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(54) **SOLID SURFACE COMPOSITES**

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(57) **ABSTRACT**

A class of solid surface composite materials has formula parameters that allow for the production of more abrasion resistant surfaces that can be either designed for fabrication of parts with carbide tipped tools, including saw blades and router bits, or to an even more abrasion resistant surface that will not be able to be machined with carbide tipped tools but will require diamond tipped tools or fabrication by other processes such as spraying, casting, injection molding, or press molding. A range of materials are added to a basic solid surface composite composition to yield the desired abrasion resistance. Depending on the amount and type of material added, the composite material can maintain the ability to fabricate parts with carbide tipped tools or it can be made so resistant so that parts cannot be fabricated with carbide tipped tools.

# SOLID SURFACE COMPOSITES

## BACKGROUND OF THE INVENTION

[0001] The invention relates generally to solid surface composite materials formed of thermoset resins with fillers, and more particularly to solid surface composite materials having compositions that improve abrasion or surface wear resistance and methods for making same. The invention also relates to the production of engineered stone material with abrasion resistant surfaces that can be shaped with carbide wood working tools.

[0002] Historically, solid surface composite materials are heavily filled thermoset resins that require a process step to remove entrapped air. This is done with vacuum mixing equipment.

[0003] The composition of a typical solid surface part is 35% thermoset resin, and 65% alumina trihydrate (ATH), by weight. Unless otherwise indicated, all percentages set forth herein are percentages by weight. The thermoset resin is usually polyester or acrylic resin. Alumina trihydrate is used because it provides a variety of properties including the ability to fabricate finished parts with carbide tipped wood working tools. Harder, more durable materials have generally been avoided because they rapidly abrade the carbide fabrication tools, or require more expensive diamond tools.

[0004] These composite materials are typically used to make artificial or synthetic stone, such as marble, granite or limestone. A primary use of these materials is for counter tops. Corian(R), sold by E.I. du Pont de Nemours and Company, Wilmington, Del., is a widely marketed solid surface material made of an acrylic matrix filled with alumina trihydrate.

[0005] U.S. Pat. No. 6,476,100 to Diao et al. shows solid surface materials made from extrudable acrylic composites with fillers. The materials are designed for high heat resistance and resistance to staining.

[0006] U.S. Pat. No. 4,085,246 to Buser shows acrylic polymer with at least one filler, including ATH and powdered glass, less than 70 microns in size, and other opaque and translucent additives to produce simulated granite. The composite materials are produced through a mixing and casting process. Buser does not identify the range of components that would allow the composites to be fabricated into parts using carbide tipped wood working tools rather than diamond tools. Buser also does not show sprayable applications of an abrasion resistant surface coating.

[0007] U.S. Pat. No. 5,476,895 to Ghahary shows a granite material made in a liquid form as a sprayable coating composition. The composition is made up of a gel coat and granules, including thermoplastic and thermoset plastic components, substantially isopycnic in density to produce the needed suspension characteristics. ATH is an optional filler component.

[0008] U.S. Pat. No. 6,028,127 to Yanagase shows a combination of a vinyl polymer with an inorganic filler greater than 1 micron, and preferably 1 to 80 microns, including ATH and powdered glass, and colloidal metal oxides to make artificial marble. The colloidal metal oxide is a particulate in the range of 1 to 100 nm.

[0009] While a variety of solid surface composite materials are available, none appear to have the combination of high abrasion resistance with the ability to form parts using carbide tipped wood working tools.

## SUMMARY OF THE INVENTION

[0010] Accordingly it is an object of the invention to provide solid surface composite materials combining high abrasion resistance with the ability to form parts using carbide tipped wood working tools.

[0011] It is also an object of the invention to provide an engineered stone material with abrasion resistant surfaces ranging from being machinable with carbide tipped tools to not being machinable with carbide tipped tools.

[0012] The invention is a class of solid surface composite materials with formula parameters that allow for the production of more abrasion resistant surfaces that can be either designed for fabrication of parts with carbide tipped tools, including saw blades and router bits, or to an even more abrasion resistant surface that will not be able to be machined with carbide tipped tools but will require diamond tipped tools. Shaped parts can also be formed by other processes than machining. The invention includes a range of materials that are added to a basic solid surface composite composition to yield the desired abrasion resistance. Depending on the amount and type of material added, the composite material can maintain the ability to fabricate parts with carbide tipped tools or it can be made so resistant so that parts cannot be fabricated with carbide tipped tools.

[0013] A solid surface composite material of the invention comprises a thermoset resin and a filler in the thermoset resin selected to provide a desired abrasion resistance to the composite material. The filler may be selected so that the composite material is machinable with carbide tipped wood working tools. In one composite material formulation, the filler comprises about 10% to 40% by weight alumina trihydrate, about 20% to 50% by weight abrasion resistant filler, and about 5% to 40% by weight solid surface granules. In another composite material formulation, the filler comprises about 20% to 50% by weight abrasion resistant fillers, and about 50% to 80% by weight granules.

[0014] A shaped part may be made from the solid surface composite material by mixing a liquid thermoset resin with a filler selected to provide a desired abrasion resistance to the composite material, and forming the shaped part from the mixture of resin and filler by spraying, casting, injection molding, or press molding. The shaped part may be formed by spraying the mixture as a surface coating on a shaped substrate or by spraying the mixture as a surface coating into a mold and then filling the mold with a substrate material.

## DESCRIPTION OF THE INVENTION

[0015] The composite materials of the invention are based on the basic solid surface composite materials known in the prior art and made up of a thermoset resin, usually polyester or acrylic resin, with a variety of fillers, with alumina trihydrate (ATH) being the most common filler. A typical composition is 35% resin and 65% filler. The basic components and the methods of making the composites are well known in the art and are illustrated by U.S. Pat. Nos. 6,476,100; 6,028,127; 4,085,246; 5,476,895; 6,790,393;

6,777,476; 6,756,446; 6,747,075; 5,226,651; 4,346,144; 3,876,587; 3,752,870; 3,847,865; 3,663,493; 3,324,074; and Re27,093, all of which are herein incorporated by reference.

[0016] The improvement provided by the present invention is the discover that particular additives or fillers, in particular amounts, can be used to produce the desired material properties. The fillers or additives are combined with the themoset resin to from the composite material.

[0017] In general the formula for producing solid surface materials according to the invention is to replace a portion of the ATH filler usually combined with the resin with another material. Preferably about 10% to 40% by weight of the ATH is replaced.

[0018] In a first aspect of the invention, the preferred particulate formula for fillers to produce a granite effect is as follows: Aluminum trihydrate 10% to 40% by weight Abrasion resistant filler 20% to 50% by weight Solid surface granule. 5% to 40% by weight

[0019] The abrasion resistant filler can be selected from any finely ground glass, ceramic, quartz, calcined alumina, or any mineral of suitable hardness. The preferred particulate size is below 20 microns. The solid surface granules are made of a thermoset resin and ATH or a suitably soft filler material. This first formulation will generally be machinable with carbide tipped tools.

[0020] In a second aspect of the invention, the preferred particulate formula for fillers to produce a granite effect is as follows: Abrasion resistant filler 20% to 50% by weight Granules 50% to 80% by weight

[0021] The abrasion resistant filler may be of a larger size than in the first formulation, i.e. greater than 20 microns, and the granules may be crushed quartz or other materials to give a desired visual effect. The granules may be abrasion resistant materials. This second formulation will generally not be machinable with carbide tipped tools.

[0022] To produce a solid color formula the granule. portion of the formula is replaced with ATH in the first formulation, and with abrasion resistant materials in the second formulation.

[0023] Shaped parts can be made without the need for machining. These particulate systems according to the above formulations can be mixed with a liquid thermoset resin and made into a finished part by a variety of well known processes, including spraying, casting, injection molding, or press molding. The preferred formula for each process may vary.

[0024] The casting, injection molding, and press molding processes yield a homogeneous composite, while the spray process only requires the surface to be abrasion resistant. The abrasion resistant composite material can be sprayed onto a surface of another material or into a mold. A particular spray process includes the following steps: 1. Spray between 20 and 50 mils thickness of the material into a mold. 2. Back the coating up with a cast or reinforced matrix to provide strength.

[0025] The invention includes the filler compositions described above in both dry and wet formulations, i.e. dry filler systems or premixed liquid systems.

[0026] The invention is typically used to make artificial, simulated or synthetic stone materials, particularly granite or marble. These materials have a variety of applications, including particularly kitchen and bath counter tops, walls, and decorative objects.

[0027] Changes and modifications in the specifically described embodiments can be carried out without departing from the scope of the invention which is intended to be limited only by the scope of the appended claims.

**1-18**. (canceled)

**19**. A method of making an abrasion resistive shaped part, comprising:

mixing a thermoset resin with a filler material to create an abrasion resistive mixture; and

applying said abrasion resistive mixture to the part by spraying.

**20**. The method of claim 19, wherein said applying step comprises spraying said mixture into a mold to surface coat said mold, and filling the mold with a substrate material.

**21**. The method of claim 19, wherein said applying step comprises spraying said mixture directly onto the shaped part, said shaped party being previously formed.

**22**. The method of claim 19, wherein said filler material comprises:

between about 20% and about 50% by weight abrasion resistant filler; and

between about 5% and about 40% by weight solid surface granules.

**23**. The method of claim 22, wherein said abrasion resistant filler is selected from ground glass, ceramic, quartz, and calcined alumina.

**24**. The method of claim 22, wherein said solid surface granules comprise a thermoset resin and alumina trihydrate.

**25**. The method of claim 19, wherein said filler material comprises:

between about 20% and about 50% by weight abrasion resistant filler; and

between about 50% and about 80% by weight solid surface granules.

**26**. The method of claim 25, wherein said abrasion resistant filler is selected from ground glass, ceramic, quartz, and calcined alumina.

**27**. The method of claim 25, wherein the granules are crushed quartz.

**28**. The method of claim 25, wherein the granules are abrasion resistant materials.

**29**. The method of claim 19, wherein said mixture is sprayed to a thickness of between about 20 and about 50 millimeters.

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