



(51) International Patent Classification:

*C08L 3/02* (2006.01)      *B01J 13/00* (2006.01)  
*C08J 3/12* (2006.01)      *C09K 3/00* (2006.01)  
*C10M 169/00* (2006.01)

(21) International Application Number:

PCT/US2013/036507

(22) International Filing Date:

13 April 2013 (13.04.2013)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/636,628      21 April 2012 (21.04.2012)      US

(71) Applicant: **OOBIEQ LTD** [US/US]; An S Corporation of The State of Maryland, 30 Office Street, Bel Air, MD 21014 (US).

(72) Inventor; and

(71) Applicant : **ZICKER, William** [US/US]; 30 Office Street, Bel Air, MD 21014 (US).

(74) Agent: **BEHR, Omri, M.**; The Behr Office, 325 Pierson Ave., Edison, NJ 08837-3554 (US).

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM,

AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

- with international search report (Art. 21(3))
- with amended claims (Art. 19(1))



**WO 2013/158510 A1**

(54) Title: STARCH BASED DILATANT COMPOSITION

(57) Abstract: There is provided a novel adhesive shear thickening dilatant fluid and process for the formation thereof comprising the sequential steps of adding to a gel comprising starch and water and adding thereto a sufficient portion of dry solid material, suitably a starch, to form a kneadable solid which is dry to the touch. In particular it is directed to a material whose principle component is uncooked waxy corn starch.

## Starch based Dilatant Composition

### Field of the Invention

5

[001] Non toxic dilatant compositions based on starch which may be molded formed and reformed and remain workable for a substantial period of time.

### Background of the invention

10

[002] Dilatant compositions made with uncooked finely divided starch suspended in water are well known. They are often used to demonstrate shear thickening. Their disadvantages are also well known. Principally once uncooked starch is put into suspension it immediately begins to settle out of suspension. Furthermore once the material is exposed to air it rapidly dries out and can no longer be used. Starch, uncooked, mixed with water yields a material that is either crumbly or runny. While it may be dilatant, it is not well suited to being molded.

15

[003] Over the years many attempts have been made to overcome some of these problems but none solve all of the problems associated with them.

20

[004] While there are a number of more stable shear thickening compositions, many require unusual or synthetic materials. Starch based shear thickening materials provide plant based non toxic compositions. There is a need for a more stable starch based material that demonstrates shear thickening.

25

[005] Materials useful for the purposes of the present invention have been in the market for many years. Silicone putty (Silly Putty®) is made of silicone oil, it is a dilatant, but can NOT be formed and dried, is relatively expensive and tends to stain objects it contacts, it is NOT biodegradable, lasts long after it gets dirty, and can NOT be cleaned.

30

[006] Play doughs (like Play Doh®) are made of wheat (gluten) and/or starch but are not dilatant. They can be formed and dried and are relatively inexpensive. They tend to be messy, and are usually biodegradable. They last long after they get dirty, and cannot be cleaned.

35

[007] The product produced by the process of the present invention is made of starch, is dilatant and can be formed and dried. It is kneadable, relatively inexpensive, very easy to clean up, and is biodegradable. After use it eventually changes to liquid, becomes crumbly and can be discarded as it gets dirty. It is not understood why the addition of a dry uncooked starch to a gel initially formed from water and starch, suitably, but not limited to dry starch, gives rise to such a product.

[008] The product is significantly more stable than a suspension of uncooked finely divided starch in a liquid medium such as water. After repeated squeezing beyond the kneading of production, the product will begin to break down. While the specific mechanism causing this is not well understood, this appears to take the form of water being released from the starch gel. Separately, if exposed to the air, water will evaporate and the material will dry and become solid

[009] After the material becomes more fluid it is still fun to play with, though somewhat more messy. As the material is used, it naturally collects dust and dirt, as well as other residues from hands or surfaces in contact with the material. Eventually it is discarded, and is biodegradable.

## 20 **Discussion of the prior art.**

[0010] US 3167440 discloses a pliable craft modeling composition made of starch (as "wheat flour") in water, and including salt and borax.

[0011] US4375535 discloses using high amylopectin starch in a chemically modified composition to make an aqueous dispersion that does not thicken. This document appears to provide some relevant details of the physical and chemical behavior of amylopectin in various chemical media and conditions.

[0012] US5362777 discloses a "thermo plastically processable starch" in which a gum (i.e. polysaccharide) involving saccharide units is used in addition to an already dispersed starch in an aqueous solution. Products made with this composition include extruded tubes.

[0013] US5614243 discloses a food formulation including pregelatinized starch and an insoluble ingredient (e.g.,  $\text{TiO}_2$ ), in order to provide a texturized product.

5 [0014] US 6713624 discloses a starch-based modeling compound including a starch-based binder and 2-10% of a "retrogradation inhibitor," such as a waxy corn starch. The invention of the present application is distinguishable from Hasbro patent 6713624 both in that the present invention has a suspended uncooked starch component, and exhibits shear thickening properties.

10 [0015] US 6713624 patent material lacks a suspended uncooked starch component, and exhibits shear thinning properties like many play doughs.

[0016] US 7861637 discloses a "pressure impulse mitigation" structure, e.g., a body armor, including a gel with additional ingredients. This document broadly covers the use of nearly any dilatant gel composition including a wide range of additional ingredients that may act as particulate matter in the gel. Also, see column 3, lines 22-25 in which the gel can be a polysaccharide, and an additional "thickener" can be starch, see column 4, lines 27-2.

20 [0017] This invention relates to a plastic modeling composition of a soft pliable, working consistency for being molded into any desired shape or form and is slow-drying so as to be retained in a workable moldable condition for a long period of time to be repeatedly reworked and molded into different shapes and forms. It particularly pertains to a modeling composition for children's play, and is clean, non-sticky and non-staining

25

### Summary of the invention

[0018] One of the main objects of the invention is a modeling composition which may be reworked and remolded, or may be used for modeling objects which are more or less permanent. Another object of the invention is a modeling composition which is easily compounded and another object of the invention is a modeling composition which is efficient in use.

[0019] Another object of the invention is a modeling composition which is non-toxic

35

[0020] Another object of the invention is a modeling composition in which additives such as colorants, texturants, odorants, flavorants and the like different colors may be incorporated. However care should be taken that the quantity of such additives do not affect its moldable consistency or shelf life.

5

[0021] The compositions may be molded into objects adapted to be painted with conventional water and oil based paints

10

[0022] Further objects, and objects relating to details of construction and composition, will readily appear from the detailed description to follow. The objects of the invention have been accomplished by the means set forth in the following specification. The invention is clearly defined and pointed out in the appended claims; example compositions are also set forth for carrying out the invention. Generally described the invention comprises a composition consisting essentially of vegetable flour, such as grain flour which is adapted to be gelatinized and water only although other ingredients may be added as will appear below.

15

[0023] There is provided a process for the formation of an adhesive shear thickening dilatant fluid comprising adding to a starch gel, a sufficient portion of dry non toxic solid material to form a kneadable solid .

20

[0024] Suitably there is provided a process for the formation of an adhesive shear thickening dilatant fluid comprising adding to a starch gel, a sufficient portion of uncooked starch to form a kneadable solid . In such a process it has been found suitable to use an aqueous based starch gel and as the added starch dry uncooked starch. Any starch may be used for this purpose including but not limited to wheat starch, potato starch, rice starch and tapioca starch . However it is preferred to use corn starch most suitably waxy corn starch containing high levels of amylopectin, most desirably at least 90% by weight of amylopectin.

25

[0025] Any starch gel prepared by any method may be used. Commercially available starch gels are generally satisfactory. The gels may be prepared by methods well known in the art either in ambient temperature solvents or heated solvents generally water, but not limited thereto.

30

35

[0026] One embodiment of the of the present invention is the provision of a shear thickening dilatant fluid and a process for the formation thereof comprising the sequential steps of forming a gel comprising a first portion of starch and water and adding a sufficient second portion of a dry non toxic solid material, suitably a dry starch to said gel to form a kneadable solid which is dry to the touch.

[0027] Suitably, the second portion of solid material is corn starch although other very finely divided materials may also be viable.

10 [0028] Suitably the process comprises swelling said first portion of starch in water to a temperature sufficient to form said gel, allowing the said thus formed gel to cool to ambient temperature, mixing said second portion of starch with said gel and applying sufficient pressure to said mixture to form a kneadable solid.

15 [0029] The nature of the starch is not critical, however it has been found useful to utilize corn starch, preferably waxy maize starch which is principally amylopectin most suitably containing at least 90% preferably 99% by weight of amylopectin, as the starch. The use of high or pure amylopectin and the absence of amylose enhances the shelf life of the product.

20

### **Description of the preferred embodiments**

[0030] Where a pregelatinized or cold water swelling starch is used as the first starch it will form a gel at ambient temperatures . No substantial amount of heating such as boiling is needed

25 \

[0031] It is desirable that the process comprises combining at least three parts by weight of starch with each 100 parts by weight of water to form a gel and adding to each 100 parts by weight of gel from about 50 to about 150 parts by weight of dry uncooked starch. In particular there should be employed 5 to 10 parts by weight of starch with each 100 parts by weight of water to form the gel and adding to each 100 parts by weight of gel, from about 67 to about 133 parts by weight of dry starch.

30

[0032] Most suitably, there are combined 5 to 10 parts by weight of starch with each 100 parts by weight of water to form the gel and there are added to each 100 parts by weight of gel from about 60 to about 80 parts by weight of dry starch.

5 [0033] There may be added other components to improve the quality of the final product. These qualities include strength, flexibility, non-stickiness, stretchability and shelf life.

10 [0034] The quality of the dilatant fluid produced by this process may be enhanced by the use of one or more additive materials selected from the group consisting of a humectant, such as glycerin, a lipid, suitably a low acid oil, such as canola oil, a non toxic salt, suitably a salt of a strong acid such as sodium or potassium chloride and the like and borax said additive material being a component of at least one member of the group consisting of the starch gel and the added starch. The designation of  
15 such additives is merely illustrative and not limiting.

[0035] The best shelf life is provided by the use of amylopectin as both of the starch components. Use of amylopectin in an air tight container will provide a shelf life of several months or more. Addition of a humectant, including but not limited to  
20 glycerin, provides an extended usable time outside of a sealed container.

[0036] The addition of antimicrobial agents is also helpful. These need not be of a complex or sophisticated nature. Most non toxic salts of strong bases and strong acids will be adequate. Common salt or sodium chloride may be readily employed.  
25

[0037] In order to improve the stretchability of the final product , borax has been found useful. The addition of lipids or vegetable oils, suitably low acid vegetable oils such as canola oil is useful to improve the smoothness of the product and is helpful in avoidance of the product sticking to the hands.  
30

[0038] Any or all of these quality enhancing components may be used. The amounts employed will vary with the nature and quantities of the starch used in the basic material and the effect desired. There is no absolute limitation as to the amount of such components which can be added. Nevertheless it has been found useful to

limit the total weight of these additional components to about 15% by weight of the final product containing them.

**Examples**

Example 1

[0039] Very fluid material, unstable due to syneresis within two weeks.

5

**Wet component:**

Water	200 g
Cornstarch (not modified, about 25% amylose, 75% amylopectin)	10 g
emulsifying wax flakes (polysorbate 60 & cetearyl alcohol)	2 g
dimethicone (polymethylsiloxane)	1 g

**Dry Component**

Cornstarch (not modified, about 25% amylose, 75% amylopectin)	250 g
Baking Soda	260 g

[0040] Wet component ingredients were combined and heated to 100° C while stirring gently. After the liquid thickened, it was removed from the heat source and allowed to cool to room temperature. Thereafter the dry ingredients were added and stirred gently to combine.

10

Example 2

[0041] Very fluid material, unstable due to syneresis within two weeks.

15

**Wet component:**

Water	100 g
Tapioca Starch	5 g
Psyllium Hydrophilic Mucilloid powder	5 g

**Dry Component**

Cornstarch (not modified, about 25% amylose, 75% amylopectin)	37 g
Borax	4 g

[0042] Wet component ingredients were combined and heated to 100° C while stirring gently. After the liquid thickened , it was removed from the heat source and allowed to cool to room temperature. Thereafter the dry ingredients were added and stirred gently to combine

Example 3

[0043] Reasonably good putty, unstable due to syneresis within two weeks.

**Wet component:**

Water	100 g
Tapioca starch	5 g

**Dry Component**

Cornstarch (not modified, about 25% amylose, 75% amylopectin)	57 g
Borax	4 g

[0044] Wet component ingredients were combined and heated to 100° C while stirring gently. After the liquid thickened , it was removed from the heat source and allowed to cool to room temperature. Thereafter the dry ingredients were added and stirred gently to combine

## Example 4

[0045] Reasonably good putty, unstable due to syneresis within two weeks.

**Wet component:**

Water	400 g
Cornstarch (not modified, about 25% amylose, 75% amylopectin)	36 g
Borax	9 g
NaCl salt	4 g

**Dry Component**

Cornstarch (not modified, about 25% amylose, 75% amylopectin)	250 g
Palm Oil	15 g

5

[0046] Wet component ingredients were combined and heated to 100° C while stirring gently. After the liquid thickened, it was removed from the heat source and allowed to cool to room temperature. Thereafter the dry ingredients were added and stirred and kneaded to combine.

10

## Example 5

[0047] Not as soft or stretchy as desired, unstable due to syneresis within two weeks.

15

**Wet component:**

Water	50 g
Wheat flour	7 g
Borax	9 g

**Dry Component**

Cornstarch (not modified, about 25% amylose, 75% amylopectin)	30 g
---	------

[0048] Wet component ingredients were combined and heated to 100° C while stirring gently. After the liquid thickened , it was removed from the heat source and allowed to cool to room temperature. Thereafter the dry ingredients were added and stirred and kneaded to combine.

5

Example 6

[0049] Good shelf life, good material qualities, requires cooking.

**Wet component:**

Water	186 g
ThermFlo modified corn starch, 99% Amylopectin, mfg by Ingredient	21 g
Borax	12 g
NaCl Salt	18 g

**Dry Component**

ThermFlo modified corn starch, 99% Amylopectin, mfg by Ingredient	135 g
Canola oil	16 g

10

[0050] Wet component ingredients were combined and heated to 100° C while stirring gently. After the liquid thickened , it was removed from the heat source and allowed to cool to room temperature. Thereafter the dry ingredients were added and stirred and kneaded to combine.

15

Example 7

[0051] Excellent shelf life, excellent material qualities, no cooking required.

20

**Wet component:**

Water (warm)	1260 g
UltraTex SR, cold water swelling modified corn starch, 99% Amylopectin, mfg by Ingredion	162 g
Borax	72 g
NaCl salt	108 g
Glycerin	120 g

**Dry Component**

ThermTex modified corn starch, 99% Amylopectin, mfg by Ingredion	930 g
Canola Oil	90 g
Glycerin	40 g

[0052] Combine wet components and allow setting as a gel, adding dry component stirring gently, and then kneading mixture, stopping when material becomes smooth and forms a cohesive mass.

5

[0053] Glycerin acts as a humectant delaying drying out. Borax increases cross linking of starch gel, and thus material stability. Salt contributes to antimicrobial property. Canola is a low acid oil that reduces stickiness without damaging starch gel stability.

10

Example 8

[0049] Cornstarch and water only ingredients, lasts only minutes before drying out. Material that results is not shelf stable due to retrogradation of the starch gel.

**Wet component:**

Water	418 g
Cornstarch (not modified, about 25% amylose, 75% amylopectin)	22 g

**Dry Component**

Cornstarch (not modified, about 25% amylose, 75% amylopectin)	560 g
--	-------

**[0050]** Wet component ingredients were combined and heated to 100° C while stirring gently. After the liquid thickened, it was removed from the heat source and allowed to cool to room temperature. Thereafter the dry ingredients were added and stirred and kneaded to combine.

5

Example 9

**[0051]** Material is stable, but prone to drying out easily.

**Wet component:**

Water	418 g
UltraTex SR (Ingredient) cold water swelling waxy maize modified food starch (99%+ Amylopectin)	22 g

**Dry Component**

ThermTex (Ingredient) uncooked waxy maize modified food starch (99%+ Amylopectin)	560 g
---	-------

10

**[0052]** Modified cornstarch and water are the only ingredients, cooking not required. The wet components were combined and allowed to set as a gel, dry component added while stirring gently, then the mixture was kneaded, stopping when material become smooth and formed a cohesive mass

15

Example 10

**[0053]** Material that results is not shelf stable due to retrogradation of the starch gel. Cornstarch and water are the only ingredients. The material lasts only minutes before drying out.

20

**Wet component:**

Water	418 g
Cornstarch (not modified, about 25% amylose, 75% amylopectin)	22 g

**Dry Component**

56% ThermTex (Ingredient) uncooked waxy maize 560 g  
 modified food starch (99%+ Amylopectin)

**[0054]** Wet component ingredients were combined and heated to 100° C while stirring gently, after the liquid thickened , it was removed from the heat source and allowed to cool to room temperature. Thereafter the dry ingredients were added and stirred and kneaded to combine.

Example 11

**[0055]** Very stable material results.

10

**Wet component:**

Water 4529 g  
 Borax, finely divided solid 259 g  
 NaCl salt, finely divided solid 388 g  
 Glycerin 431 g  
 UltraTex SR (Ingredient) cold water swelling waxy maize 582 g  
 modified food starch (99%+ Amylopectin)

**Dry Component**

ThermTex (Ingredient) uncooked waxy maize modified 3343 g  
 food starch  
 Canola 324 g  
 Glycerin 144 g

**[0056]** Wet components were mixed with water at ambient The wet components were combined stirred and allowed to set as a gel in about 10 minutes, dry component added while stirring gently, then the mixture was kneaded, stopping when material become smooth and formed a cohesive mass

**[0057]** Glycerin acts as a humectant, delaying drying out. Borax increases cross linking of starch gel, and thus material stability. Salt contributes to antimicrobial

property. Canola is a low acid oil that reduces stickiness without damaging starch gel stability.

Example 12

5

**[0058]** High-quality material results. Stability highly variable, and limited by type of starch used in gel.

**Wet component:**

Water	4529 g
Borax, finely divided solid	259 g
NaCl salt, finely divided solid	388 g
Glycerin	431 g
Starch: any type of starch, or any combination of modified or unmodified starches (Rice, Potato, Tapioca, Corn, etc.)	582 g

**Dry Component**

Starch: any type of starch, or any combination of modified or unmodified starches (Rice, Potato, Tapioca, Corn, etc.)	3343 g
Canola	324 g
Glycerin	144 g

10 **[0059]** All wet non starch components are mixed into water heated to 37°C. Mix in starch, stirring slowly, cook if required to form gel, heating to about 100°C depending on starch type as starch begins to gel, allow setting for 10 minutes. Then add dry components stirring gently, knead mixture, stopping when material becomes smooth and forms a cohesive mass.

15

**[0060]** Glycerin acts as a humectant, delaying drying out. Borax increases cross linking of starch gel, and thus material stability. Salt contributes to antimicrobial property. Canola is a low acid oil that reduces stickiness without damaging starch gel stability. Glycerin, borax, salt and canola are each optional, and may be used in any combination independent of each other.

20

## Example 13

[0061] Material of fair quality. Stability highly variable, dependent on starch used.

**Wet component:**

Water	4762 g
Starch: any type of starch, or any combination of modified or unmodified starches (Rice, Potato, Tapioca, Corn, etc.)	238g

**Dry Component**

Starch: any type of starch, or any combination of modified or unmodified starches (Rice, Potato, Tapioca, Corn, etc.)	5000 g
--	--------

- 5 [0062] Cook wet components if required to form gel, heating to about 100° C depending on starch type. Stir slowly as starch begins to gel, allow to set 10 minutes and reach room temperature. Add dry component stirring gently, then knead mixture, stopping when material becomes smooth and forms a cohesive mass.

## 10 Example. 14

[0063] Gel made with less starch. Material of variable quality and stability, dependent on starch used.

**Wet component:**

Water	5882 g
Starch: any type of starch, or any combination of modified or unmodified starches (Rice, Potato, Tapioca, Corn, etc.)	176 g

**Dry Component**

Starch: any type of starch, or any combination of modified or unmodified starches (Rice, Potato, Tapioca, Corn, etc.)	3942 g
--	--------

- 15 [0064] Cook wet components if required to form gel, heating to about 100° C depending on starch type. Stir slowly as starch begins to gel, allow to set 10 minutes and reach room temperature. Add dry component stirring gently, then knead mixture, stopping when material becomes smooth and forms a cohesive mass.

Example 15

Prepared in accordance with US Patent 6713624

**Wet component:**

Water	500 g
Starch: Wheat flour	400 g
High Amylopectin Corn Starch	100g

5

Mixed all ingredients and heated slightly while mixing, to simulate heat generated by larger batch mixed for 5 minutes as illustrated in the Hasbro patent. All starch in the mixture gelatinized and resultant material was not significantly different in texture and material properties from any number of well known play dough materials.

10

Example. 16

[0065] Gel made with more starch. Material of variable quality and stability, dependent on starch used.

**Wet component:**

Water	4115 g
Starch: any type of starch, or any combination of modified or unmodified starches (Rice, Potato, Tapioca, Corn, etc.)	412 g

**Dry Component**

Starch: any type of starch, or any combination of modified or unmodified starches (Rice, Potato, Tapioca, Corn, etc.)	5473 g
---	--------

15

[0066] Cook wet components if required to form gel, heating to about 100°C depending on starch type. Stir slowly as starch begins to gel, allow to set for 10 minutes and reach room temperature. Add dry component stirring gently, then knead mixture, stopping when material becomes smooth and forms a cohesive mass.

20

[0067] In accordance with any of the foregoing procedures, in place of creating the initial gel there may be used starch gel, and this is commonly known to persons skilled in the art, which may be made using "cold water swelling (CWS)" or "cook up" starch. CWS starch does not require heating to form a gel with water, cook up starch

does require heating. Heating temperature and duration required to gel "cook up" starches in water varies by type of starch, and may be affected by other additives such as salt.

5

I claim

1. A process for the formation of an adhesive shear thickening dilatant fluid comprising  
5 adding to a starch gel, a sufficient portion of dry non toxic solid material to form a kneadable solid.
2. A process for the formation of an adhesive shear thickening dilatant fluid comprising adding to a starch gel, a sufficient portion of uncooked starch to form a  
10 kneadable solid.
3. The process of claim 2 wherein the added starch. Is dry uncooked starch.
4. The process of claim 3 wherein the starch gel is an aqueous based starch gel.  
15
5. The process of claim 2 wherein the added starch is corn starch.
6. The process of claim 5 wherein the corn starch is principally amylopectin.
- 20 7. The process of claim 6 where said corn starch comprises at least 90% by weight of amylopectin.
8. The process of claim 3 or 6 which comprises utilizing an initial starch gel containing at least three parts by weight of starch with each 100 parts by weight of  
25 water and adding to each 100 parts by weight of gel from about 50 to about 150 parts by weight of dry starch.
9. The process of claim 8 which comprises utilizing an initial starch gel containing about 5 to about 10 parts by weight of starch with each 100 parts by weight of  
30 water and adding to each 100 parts by weight of gel from about 67 to about 133 parts by weight of dry starch.
10. The process of claim 8 which comprises utilizing an initial starch gel containing combining about 10 to about 15 parts by weight of starch with each 100 parts by

weight of water and adding to each 100 parts by weight of gel from about 60 to about 80 parts by weight of dry starch.

11. The process of claim 2 additionally comprising as an additive material, at least  
5 one member selected from the group consisting of a humectant, a lipid, a non toxic salt, and borax said additive material being a component of at least one member of the group consisting of the starch gel and the added starch.

12. The dilatant material of claim 11 wherein said additive material comprises up to  
10 about 15% by weight of the entire dilatant material.

13. The process of claim 11 wherein said additive material at least comprises a salt of a strong acid.

14. The process of claim 11 wherein the said additive material at least comprises  
15 borax.

15. The process of claim 11 wherein the said additive material at least comprises a  
lipid.

20

16. The process of claim 15 wherein the said lipid is a low acid oil.

17. The process of claim 16 wherein the oil is canola oil.

18. The process of claim 11 wherein the humectant is glycerin.

19. The process of claim 13 wherein the salt is sodium chloride

20. An adhesive shear thickening dilatant fluid material produced by the process of  
30 claim 2.

21. The dilatant material of claim 20 additionally comprising as an additive material, at least one member selected from the group consisting of a humectant, a lipid, a non toxic salt, and borax.

35

22. The dilatant material of claim 21 wherein said additive material comprises up to about 15% by weight of the entire dilatant material.

## AMENDED CLAIMS

received by the International Bureau on 26 September 2013 (26.09.2013)

1. A process for the formation of an adhesive shear thickening dilatant fluid comprising adding to a member of the group consisting of uncooked starch and cold water swelling starch, completely gelled in a solvent consisting of water only, a sufficient portion of dry non toxic solid material and stirring said gel and said solid material for a time sufficient to form a kneadable smooth and cohesive mass.
2. A process for the formation of an adhesive shear thickening dilatant fluid comprising adding to a member of the group consisting of uncooked starch and cold water swelling starch, completely gelled in a solvent consisting of water only, a sufficient portion of dry uncooked starch and stirring said gel and said dry uncooked starch for a time sufficient to form a kneadable smooth and cohesive mass.
3. The process of claim 2 wherein the added starch is corn starch.
4. The process of claim 3 wherein the corn starch is principally amylopectin.
5. The process of claim 4 where said corn starch comprises at least 90% by weight of amylopectin.
6. The process of claim 2 or 5 which comprises utilizing an initial starch gel containing at least three parts by weight of starch with each 100 parts by weight of water and adding to each 100 parts by weight of gel from about 50 to about 150 parts by weight of dry starch.
7. The process of claim 6 which comprises utilizing an initial starch gel containing about 5 to about 10 parts by weight of starch with each 100 parts by weight of water and adding to each 100 parts by weight of gel from about 67 to about 133 parts by weight of dry starch.
8. The process of claim 6 which comprises utilizing an initial starch gel containing combining about 10 to about 15 parts by weight of starch with each 100 parts by weight

of water and adding to each 100 parts by weight of gel from about 60 to about 80 parts by weight of dry starch.

9. The process of claim 2 additionally comprising providing, as an additive material, at least one member selected from the group consisting of a humectant, a lipid, a non toxic salt, and borax said additive material being a component of at least one member of the group consisting of the starch gel and the added starch.

10. The process of claim 9 wherein said additive material comprises up to about 15% by weight of the entire dilatant material formed in said process.

11. The process of claim 9 wherein said additive material at least comprises a salt of a strong acid.

12. The process of claim 9 wherein the said additive material at least comprises borax.

13. The process of claim 9 wherein the said additive material at least comprises a lipid.

14. The process of claim 13 wherein the said lipid is a low acid oil.

15. The process of claim 14 wherein the oil is canola oil.

16. The process of claim 9 wherein the humectant is glycerin.

17. The process of claim 11 wherein the salt is sodium chloride.

18. An adhesive shear thickening dilatant fluid material produced by the process of claim.

19. The dilatant material of claim 18 additionally comprising as an additive material, at least one member selected from the group consisting of a humectant, a lipid, a non toxic salt, and borax.

20. The dilatant material of claim 19 wherein said additive material comprises up to about 15% by weight of the entire dilatant material.

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2013/036507****A. CLASSIFICATION OF SUBJECT MATTER****C08L 3/02(2006.01)i, C08J 3/12(2006.01)i, C10M 169/00(2006.01)i, B01J 13/00(2006.01)i, C09K 3/00(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

C08L 3/02; C04B 16/00; C09J 103/12; B32B 9/02; C09D 103/00; C13F 3/00; C09J 3/06; C09J 103/02; B32B 3/28; C08J 3/12; C10M 169/00; B01J 13/00; C09K 3/00

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean utility models and applications for utility models  
Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) &amp; Keywords: shear thickening, dilatant, starch, dry, water, adhesive

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0576221 A2 (ABR FOODS LIMITED) 29 December 1993 See abstract; claim 1; column 3, line 8-13; column 3, lines 39-56; column 4, lines 49-51.	1-22
A	JP 05-320597 A (HONSHU PAPER CO., LTD.) 3 December 1993 See abstract; claim 1; paragraph [0014].	1-22
A	JP 07-076677 A (NAT'L STARCH & CHEM. INVESTMENT HOLDING CORP.) 20 March 1995 See abstract; claim 1.	1-22
A	EP 0038627 A2 (CPC INTERNATIONAL INC.) 28 October 1981 See abstract; claims 1, 3; page 6, lines 13-16.	1-22
A	US 2011-0300394 A1 (WELSCH, GREGORY W. et al.) 8 December 2011 See abstract; claim 1.	1-22
A	US 2004-0216639 A1 (ATKINSON, JEFFREY G.) 4 November 2004 See abstract; claim 26.	1-22

 Further documents are listed in the continuation of Box C. See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family


Date of the actual completion of the international search

25 July 2013 (25.07.2013)

Date of mailing of the international search report

**26 July 2013 (26.07.2013)**

Name and mailing address of the ISA/KR


 Korean Intellectual Property Office  
 189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City,  
 302-701, Republic of Korea

Facsimile No. +82-42-472-7140

Authorized officer

KIM Dong Seok

Telephone No. +82-42-481-8647



## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

**PCT/US2013/036507**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0576221 A2	29/12/1993	EP 0576221 A3 GB 9213174 D0	18/05/1994 05/08/1992
JP 05-320597 A	03/12/1993	None	
JP 07-076677 A	20/03/1995	AT 179449 T AU 6328594 A AU 663256 B2 BR 9402139 A CA 2124611 A1 CA 2124611 C DE 69418090 D1 DE 69418090 T2 EP 0627477 A1 EP 0627477 B1 ES 2134292 T3 US 05393336 A US 05454863 A	15/05/1999 08/12/1994 28/09/1995 04/07/1995 02/12/1994 08/12/1998 02/06/1999 23/12/1999 07/12/1994 28/04/1999 01/10/1999 28/02/1995 03/10/1995
EP 0038627 A2	28/10/1981	AR 231302 A1 AU 542496 B2 AU 6875381 A BR 8101776 A CA 1165058 A1 DE 3174836 D1 DK 134380 A DK 149925 B DK 149925 C EP 0038627 A3 EP 0038627 B1 ES 500776 D0 ES 8202050 A1 FI 70588 B FI 70588 C FI 801289 A GB 2072693 A GB 2072693 B IN 160786 A1 MX 159063 A MY 8500987 A MY 98785 A NO 151830 B NO 151830 C NO 801158 A NZ 196565 A PH 18685 A SE 450004 B SE 450004 C SE 8002989 A	31/10/1984 21/02/1985 01/10/1981 29/09/1981 10/04/1984 24/07/1986 29/09/1981 27/10/1986 22/06/1987 21/04/1982 18/06/1986 01/01/1982 01/04/1982 06/06/1986 13/10/1987 29/09/1981 07/10/1981 25/07/1984 01/08/1987 14/04/1989 31/12/1985 31/12/1985 04/03/1985 12/06/1985 29/09/1981 27/04/1984 29/08/1985 01/06/1987 10/09/1987 29/09/1981

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2013/036507**

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
		SE 8002989 L	29/09/1981
US 2011-0300394 A1	08/12/2011	AU 2011-264699 A1 CN 103068855 A EP 2576211 A2 WO 2011-155979 A2 WO 2011-155979 A3	10/01/2013 24/04/2013 10/04/2013 15/12/2011 26/01/2012
US 2004-0216639 A1	04/11/2004	US 2003-0019397 A1 US 6716280 B2 US 7033426 B2	30/01/2003 06/04/2004 25/04/2006