN COMPOSITES.

The present invention is in the field of gel coats, more particularly, gel coat compositions with an organic powder filler material and articles coated with such gel coats.

5 Gel coated composite articles are commonly used in a wide variety of applications. Gel coats provide improved weathering characteristics and surface appearance. In some applications, e.g., countertops and bathroom fixtures, the composite article preferably simulates the appearance of natural materials such as granite, marble or other stone. A number of methods are known to produce the simulated stone appearance.

10 US patent 5,504,126 described a simulated mineral article comprises a discrete suspended plastic material and a continuous thermoplastic matrix. The plastic material and the thermoplastic matrix are visually distinguishable from each other and each contains a coupling agent. The patent also provides a method of preparing a simulated mineral article which entails preparing a liquid thermoplastic to serve as a matrix and then suspending a
15 plastic material therein. The plastic material is composed of a thermoset plastic made from resin which comprises an acid component having thermoplastic characteristics.

 US patent 5,476,895 describes a sprayable coating composition that is useful for forming a simulated granite surface having high-impact strength, superior hardness and an aesthetically-pleasing look. The coating composition has a gel coat and granules which
20 include thermoplastic and thermoset plastic components. The gel coat and granules are visually differentiable from each other, substantially immiscible and substantially isopycnic in density. The composition, when combined with a hardener, may be sprayed into a mold and backed with fiber glass, plastic or other suitable resin to form a panel or similar structure, or may be directly applied to a surface to provide a simulated-granite
25 appearance.

 JP 02-102156 described a hot press molding resin composition to improve transparency and gloss by hot-pressing a molding composition containing an unsaturated polyester resin, curing agent, cured product powder of an unsaturated polyester resin, specific inorganic filler and mold releasing agent.

30 JP 06-25539 described colored resin particles for decorated moldings. The colored resin particles were obtained by dissolving the thermoplastic resin, in uncured thermosetting resin. Filler and pigment were then added into the resin solution and the resin solution was cured and crushed into small pieces.

In one embodiment, the invention is an organic filler useful as the replacement of mineral fillers in gel coats and other type of composites materials, the organic filler comprising from about 50 to 100 wt%, based on the total weight of the filler, of an organic material that comprises at least one of : (a) the reaction products of unsaturated polyester
5 resins, unsaturated polyester/polyurethane hybrid resins, cross-linkable acrylics, melamine, or (b) thermoplastic polymers that are neither soluble in, nor swellable in ethylenically unsaturated monomers.

In another embodiment, the invention is a gel coat composition comprising an organic filler, the organic filler comprising from about 50 to 100 wt%, based on the total
10 weight of the filler, of an organic material that comprises at least one of : (a) the reaction products of unsaturated polyester resins, unsaturated polyester/polyurethane hybrid resins, cross-linkable acrylics, melamine, or (b) thermoplastic polymers that are neither soluble in, nor swellable in ethylenically unsaturated monomers. The said total filler weight should preferably not exceed 50 weight % of the total gel coat composition. The invention does
15 also relate to the resulting gel coat and the article comprising such a gel coat. Other uses are also part of the invention, in coatings such as barrier or skin coats or in composites molding compositions (BMC/SMC composites) and resulting articles.

The invention firstly relates to powder organic filler materials (organic filler) useful as the replacement of mineral fillers, such as aluminum trihydrate, barium sulfate, calcium
20 carbonate, talc, clay, etc., in gel coats, and other type of composite materials. The mineral filler can be entirely or partially replaced by the powder material in the application. The powder materials are made from organic materials. The amount of organic filler material to inorganic filler material in the gel coat composition is from 50/50 to 100/0 by weight, the total of the filler (organic filler + inorganic filler) not exceeding 50% of the total gel coat
25 composition. The maximum particle size of the powder organic filler materials is less than 60 μm . More preferably, the particle size of the organic filler has a typical range of 0.1 to 45 μm , and is visually non-differentiable when incorporated into the gel coats or composites.

The organic materials used to make the organic filler powders are a) the reaction
30 products of unsaturated polyester resins, unsaturated polyester/polyurethane hybrid resins, cross-linkable acrylics, and melamine, or b) thermoplastic polymers that do neither dissolve in (not soluble in) nor swell in (not swellable in) ethylenically unsaturated monomers. The organic filler materials have glass transition temperature above 50°C,

preferably above 60°C. The reaction products have a degree of cure (conversion) above 70%, preferably above 80%. The reaction products have less than 10 wt% volatile content, preferably less than 5% volatile content.

The unsaturated polyester resin has at least one dicarboxylic alkene moiety and is preferably an oligomer of an α,β -ethylenically unsaturated dicarboxylic acid compound obtained by the condensation reaction of one or more of a saturated di- or polycarboxylic acid or anhydride and an unsaturated di- or polycarboxylic acid or anhydride with a glycol or a polyhydric alcohol. The unsaturated polyester resin can also be prepared from unsaturated di- or polycarboxylic acid(s) or anhydride(s) with glycols and/or polyhydric alcohol(s). Examples of suitable saturated di- or polycarboxylic acids include isophthalic, orthophthalic, terephthalic, adipic, succinic, sebacic acid and mixtures of two or more of these compounds with isophthalic acid being preferred. Typical unsaturated carboxylic acids or anhydrides include maleic acid, fumaric acid, citraconic acid, chloromaleic acid, allyl succinic acid, itaconic acid, mesaconic acid, their anhydrides and mixtures of two or more such compounds, with maleic anhydride being the preferred choice. Examples of polyhydric alcohols which are useful in the invention include neopentyl glycol, ethylene glycol, diethylene glycol, triethylene glycol, propylene glycol, dipropylene glycol, 1,4-butanediol, polyethylene glycols, glycerol, mannitol, 1,2-propanediol, pentaerythritol, 1,6-hexanediol, 1,3-butylene glycol and mixtures of two or more of such compounds. The production of such resins is well-known to those skilled in the art and, additionally, many suitable resins are commercially available from resin manufacturers, such as Cook Composites & Polymers Company.

The unsaturated polyester resin solution also contains ethylenically unsaturated monomer. The ethylenically unsaturated monomer can be any ethylenically unsaturated monomer capable of crosslinking the unsaturated polyester resin via vinyl addition polymerization.

Examples of useful ethylenically unsaturated monomers are styrene, o-, m-, p-methyl styrene, methyl acrylate, methyl methacrylate, t-butylstyrene, divinyl benzene, diallyl phthalate, triallyl cyanurate and mixtures of two or more unsaturated monomers. The preferred monomer is styrene because it provides an economical monomer solution.

The reaction products are made through the typical curing processes of thermosetting resins. The typical curing process of thermosetting resin comprises adding initiators and promoters to a resin or resin solution and by (i) curing at ambient

temperature, or (ii) heating the material to elevated temperature to cure the resin, or (iii) curing by exposing the resin to UV light, or (iv) curing by exposing the resin to microwave and submitting the cured product to a size reduction process for obtaining a particle size of less than 60 μ m. The cured materials can be post-cured at elevated temperature to further increase the degree of cure and removal of the volatile materials. The cured organic materials then went through a size reduction process to obtain the final powder product with proper size range. The traditional size reduction process includes ball mill, cryogenic grinding, hammer mill, jet mill, roller mill, etc.

The initiators useful in producing the cured resin compositions of this invention are vinyl polymerization catalysts such as peroxides, persulfides, perborates, percarbonates, and azo compounds or any other suitable catalyst capable of catalyzing the vinyl polymerization of the polyester polyol and/or the ethylenically unsaturated monomer. Illustrative of a few such catalysts are benzoyl peroxide (BPO), tertiarybutyl peroxybenzoate (TBPB), 2,2'-azo-bis-isobutyronitrile, dibenzoyl peroxide, lauryl peroxide, di-t-butyl peroxide, diisopropyl peroxide carbonate and t-butyl peroxy-2-ethylhexanoate. Promoters can also be used in combination with vinyl polymerization peroxide catalysts to control the rate of free radical initiation. A common benzoyl peroxide promoter is N,N-diethylaniline.

Gel coat compositions can be formulated with the organic filler powder of this invention in the usual method. Gel coat compositions include pigment, promoters, catalysts, stabilizers, extenders, and the like as practiced in the art. The amount of organic filler powder material in gel coat composition is of at least about 2 wt%, preferably from about 2 wt% to about 50 wt%, more preferably from about 10 wt% to about 50 wt% of total gel coat formula, with HAP value of less than about 37%. Preferably, the total filler weight does not exceed 50% of the total weight of the gel coat composition. The gel coat materials with the organic powder have uniform color appearance and have improved color stability when exposed to moisture.

The following examples illustrate the preparation of organic fillers and gel coats with the organic filler.

Example 1

1.5 wt% initiators (TBPB) were added into an unsaturated polyester resin containing 60 wt% PG/NPG/IPA/MA (propylene glycol/neopentyl glycol/isophthalic

acid/maleic anhydride) type resin solid and 40 wt% styrene monomer. The resin used was a base resin in CCP STYPOL brand gel coats. The resin solution was poured into metal mold at 150°C and cured for 3 minutes. The cured resin was then broken into small pieces about 1 square inches. The pieces were then grinded to powder with the maximum particle size of 45 µm with a hammer mill.

Example 2

0.15% of 6% cobalt and 1.5 wt% initiators methyl ethyl Ketone peroxide (MEKP) was added into an unsaturated polyester resin containing 60 wt% PG/NPG/IPA/MA type resin solid and 40 wt% styrene monomer (the same resin as used in Example 1). The resin solution was poured into a metal mold at ambient temperature and cured for 12 hours. The cured resin was then post-cured at 65°C for 24 hours and broken into small pieces about 1 square inches. The pieces were then grinded to powder with the maximum particle size of 45 µm with a hammer mill.

Example 3

A gel coat composition is then prepared by blending the following ingredients :

Table 1

Component	Weight Percent
Unsaturated Polyester Resin (same resin as Example 1)	53.6
Organic Fillers from Ex. 1	25.0
Fumed Silica	1.5
Monomer	19.0
Air Release	0.5
12% Cobalt	0.2
Ethylene Glycol	0.2

Example 4

A gel coat composition is then prepared by blending the following ingredients :

Table 2

Component	Weight Percent
Unsaturated Polyester Resin (same resin as Example 1)	53.6
Organic Fillers from Ex. 2	25.0
Fumed Silica	1.5
Monomer	19.0
Air Release	0.5
12% Cobalt	0.2
Ethylene Glycol	0.2

Example 5

A low VOC gel coat composition is then prepared by blending the following
5 ingredients :

Table 3

Component	Weight Percent
Unsaturated Polyester Resin (same resin as Example 1)	53.6
Mineral Fillers	25.0
Fumed Silica	1.5
Monomer	19.0
Air Release	0.5
12% Cobalt	0.2
Ethylene Glycol	0.2

The gel coat from Example 3 was very stable in that it did not gel after three
10 months storage. The gel coat of Example 4 was not stable in that it gelled within one week.

Examples 6 and 7

Pigmented gel coat compositions were prepared by adding 7.5 wt% black pigment
paste into the gel coat composition shown in Examples 3 and 5 :

Table 4

Example 6	Example 7
Gel coat from Example 3 : 92.5 wt%	Gel coat from Example 5 : 92.5 wt%
Black pigment paste : 7.5%	Black pigment paste : 7.5%

The resulting gel coats had a Brookfield viscosity of 18000 - 20000 cps at 4 rpm at 77°C and a thixotropic index of 5.0-7.0. 1.8% methyl ethyl ketone peroxide (MEKP) is used to cure the gel coat. The gel time is around 15 minutes and cure time is around 60 minutes. Two gel coated laminates were prepared by spraying the catalyzed gel coat onto a mold and letting the gel coat cure at the ambient temperature for about one hour. The laminate was then put on the gel coat to about 3.5 mm in thickness. The color of cured gel coat was measured by a spectrophotometer. Part of the gel coated surface was sanded and buffed (known as "buff back"), and the color difference before and after buff back was also compared with the spectrophotometer. Table 5 shows the color difference of cured gel coat from Examples 6 and 7. The results indicated the color difference before and after buff back were much smaller for the gel coat sample from Example 6.

Table 5

Color Difference	Example 6	Example 7
DE	0.93	4.09
DL	0.91	3.90
Da	-0.16	-0.07
Db	0.08	-1.24

Example 8 - Comparison of 100 Hours Water Boil of Laminates

The gel-coated laminates were prepared with the gel coat samples from Examples 6 and 7. The laminates had the cured gel coat thickness around 15 mils. The panels were immersed in boiling de-ionized water for 100 hours, and the color difference before and after boil test was measured by a spectrophotometer. The results indicated the gel coat sample from Example 6 has much less color change compared to the gel coat sample from Example 7.

Table 6

Color Difference	Example 6	Example 7
DE	5.11	12.19
DL	5.09	12.18
Da	0.07	-0.32
Db	-0.48	-0.47

Examples 9 to 11 - Preparation of gel coat with low VOC gel coat resin

A low VOC type unsaturated polyester resin having the viscosity around 500 cP (500 mPa.s) at 70% NVM in styrene, was used to prepare the gel coat samples. Gel coat samples with different level of filler were prepared by blending the ingredients listed in Table 7.

Table 7

	Example 9	Example 10	Example 11
Low VOC Gel Coat Resin	72.3	70.0	67.8
Organic Filler from Ex. 1	4.5	6.8	9.0
Fumed Silica	2.0	2.0	2.0
Monomer	10.3	10.3	10.3
Air Release	0.5	0.5	0.5
12% Cobalt	0.2	0.2	0.2
Ethylene Glycol	0.2	0.2	0.2
Pigment Paste	10.0	10.0	10.0

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The resulting gel coat samples had a Brookfield viscosity of 8000 – 14000 cP (mPa.s) at 4 rpm at 77°C and a thixotropic index of 4.0-6.5. The gel coats were then initiated with 1.8% methyl ethyl ketone peroxide (MEKP) and sprayed onto glass mold with various thicknesses. The gel coats had gel time around 15 minutes and cure time around 60 minutes. The cured gel coat films were then checked for the porosity. Cured gel coat films of Examples 9 to 11 showed porosity at the gel coat thickness around 15, 27, and 40 mils (0.38, 0.69 and 1.02 mm).

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CLAIMS

1. An organic filler for the replacement of mineral fillers in gel coats and other type of composites materials, the organic filler comprising from about 50 to 100 wt%, based on the total weight of the filler, of an organic material that comprises at least one of : (a) the reaction products of unsaturated polyester resins, unsaturated polyester/polyurethane hybrid resins, cross-linkable acrylics, melamine, or (b) thermoplastic polymers that are neither soluble in, nor swellable in ethylenically unsaturated monomers, the said organic filler being in the form of particles having a maximum particle size less than about 60 μm .
2. The organic filler of claim 1, wherein the particle size is in the range of about 0.1 to about 45 μm .
3. The organic filler of claims 1 or 2, wherein the particles are visually non-differentiable from a composite matrix when the particles are incorporated into composites.
4. The organic filler of one of claims 1 to 3, wherein the organic material has a glass transition temperature above about 50°C.
5. The organic filler of claim 4, wherein the organic material has a glass transition temperature above about 60°C.
6. The organic filler of one of claims 1 to 5, wherein the said reaction products a) have a degree of cure above about 70%.
7. The organic filler of claim 6, wherein the reaction products have a degree of cure above about 80%.
8. The organic filler of one of claims 1 to 7, wherein the said reaction products a) have less than about 10 wt% volatile content.
9. The organic filler of claim 8, wherein the said reaction products a) have less than about 5% volatile content.

10. The organic filler of one of claims 1 to 9, wherein the said reaction products a) are made by adding initiators and promoters to the unsaturated polyester resins, unsaturated polyester/polyurethane hybrid resins, cross-linkable acrylics, or melamine to form a curable mixture, and curing the curable mixture by i) curing at ambient temperature, or ii) heating the mixture to elevated temperature, or iii) exposing the mixture to UV light, or iv) exposing the mixture to microwave and then submitting the cured product to a size reduction process for obtaining a powder with a particle size of less than 60 μm .

11. The organic filler of claim 10, wherein the said reaction products a) are further post-cured at elevated temperature to increase the degree of cure and remove the volatile compounds (or reduce volatiles content).

12. A gel coat composition comprising an organic filler as defined according to any one of claims 1 to 11, the amount of organic filler being from 50 to 100 weight % based on the total weight of the filler in gel coat.

13. The gel coat composition of claim 12, wherein the organic filler is present in an amount from about 10 to about 50 wt% of total gel coat composition weight, the total weight of the filler in the gel coat, not exceeding 50% by weight of the total gel coat composition.

14. The gel coat composition of claims 12 or 13, wherein the organic filler is in particle form and the particles are visually non-differentiable from the gel coat.

15. The gel coat composition of claims 12 or 13, further comprising reactive ethylenically unsaturated monomers.

16. The gel coat composition of claim 12, wherein the organic filler is present in an amount of at least about 2 wt%, preferably from 2 to 50 wt% of the total gel coat composition weight and wherein the gel coat composition has a HAP value less than about 37 wt%.

17. A gel coat obtained by curing the gel coat composition of one of claims 12 to 16.

18. An article comprising the gel coat of claim 17.

19. Use of an organic filler according to any one of claims 1 to 11 as filler in gel coats, barrier coats, skin coats or composite molding compositions.