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(54) **METHODE DE PREPARATION DE MATERIAUX CERAMIQUES**

(54) **METHOD FOR PREPARING A CERAMIC-FORMING PREPREG TAPE**

(57) A tacky, drapeable, ceramic-forming sheet is prepared by (a) dispersing in water a ceramic-forming powder and a fiber, (b) flocculating the dispersion by adding a cationic wet strength resin and an anionic polymer, (c) dewatering the flocculated dispersion to form a sheet; (d) wet pressing and drying the sheet, and (e) coating or impregnating the sheet with a ceramic-forming adhesive that is a polymeric ceramic precursor, or a dispersion of an organic binder and the materials used to form the sheet. The sheets can be stacked on top of one another to form laminates, which are then fired to consolidate the sheets to a ceramic.

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PATENT

Brungardt Case 1

METHOD FOR PREPARING A TACKY, DRAPEABLE CERAMIC-FORMING SHEET

Abstract of the Disclosure

A tacky, drapeable, ceramic-forming sheet is prepared by (a) dispersing in water a ceramic-forming powder and a fiber, (b) flocculating the dispersion by adding a cationic wet strength resin and an anionic polymer, (c) dewatering the flocculated dispersion to form a sheet, (d) wet pressing and drying the sheet, and (e) coating or impregnating the sheet with a ceramic-forming adhesive that is a polymeric ceramic precursor, or a dispersion of an organic binder and the materials used to form the sheet. The sheets can be stacked on top of one another to form laminates, which are then fired to consolidate the sheets to a ceramic.

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This invention relates to a wet forming process for making a sheet from ceramic-forming powders and fibers.

In general, the traditional methods used to shape ceramics, such as slip-casting, tape-casting and hot-pressing, are slow and labor-intensive, and the green bodies that are formed by these methods are often fragile and difficult to handle. Papermaking methods have also been proposed for shaping ceramic powders. For example, U.S. 3,899,555 discloses a method for making a porous ceramic honeycomb structure by making a sheet on a papermaking machine from an aqueous dispersion of particulate ceramic material and short cellulose fibers, draining water from the sheet, drying, forming into a plasticized green honeycomb structure and baking to sinter the particulate ceramic material and burn off the cellulose fibers. U.S. 4,421,599 discloses a fibrous material for the preparation of a sheet material containing large amounts of inorganic fine powders by papermaking methods. The raw material for forming the fibrous material, e.g., cellulose fibers, synthetic fibers, metal fibers or inorganic fibers, is previously impregnated with a polymer flocculant of the polyacrylamide type. U.S. 4,488,969 discloses a self-supporting fibrous matrix such as cellulose containing microparticulates such as fumed silica

or alumina immobilized therein and flocculating amounts of an organic polycationic resin and an organic polyanionic resin. U.S. 4,529,662 discloses a non-asbestos flexible sheet material made by dewatering a layer of aqueous slurry on a water-permeable conveyer and compressing and drying the dewatered layer. The aqueous slurry contains china clay, mica or chlorite, graphite, cellulose fibers, vitreous fiber in wool form and a synthetic organic polymer binder.

However, these methods have several disadvantages. It is difficult to form dense ceramics by these methods since the amount of fibrous material needed to form a strong sheet on a continuous paper machine limits the density of the resulting ceramic "green", i.e., unfired, body and in turn, the density of the fired ceramic. The mechanical strength of the fired ceramic is usually directly related to the ceramic's density, i.e., dense ceramics are generally stronger than porous ceramics. In addition, the preparation of highly filled paper sheets is limited to the use of ceramic-forming powders that yield strong green bodies. For example, an inorganic sheet filled with silicon nitride or silicon carbide disintegrates to powder as the wood pulp burns out during firing. Moreover, some of the prior art ceramic sheet materials are difficult to prepare in a continuous process, some are difficult to handle because they lack strength in the wet state, most are not flexible enough to be wound into shapes such as multi-layer tubes, and none are tacky and drapeable.

The process of this invention for preparing a sheet from an aqueous dispersion of a ceramic-forming powder and a fiber, followed by dewatering of the dispersion, wet pressing and drying, is characterized by (a) flocculating the dispersion by adding a cationic wet strength resin and an anionic polymer, and (b) coating or impregnating the sheet with a ceramic-forming adhesive that is a ceramic precursor, or a

dispersion of an organic binder and the materials used to form the sheet. Also according to the invention, the sheets can be stacked on top of one another to form laminates, which are then fired to consolidate the sheets to a ceramic.

The green sheets of this invention are drapeable and highly filled, can be formed by a continuous papermaking process and are typically stronger and more flexible than green sheets formed by prior art methods, particularly when wet. The coated or impregnated sheets can be stored in the unfired state and can subsequently be stacked or wound to build up multilayer, three dimensional shapes such as laminates, tubes and honeycombs. Because of their tacky surface, they can be used to form multilayer structures without a separate step for applying an adhesive. Since a significant amount of the adhesive is also converted to a ceramic, a denser product is obtained than would be possible without the use of the adhesive.

Fibers suitable for use in the process of this invention include, for example, wood pulp, polyolefin pulp, carbon fiber, glass fiber and alumina fiber. A mixture of fibers can also be used. The desired end use of the product will determine whether inorganic or organic fibers are selected. For example, an inorganic fiber is used when a ceramic with increased fracture toughness is desired. An organic fiber, which is subsequently burned out, is used if a porous material is desired, e.g., for filtration applications. When making a porous ceramic, any organic filler commonly used in the ceramics art for making porous materials, e.g., walnut shell flour or sawdust, can be used in addition to the fiber.

Any type of ceramic-forming powder can be used in the process of this invention, e.g., clays, oxide ceramics, and non-oxide ceramics. Although the ceramic materials are referred to as "powders" throughout this specification, it

should be understood that these materials can also be in the form of whiskers and platelets. When a dense ceramic product is desired, a sintering aid can be added to the starting mixture. The sintering aid used will depend upon which ceramic-forming powder is employed to make the sheet. For example, alumina and yttria are typically used as sintering aids for silicon nitride powder, while CaO, MgO and SiO_2 are typically used with alumina powder.

The type and amount of fiber used depends upon the desired end use of the product. When using inorganic fibers, the amount used is determined by the degree of reinforcement desired in the end product. For example, a minimum of 20-30% by weight inorganic fiber is typically used for making a reinforced ceramic composite. When using organic fibers, the porosity of the product increases with the amount of fiber used. If the product is to be used as a filter, enough organic material must be added to form a continuous network of pores after the material is burned out, typically at least 20% by weight organic fiber or at least 35-40% by volume of organic filler.

After the fiber and ceramic-forming powder are dispersed in water, the dispersion is flocced by adding a cationic wet strength resin and an anionic polymer. The order of addition of the cationic and anionic polymers is not critical, although the cationic polymer is generally added first. Examples of suitable cationic wet strength resins include KYMENE^R 2064, KYMENE^R 557H, KYMENE^R 367, KYMENE^R 450 and KYMENE^R 460 amine-epichlorohydrin resins, which are commercially available from Hercules Incorporated. The cationic resins provide wet strength during sheet formation, particularly when using a continuous papermaking process, and during the subsequent coating or impregnating step. Suitable anionic polymer flocculating agents include, for example, RETEN^R 523P and RETEN^R 235 polyacrylamide resins, both

manufactured by Hercules Incorporated, and carboxymethyl cellulose. The flocculated dispersion is dewatered to form a sheet in which the fibers and inorganic powder are uniformly dispersed, and the sheet is wet pressed and dried. The sheet can optionally be calendered after drying.

After the drying step the sheet is coated or impregnated with an adhesive to make a tacky, drapeable product. The adhesive can be a polymeric ceramic precursor that is liquid or fusible, or a dispersion of an organic binder and the materials from which the sheet is formed. Suitable polymeric ceramic precursors include, for example, polysiloxanes, polycarbosilanes, and polysilazanes. The polymeric ceramic precursor can be used with or without a solvent, depending upon its viscosity. When a solution of a preceramic polymer is used as an impregnant, the sheets are dried to evaporate the solvent, although the surface remains tacky.

An adhesive comprising a dispersion of an organic binder and the materials used to form the sheet is typically used when making porous sheets, and is generally applied by coating. Suitable organic binders include, for example, starch and poly(vinyl alcohol)-based commercial adhesives such as Elmer's GLUE-ALL. The adhesive containing the organic binder can include the organic filler, if one is used, but generally does not contain the fiber used to form the sheet. Sheets coated with an adhesive containing an organic binder are preferably stored in such a manner that the water or solvent does not evaporate.

When forming laminates by stacking several sheets on top of each other, the composition of the sheets used to form the layers can be the same or different. After stacking, the layers are pressed, with or without heating, and fired to consolidate the material to a ceramic by standard methods. Ceramics formed by this method can be used to prepare capacitors, heat-exchangers, filters, and catalyst supports.

Example 1

A dispersion is prepared by mixing 48 g of walnut shell flour, 145.5 g of an alumina dispersion (69% solids in water), 640 g of a wood pulp dispersion (2.5% solids, white hardwood bleached kraft), and sufficient water to dilute the mixture to 16 liters. After transferring a 2 liter portion of this dispersion to a glass jar and a second dilution to 3 liters, the dispersion is flocced by first adding 6 ml of a solution of KYMENE^{R} 2064 cationic synthetic resin (Hercules Incorporated) (3.75% solids in water), followed by 95 g of an aqueous solution of RETEN^{R} 235 anionic synthetic resin supplied by Hercules Incorporated (0.125% solids) until the supernatant becomes clear and a cottony floc is formed. An 8" x 8" (20.3 x 20.3 cm) sheet is formed from the flocced dispersion on a Noble and Wood handsheet machine. A 100 mesh stainless steel papermaking screen is used to form the sheet. The drainage of the sheet is rapid (approximately 10 seconds), and paper formation is good. The sheet is then wet pressed and dried. Five additional handsheets are formed from the dispersion using an identical procedure. Calculations based on the weight of the sheet show that retention of the alumina and the organic filler is greater than 95%.

Six squares of the alumina paper (2.5" x 2.5") (6.35 x 6.35 cm) are soaked in a solution consisting of 79% polydimethylsiloxane (7.5% vinyl-methyl copolymer supplied by Petrarch Systems, Inc.), 1% dicumyl peroxide, and 20% 1,1,1-trichloroethane. The squares are then air dried for 24 hours to remove the solvent. Once dried, a six layer laminate is stacked and pressed by hand.

The laminate is pressed at 1,000 psi (70 kg/cm^2) at 150°C. for one hour on a Carver Laboratory Press to cure the siloxane polymer. One-sixteenth inch (0.16 cm) shims are

used to control the thickness of the pressed laminates. Curing is continued without pressure in a 125°C. oven for an additional 16 hours.

The dried laminate is fired in air according to the following schedule: 60°C./hour, room temperature to 200°C; 10°C./hour, 200°C. to 400°C; 60°C./hour, 400°C. to 800°C; 120°C./hour, 800°to 1400°C; hold at 1400°C. for 4 hours; cool to room temperature.

A ceramic body having a density of 1.72 g/cc is formed from the laminate.

Example 2

Silcon nitride (37.67 g), 1.67 g of yttrium oxide, 0.83 g of alumina and 0.125 g of sodium tripolyphosphate are dispersed in 500 ml of distilled water using a Waring Blendor. After transferring the dispersion to a 1 gallon (3.8 liters) jar, 10.00 g of wood pulp are added as a dilute dispersion in distilled water (approximately 2.5% solids). Distilled water is added to raise the solution level to 3 liters. The dispersion is flocced by first adding unactivated KYMENE^{R} 2064 cationic synthetic resin supplied by Hercules Incorporated (6.48 g of a 19.3% solids solution) to the dispersion, followed by adding an aqueous solution of carboxymethyl cellulose (CMC) type 7-H, supplied by The Aqualon Group (1.0% solids) until the supernatant becomes clear. Typically, 79.2 g of the CMC solution are required. Three 8" x 8" (20.3 x 20.3 cm) sheets are formed from 1000 ml aliquots of this dispersion on a Noble and Wood handsheet machine. A 100 mesh stainless steel papermaking screen is used. The drainage of water from the flocced dispersion is rapid (14 seconds). Paper formation is good. Each sheet is then wet pressed and dried. Calculations based on the weight of the paper show greater than 95% inorganic powder retention.

Each sheet of silicon nitride paper is pressed at 6,000 psi (422 kg/cm^2) using a Carver Laboratory Press. The pressed samples are then cut into 1" x 3" (2.54 x 7.62 cm) strips.

Poly(methylvinyl)silazane to be used as the adhesive for the sheets is prepared as follows. A 5 liter, three-necked flask is equipped with an overhead mechanical stirrer, a dry ice/acetone condenser (-78°C), an ammonia/nitrogen inlet tube and a thermometer. The apparatus is sparged with nitrogen and then charged with hexane (1760 ml, dried over 4 A molecular sieves), methyldichlorosilane (209 ml, 230.9 g, 2.0 mol) and vinylmethyldichlorosilane (64 ml, 69.6 g, 0.5 mol). The ammonia is added at a rate of 3.5 l/min (9.37 mol) for one hour. During the addition, the temperature of the reaction rises from 25°C to 69°C. After one hour, the ammonia flow is stopped and the reaction mixture cooled to room temperature. The reaction mixture is filtered on a glass-fritted funnel to remove the precipitated ammonium chloride. The hexane is removed from the filtrate under reduced pressure (28 mm Hg, 60°C) to give $(CH_3SiHNH)_{0.8}(CH_3SiCH{=}CH_2NH)_{0.2}$ as a clear oil (150.76 g, 2.34 mol, 94% yield). The oil has a viscosity of 43 cps (43 mPa) at 25°C and a molecular weight of 560 g/mol.

Ten silicon nitride strips are impregnated by soaking for 1 hour in a solution of the poly(methylvinyl)silazane containing 1% dicumyl peroxide. Excess polysilazane is wiped off and the strips are stacked and pressed by hand.

The silicon nitride laminate is pressed at 2,500 psi (176 kg/cm^2) and 160°C for 10 minutes on a Carver Lab Press to cure the polysilazane. One-eighth inch (0.3 cm) shims are used to control the thickness of the pressed laminate.

The laminate is fired according to the following schedule: 60°C./hour, room temperature to 500°C., in air;

120°C/hour, 500°to 1500°C., in nitrogen; hold at 1500°C. for 2 hours; cool to room temperature.

A solid, dark blue ceramic with a density of 1.53 g/cc is formed.

Example 3

Cordierite paper is prepared as follows. A dispersion is prepared by mixing 36.2 g of talc, 36.88 g of kaolin clay, 4.51 g of alumina powder, and 0.25 g of sodium tripolyphosphate in 500 ml of distilled water using a Waring Blendor. After transferring the clay dispersion to a 1 gallon (3.8 liters) jar, 22.38 g of wood pulp are added as a dilute dispersion in distilled water (2.5% solids). The dispersion is then diluted to 3 liters with distilled water and flocced by first adding 2.5 g of unactivated KYMENE^{R} 2064 cationic synthetic resin supplied by Hercules Incorporated (26.15 g of a 9.56% solids aqueous solution), followed by an aqueous solution of carboxymethyl cellulose (CMC), type 7H, supplied by The Aqualon Group until the supernatant becomes clear. Typically, 80 g of CMC solution are required. A total of six 8" x 8" (20.3 x 20.3 cm) sheets are formed from 500 ml aliquots of the flocced dispersion on a Noble and Woods hand-sheet machine. A 100 mesh stainless steel papermaking screen is used to form the sheet. The drainage of the sheet is rapid (approximately 10 seconds), and paper formation is good. Each sheet is then wet pressed and dried. Calculations based on the weight of the sheet show that retention of the inorganic powders is greater than 95%. The dried cordierite paper is calendered on both sides at 1250 pounds per linear inch (p.l.i.) (22,325 kg/m) using a Perkins calender. Each calendered sheet is then cut into 1" x 3" (2.54 x 7.62 cm) strips for lamination.

A laminate is formed from ten 1" x 3" (2.54 x 7.62 cm) strips of calendered cordierite sheet that have been coated

on both sides with a dispersion consisting of 95.0 g of a 10% aqueous starch solution and 90.5 g of the mixture of talc, clay and alumina used to prepare the cordierite sheet. The strips are stacked, pressed by hand, and dried for 30 minutes at 125°C. The laminate is then pressed at 6,000 psi (422 kg/cm^2) for 2 minutes on a Carver Laboratory Press, and dried for 48 hours at 125°C.

The dried cordierite laminate is fired in air according to the following schedule: 60°C./hour, room temperature to 800°C.; 120°C/hour, 800° to 1300°C; hold at 1300°C for 4 hours; cool to room temperature.

A porous ceramic with a density of 1.3 g/cc is formed.

Example 4

A porcelain sheet is prepared as follows. A dispersion is prepared by mixing 28.03 g of feldspar, 23.88 g of kaolin clay, 26.17 g of alumina, and 0.25 g of sodium tripolyphosphate in 500 ml of distilled water using a Waring Blendor. After transferring the clay dispersion to a 1 gallon (3.8 liters) jar, 21.91 g of wood pulp are added as a dilute dispersion in distilled water (2.5% solids). The dispersion is then diluted to 3 liters with distilled water and flocced by first adding 2.5 g of unactivated KYMENE^R 2064 cationic synthetic resin supplied by Hercules Incorporated (26.15 g of a 9.56% solids aqueous solution), followed by an aqueous solution of carboxymethyl cellulose (CMC) type 7H, supplied by The Aqualon Group, until the supernatant becomes clear. Typically, 80 g of CMC solution are required. A total of six 8" x 8" (20.3 x 20.3 cm) sheets are formed from 500 ml aliquots of the flocced dispersion on a Noble and Woods handsheet machine. A 100 mesh stainless steel papermaking screen is used to form the sheet. The drainage of the sheet is rapid (approximately 20 seconds), and paper formation is

good. Each sheet is then wet pressed and dried. Calculations based on the weight of the sheet show that retention of inorganic powders is greater than 95%.

A laminate is formed from ten 1" x 3" (2.54 x 7.62 cm) strips of calendered porcelain sheet that have been coated on both sides with a dispersion consisting of 95.0 g of a 10% aqueous starch solution and 90.5 g of the mixture of feldspar, clay, and alumina used to prepare the porcelain sheet. The strips are stacked, pressed by hand, and dried for 30 minutes at 125°C. The laminate is then pressed at 6,000 psi (422 kg/cm^2) for 2 minutes on a Carver Laboratory Press, and dried for 48 hours at 125°C.

The dried porcelain laminate is fired in air according to the following schedule: 60°C./hour, room temperature to 800°C; 120°C/hour, 800°to 1300°C; hold at 1300°C. for 4 hours; cool to room temperature.

A solid ceramic with a density of 2.4 g/cc is formed.

Example 5

An alumina dispersion is prepared by milling a 50% solids slurry of alumina and water in a vibratory mill. Alumina cylinders are used as the grinding medium. Sodium tripolyphosphate (0.25% based on alumina solids) is used as the dispersant. The milled dispersion (170 g) and 600 g of a wood pulp dispersion (2.5% solids) are mixed in a 1 gallon (3.8 liters) jar. The dispersion is then diluted to 3 liters with distilled water and flocced by first adding 2.5 g of unactivated KYMENE^R 2064 cationic synthetic resin supplied by Hercules Incorporated (26.15 g of a 9.56% solids aqueous solution), followed by an aqueous solution of carboxymethyl cellulose type 7H supplied by The Aqualon Group (1.0% solids) until the supernatant becomes clear. Typically, 200 g of CMC solution are required. Four 6" x 6" (15.2 x 15.2 cm) sheets are formed from 500 ml aliquots of the flocced dispersion on

a Noble and Woods handsheet machine. A 100 mesh stainless steel papermaking screen is used to form the sheet. The drainage of the sheet is rapid (approximately 20 seconds), and paper formation is good. The sheets are then wet pressed and dried. Calculations based on the weight of the sheet show that alumina retention is greater than 95%.

A cylinder is formed by wrapping a sheet of the inorganic paper that has been coated on both sides with adhesive around a paper mandrel. The adhesive is a dispersion of 95.0 g of a 10% aqueous starch solution and 95.5 g of the alumina used to form the sheet. Three additional sheets are added to increase the thickness of the cylinder. The cylinder is then dried in an oven overnight.

Example 6

A dispersion is prepared by mixing 32 g of walnut shell flour, 145.5 g of alumina dispersion (69% solids in water), 640 g of a wood pulp dispersion (2.5% solids, white hardwood bleached kraft), and sufficient water to dilute the mixture to 16 liters. After transferring a 2 liter portion of this dispersion to a glass jar and a second dilution to 3 liters, the dispersion is flocced by first adding 6 ml of a solution of KYMENE^{R} 2064 cationic synthetic resin supplied by Hercules Incorporated (3.75% solids in water), followed by 90 g of an aqueous solution of RETEN^{R} 235 anionic synthetic resin supplied by Hercules Incorporated (0.125% solids) until the supernatant becomes clear and a cottony floc is formed. An 8" x 8" (20.3 x 20.3 cm) sheet is then formed from the flocced dispersion on a Noble and Wood handsheet machine. A 100 mesh stainless steel papermaking screen is used to form the sheet. The drainage of the sheet is rapid (approximately 10 seconds), and paper formation is good. The sheet is then wet pressed and dried. Seven additional handsheets are formed from the dispersion using an identical procedure. Calculations based on the weight of the sheet show that

retention of alumina and the organic filler is greater than 95%.

A laminate is formed from eight 2.5" x 2.5" (6.35 x 6.35 cm) squares of alumina sheet that have been coated on both sides with a dispersion consisting of 20.0 g of a commercial polyvinyl alcohol-based adhesive (Elmer's GLUE-ALL), 20 g of walnut shell flour, and 90.0 g of the alumina dispersion used to prepare the sheet. The squares are stacked, pressed by hand, and dried for 30 minutes at 125°C. The laminate is then pressed at 6,000 psi (422 kg/cm^2) for 2 minutes on a Carver Laboratory Press, and dried for 48 hours at 125°C.

The dried alumina laminate is fired in air according to the following schedule: 60°C./hour, room temperature to 200°C; 5°C./hour, 200°C. to 250°C; 30°C./hour, 250°C. to 300°C; 5°C./hour, 300°C. to 375°C; 60°C/hour, 375°to 1600°C. hold at 1600°C. for 4 hours; cool to room temperature.

A porous ceramic with a density of 1.56 g/cc is formed.

Example 7

A handsheet is prepared from a dispersion of the materials listed below using the procedure described in Example 5: 6.0 g chopped alumina fiber (1/8" (0.32 cm), supplied by Du Pont); 34.0 g alumina powder; 0.10 g sodium tripolyphosphate.

KYMENE^R 2064 cationic synthetic resin (1.0 g) supplied by Hercules Incorporated (5.18 g of a 19.3% solids solution) and 75.0 g of an aqueous solution of carboxymethyl cellulose type 7H supplied by The Aqualon Group (1.0% solids) are used to floc the dispersion. The sheet is strong and well-formed. Retention of alumina powder is approximately 95%.

A laminate is formed from twelve 1" x 3" (2.54 x 7.62 cm) strips of the alumina/alumina fiber sheet that have been coated on both sides with a dispersion consisting of 95.0 g of a 10% aqueous starch solution and 90.5 g of the

alumina used to prepare the sheet. The strips are stacked, pressed by hand, and dried for 30 minutes at 95°C. The laminate is then pressed at 6,000 psi (422 kg/cm^2) for 2 minutes on a Carver Laboratory Press, and dried for 48 hours at 125°C.

The dried alumina laminate is fired in air according to the following schedule: 60°C./hour, room temperature to 800°C; 120°C/hour, 800°to 1600°C; hold at 1600°C. for 4 hours; cool to room temperature.

A solid ceramic with a density of 2.7 g/cc is formed.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A process for preparing a sheet from an aqueous dispersion of a ceramic-forming powder and a fiber, followed by dewatering of the dispersion, wet pressing and drying, characterized by (a) flocculating the dispersion by adding a cationic wet strength resin and an anionic polymer, and (b) coating or impregnating the sheet with a ceramic-forming adhesive that is a polymeric ceramic precursor, or a dispersion of an organic binder and the materials used to form the sheet.

2. The process as claimed in claim 1, further characterized in that the sheet is calendered after wet pressing and drying.

3. The process as claimed in claims 1 or 2, further characterized in that the adhesive is a polymeric ceramic precursor.

4. The process as claimed in claims 1 or 2, further characterized in that the polymeric ceramic precursor is selected from a polysiloxane, a polysilazane and a polycarbosilane.

5. The process as claimed in claim 1, further characterized by adding an organic filler to the aqueous dispersion of ceramic-forming powder and fiber.

6. The process as claimed in claim 5, further characterized in that the organic filler is walnut shell flour.

7. The process as claimed in claims 1, 2, or 5, further characterized in that the fiber is an organic fiber.

8. The process as claimed in claims 1, 2, or 5, further characterized in that the ceramic-forming powder is alumina and the fiber is wood pulp.

9. The process as claimed in claims 1, 2, or 5, further characterized by forming the sheets by a continuous papermaking process.

10. The process as claimed in claims 1, 2, or 5, further characterized by firing the coated or impregnated sheet to consolidate the sheet to a ceramic.

11. The process as claimed in claims 1, 2, or 5, further characterized by stacking a multiplicity of layers of the coated or impregnated sheet to form a laminate, pressing the laminate, and firing to consolidate the sheets to a ceramic.

12. A sheet made from a mixture of a ceramic-forming powder and a fiber, characterized in that the sheet is coated or impregnated with a ceramic-forming adhesive that is a polymeric ceramic precursor or a dispersion of an organic binder and the materials used to form the sheet.

13. A sheet as claimed in claim 12, further characterized in that it also comprises an organic filler.

14. A sheet as claimed in claim 13, further characterized in that the organic filler is walnut shell flour.

15. A sheet as claimed in claims 12 or 13, further characterized in that the fiber is an organic fiber.

16. A sheet as claimed in claims 12 or 13, further characterized in that the ceramic-forming powder is alumina and the fiber is wood pulp.

17. A sheet as claimed in claims 12 or 13, further characterized in that the polymeric ceramic precursor is a polysiloxane, a polysilazane or a polycarbosilane.

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