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AND CHEWING GUM INCLUDING THE SORBITOL COMBINATION

(57) Abstract: A method of manufacturing a chewing gum, comprises selecting a ratio of a first sorbitol powder to a second sorbitol powder that results in a chewing gum having rheological properties within a target range, wherein the second sorbitol powder comprises sorbitol crystals having a predetermined crystal size that is at least three times larger than a crystal size of the first sorbitol powder; and mixing the first sorbitol powder and the second sorbitol powder with a gum base to form the chewing gum having the rheological properties within the target range. Chewing gum compositions are also provided.



PROCESS OF USING SORBITOL OF SMALL AND LARGE CRYSTAL SIZES TO ACHIEVE GUM TEXTURE AND CHEWING GUM INCLUDING THE SORBITOL COMBINATION

BACKGROUND

[0001] Chewing gums available today generally contain a water-insoluble gum base, sweeteners, natural or artificial flavors, and a variety of additional components tailored to provide specific characteristics. For example, some chewing gums can include plasticizers or softeners to improve consistency during chew. Sugarless chewing gums often employ powdered polyols such as sorbitol, as bulk sweeteners.

[0002] When manufacturing facilities transfer from one source of sorbitol to another, a change in texture is often observed in sorbitol powder-containing chewing gum formulations following a change in the supplier of the sorbitol product. However, a change in the supplier can have a significant impact on the final texture of the prepared chewing gum composition, particularly when no other changes are made to the formulation. In some instances, the gum produced may be too soft to package, and in other instances, too firm for consumer liking. Thus, in order to achieve a chewing gum composition having a similar texture and/or hardness using the new sorbitol product, the chewing gum formulations often are modified and tested multiple times until the chewing gum has the desired properties. This “tweaking” process involves the production of multiple sample batches of chewing gum which is costly, inefficient, and time consuming.

[0003] There is a therefore need for a reliable, efficient, cost-effective method for manufacturing a sorbitol-containing chewing gum composition which results in a composition having the desired properties, and which requires little to no optimization when switching from one source of sorbitol to another.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] Referring now to the figures, which are exemplary embodiments, and wherein the like elements are numbered alike.

[0005] Figure 1 is a graph showing the chewing gum Peak Force (PF) (Newtons; N) versus the sorbitol crystal size (measured by X-ray diffraction).

[0006] Figure 2 is a graph showing the Young’s modulus (YM) of chewing gum containing glycerin as a softener versus the ratio of small to large sorbitol crystals in the chewing gum composition.

[0007] Figure 3 is a graph showing the Peak Force (PF) of chewing gum containing glycerin as a softener versus the ratio of small to large sorbitol crystals in the chewing gum.

[0008] Figure 4 is a graph showing the Young's modulus (YM) of chewing gum containing Lycasin as a softener versus the ratio of small to large sorbitol crystals in the chewing gum.

[0009] Figure 5 is a graph showing the Peak Force (PF) of chewing gum containing Lycasin as a softener versus the ratio of small to large sorbitol crystals in the chewing gum.

[0010] Figure 6 is a graph showing the Young's modulus (YM) of chewing gum containing 70% Lycasin/30% glycerin as a softener versus the ratio of small to large sorbitol crystals in the chewing gum.

[0011] Figure 7 is a graph showing the Peak Force (PF) of chewing gum containing 70% Lycasin/30% glycerin as a softener versus the ratio of small to large sorbitol crystals in the chewing gum.

SUMMARY

[0012] In some embodiments, a method of manufacturing a chewing gum comprises selecting a ratio of a first sorbitol powder to a second sorbitol powder that results in a chewing gum having rheological properties within a target range, wherein the second sorbitol powder comprises sorbitol crystals having a predetermined crystal size that is at least three times larger than a crystal size of the first sorbitol powder; and mixing the first sorbitol powder and the second sorbitol powder with a gum base to form the chewing gum having rheological properties within the target range.

[0013] In other embodiments, a chewing gum comprises gum base, sorbitol powder, and a hydrophilic softener, wherein the sorbitol is a combination of first and second sorbitol crystals in a ratio of 10:90 to 90:10 of first sorbitol crystals to second sorbitol crystals; and wherein the first sorbitol crystals have an average crystal size of about 0.1 micrometers (μm) to about 0.37 μm in diameter and the second sorbitol crystals have an average crystal size of about 0.9 μm to about 1.5 μm in diameter as measured by scanning electron microscopy (SEM).

[0014] In yet other embodiments, a chewing gum comprises gum base; sorbitol; and a hydrophilic softener, wherein the sorbitol is a combination of first and second sorbitol crystals in a ratio of 10:90 to 90:10 of the number of first sorbitol crystals to the number of second sorbitol crystals, wherein the first sorbitol crystals have an average crystal size of about 0.06 μm to about 0.2 μm in diameter and the second sorbitol crystals have an average

crystal size of about 0.7 μm to about 3 μm in diameter as measured by scanning electron microscopy (SEM), and wherein the second sorbitol powder comprises sorbitol crystals having a crystal size that is at least 3.5 times larger than the crystal size of the first sorbitol powder.

[0015] These and other embodiments are described in detail below.

DETAILED DESCRIPTION

[0016] Disclosed herein is a method of manufacturing a chewing gum using at least two different sorbitol powders in a defined ratio as a bulking agent. The sorbitol powders differ from one another based upon size of the sorbitol crystals. A chewing gum having rheological properties which fall into a target range can thus be manufactured by selecting the ratio of crystal sizes of the two or more sorbitol powders.

[0017] The methods disclosed herein solve the problem which occurs when manufacturing facilities transfer from one sorbitol supplier to another. While the specifications of the final sorbitol product may be similar from one supplier to another, e.g. in terms of sorbitol particle size, a change in the supplier can have a significant impact on the hardness of the prepared chewing gum, particularly when no other changes are made to the formulation. For example, the gum produced may be too soft to package, and in other instances, too firm for consumer liking. The inventors have found that the crystal size of the sorbitol varies between the powdered sorbitol products produced by different suppliers. It has thus been surprisingly discovered that the crystal size of the sorbitol product directly affects the rheological properties of the chewing gum and that it is possible to modify the properties of a chewing gum based upon the predetermined crystal size of the sorbitol product. For example, the use of sorbitol powder having a small crystal size results in a chewing gum having a relatively hard texture, while the use of sorbitol powder having a large crystal size results in a chewing gum having a much softer texture. In particular, the inventors have discovered that by modifying the ratio of sorbitol crystals having a small size to sorbitol crystals having a large size, the rheological properties (e.g. hardness, elasticity, etc.) of the chewing gum can be controlled and manipulated. That is, by using a combination of small crystals that produce hard gum and large crystals that produce soft gum, it is possible to form a defined amount of both to achieve a desired intermediate gum texture.

[0018] In view of the present invention, it is therefore possible to design a chewing gum having the desired rheological properties by calculating the ratio of small and large crystals to match the texture produced by the crystal size of the previously used sorbitol,

without having to run multiple trials, stability studies, and consumer testing. Using at least two sizes of sorbitol crystals also allows for the ability to source sorbitol that was previously unusable to make chewing gum, which could potentially be a cost saving when purchasing sorbitol that is not in demand in the market.

[0019] As used herein, the term “crystal” refers to a single, individual crystalline form of sorbitol. Sorbitol has four crystal forms, alpha (α), beta (β), gamma (γ) and delta (δ). The gamma polymorph is considered to be the most stable of the anhydrous crystalline forms as evidenced by its high melting point and low hygroscopicity, and is generally the form used in the confectionery industry.

[0020] As used herein, the term “particle” in the context of sorbitol, refers to an agglomeration of individual sorbitol crystals. For some polyols, such as xylitol, each particle is a single (or at most two or three) crystal of xylitol. However, this is not the case for sorbitol, where a single particle is an agglomeration of thousands of sorbitol crystals. The size of a particle of sorbitol, including thousands of sorbitol crystals, is therefore significantly greater than the size of a single sorbitol crystal. Thus in the context of sorbitol, the terms “crystal” and “particle” are distinct and are not synonymous or interchangeable.

[0021] As used herein, “crystal size” refers to the average shortest dimension (diameter) of the measured sorbitol crystals. Measurement of sorbitol crystal size can be conducted using any suitable methods known in the art to measure crystal size by diameter. Examples of such methods include x-ray diffraction (XRD) and scanning electron microscopy (SEM).

[0022] As used herein, the term “rheological properties” refers to the measurable physical properties of a chewing gum composition such as, for example, the hardness and stiffness (elasticity) of the chewing gum composition. The hardness of a chewing gum composition can be determined by measuring the peak (maximum) force required to drive a probe through a piece of chewing gum through a portion of the total gum thickness. The stiffness or elasticity of a chewing gum composition can be determined by the compressive modulus (Young’s modulus) as determined by measuring the ratio of stress to strain in a compression test.

[0023] As used herein, the terms “gum,” “chewing gum,” “gum composition” and “chewing gum composition” are used interchangeably and are meant to include any “chewing gum composition”. Coating(s), shell(s), particulates within the gum of larger than 400 micrometers, center-fill(s) and/or cores made from non-gum materials and/or dusting particle(s) are excluded from the definition of “chewing gum composition” for purposes of

determining the rheological properties of the chewing gum. With regard to chewing gum compositions herein, such compositions contain a gum base, sorbitol powder, a hydrophilic softener and various additives. In addition to the sorbitol powder and hydrophilic softener, the chewing gum composition comprises a gum base, emulsifiers, additional bulk sweeteners, high intensity sweeteners, flavorants, coloring agents, sensates, and any other optional additives, including throat-soothing agents, spices, tooth-whitening agents, breath-freshening agents, vitamins, minerals, caffeine, drugs (e.g., medications, herbs, and nutritional supplements), oral care products, and combinations thereof.

[0024] The gum compositions disclosed herein can be uncoated, and be in the form of slabs, sticks, pellets, balls, and the like. While gum compositions as disclosed herein can further be coated, such coating is not included in the definition of the gum composition, as noted above, and is thus excluded from rheological property measurements. The composition of the different forms of the gum compositions will be similar but can vary with regard to the ratio of the ingredients. For example, coated gum compositions can contain a lower percentage of softeners. Pellets and balls can have a chewing gum core, which has been coated with either a sugar solution or a sugarless solution to create the hard shell. Slabs and sticks are usually formulated to be softer in texture than the chewing gum core. In some cases, a hydroxy fatty acid salt or other surfactant actives can have a softening effect on the gum base. In order to adjust for any potential undesirable softening effect that the surfactant actives can have on the gum base, it can be beneficial to formulate a slab or stick gum having a firmer texture than usual (i.e., use less conventional softener than is typically employed).

[0025] Center-filled gum can be another common gum form and the gum portion can have a similar composition and mode of manufacture to that described herein. The center-fill can be an aqueous liquid or gel, which is injected into the center of the gum during processing, or it can be in powder form. The center-filled gum can also be optionally coated and can be prepared in various forms, such as in the form of a lollipop. As noted above, however, center-fill and/or coating(s) are not included in the definition of the gum composition and are thus excluded from rheological property measurements.

[0026] Generally, the chewing gum composition comprises a water insoluble gum base portion and a water-soluble bulk portion, e.g. sorbitol powder. The gum base can vary greatly depending upon various factors such as the type of base desired, the consistency of gum desired, and the other components used in the composition to make the final chewing gum. The gum base can be any water-insoluble gum base known in the art, and includes those gum bases utilized for chewing gums and bubble gums. Illustrative examples of

suitable polymers in gum bases include both natural and synthetic elastomers and rubbers, for example, substances of vegetable origin such as chicle, crown gum, nispero, rosidinha, jelutong, perillo, niger gutta, tunu, balata, gutta-percha, lechi-capsi, sorva, gutta kay, and the like, and combinations thereof.

[0027] Synthetic elastomers for the gum base include high- and low-molecular weight elastomers. Useful high molecular weight elastomers include butadiene-styrene copolymers, polyisoprene, polyisobutylene, isobutylene-isoprene copolymers, polyethylene, combinations thereof, and the like. Useful low-molecular weight elastomers include polybutene, polybutadiene, polyisobutylene, and combinations thereof. Suitable gum bases can also include vinyl polymeric elastomers such as poly(vinyl acetate) (PVA), polyethylene, vinyl copolymeric elastomers such as copolymers of vinyl acetate and vinyl laurate, copolymers of vinyl acetate and vinyl stearate, copolymers of ethylene and vinyl acetate, poly(vinyl alcohol) and combinations thereof. When utilized, the number average molecular weight of the vinyl polymers can range about 3,000 to about 94,000. Vinyl polymers such as poly(vinyl alcohol) and poly(vinyl acetate) (when employed in the gum base, as distinguished from the encapsulated food-grade acid) can have a number average molecular weight of about 8,000 to about 65,000. Furthermore, any combination of the aforementioned high- and low-molecular weight, natural and synthetic elastomers, and rubbers can be used as a gum base.

[0028] The amount of gum base employed will vary greatly depending upon various factors such as the type of base used, the consistency of the gum desired, and the other components used in the composition to make the final chewing gum composition. In general, the gum base will be present in an amount of about 5 to about 94 weight percent of the final chewing gum composition. In some embodiments, the gum base amount is about 15 to about 45 weight percent, specifically about 15 to about 35 weight percent, more specifically about 20 to about 30 weight percent, based upon the total weight of the chewing gum composition.

[0029] The gum base composition can contain conventional elastomer plasticizers to aid in softening the elastomer base component, for example terpene resins such as polymers derived from alpha-pinene, beta-pinene, and/or d-limonene; methyl, glycerol or pentaerythritol esters of rosins or modified rosins and gums, such as hydrogenated, dimerized or polymerized rosins, or combinations comprising at least one of the foregoing resins; the pentaerythritol ester of partially hydrogenated wood or gum rosin; the pentaerythritol ester of wood or gum rosin; the glycerol ester of wood rosin; the glycerol ester of partially dimerized wood or gum rosin; the glycerol ester of polymerized wood or gum rosin; the glycerol ester of tall oil rosin; the glycerol ester of wood or gum rosin; the partially hydrogenated wood or

gum rosin; the partially hydrogenated methyl ester of wood or rosin; and the like. Any combination of the foregoing elastomer plasticizers can be used to soften or adjust the tackiness of the elastomer base component. The elastomer plasticizer can be used in amounts of about 5 to about 75 weight percent of the gum base, specifically about 45 to about 70 weight percent of the gum base.

[0030] Conventional additives can be included in the gum base in effective amounts such as plasticizers or softeners to provide a variety of desirable textures and consistency properties. Because of the low molecular weight of these components, the plasticizers and softeners are able to penetrate the fundamental structure of the gum base making it plastic and less viscous. Suitable plasticizers and softeners include lanolin, palmitic acid, oleic acid, stearic acid, sodium stearate, potassium stearate, glyceryl triacetate, glyceryl lecithin, glyceryl monostearate, propylene glycol monostearate, acetylated monoglyceride, glycerine, and combinations thereof. Waxes, for example, natural and synthetic waxes, hydrogenated vegetable oils, petroleum waxes such as polyurethane waxes, polyethylene waxes, paraffin waxes, microcrystalline waxes, fatty waxes, sorbitan monostearate, tallow, propylene glycol, and the like can also be incorporated into the gum base to obtain a variety of desirable textures and consistency properties. These additives are generally used in amounts of up to about 30 weight percent of the gum base, specifically about 3 to about 20 weight percent of the gum base.

[0031] When a wax is present in the gum base, it softens the polymeric elastomer mixture and improves the elasticity of the gum base. The waxes employed can have a melting point below about 60 degrees Celsius, and preferably between about 45 and about 55 degrees Celsius (°C). The low melting wax can be a paraffin wax. The wax can be present in the gum base in an amount about 6 to about 10 weight percent, and preferably about 7 to about 9.5 weight percent, based on the total weight of the gum base.

[0032] In addition to the low melting point waxes, waxes having a higher melting point can be used in the gum base in amounts up to about 5 weight percent of the gum base. Such high melting waxes include beeswax, vegetable wax, rice bran wax, candelilla wax, carnuba wax, polyethylene wax, microcrystalline wax, most petroleum waxes, and the like, and mixtures thereof.

[0033] The gum base can include effective amounts of bulking agents such as mineral adjuvants, which can serve as fillers and textural agents. Suitable mineral adjuvants include calcium carbonate, magnesium carbonate, alumina, aluminum hydroxide, aluminum silicate, talc, tricalcium phosphate, tricalcium phosphate and the like, which can serve as fillers and

textural agents. These fillers or adjuvants can be used in the gum base in various amounts. Specifically the amount of filler, when used, will be present in an amount of greater than about 15 to about 40 weight percent, specifically about 20 to about 30 weight percent, based on the weight of the gum base.

[0034] In addition to a water insoluble gum base portion, a typical chewing gum composition includes a water soluble bulk portion and one or more flavoring agents. The water soluble portion can include bulk sweeteners, high-intensity sweeteners, flavoring agents, hydrophilic softeners, emulsifiers, coloring agents, acidulants, fillers, antioxidants, and other conventional chewing gum additives that provide desired attributes. These and other conventional chewing gum additives known to one having ordinary skill in the art can also be incorporated into the gum base.

[0035] As mentioned above, a wide variety of one or more conventional additives can be used in the chewing gum composition, including sweeteners, high intensity sweeteners, flavor modulators or potentiators, flavorants/flavorings, coloring agents, medicaments, oral care agents, throat care agents, breath fresheners, mineral adjuvants, bulking agents, acidulants, buffering agents, sensates (e.g., warming agents, cooling agents, tingling agents, effervescent agents), thickeners, mouth moisteners, flavor enhancing compositions, antioxidants (e.g., butylated hydroxytoluene (BHT), butylated hydroxyanisole (BHA), or propyl gallate), preservatives, emulsifiers, thickening agents, and the like. Some of these additives can serve more than one purpose. For example, a sweetener such as sucrose, sorbitol or other sugar alcohol, or combinations of the foregoing and below-mentioned sweeteners, can also function as a bulking agent. In addition, combinations comprising at least one of the foregoing additives are often used.

[0036] Additional bulking agents (carriers, extenders) suitable for use include sweetening agents such as monosaccharides, disaccharides, polysaccharides, sugar alcohols, polydextrose, maltodextrins, minerals, such as calcium carbonate, talc, titanium dioxide, dicalcium phosphate, and combinations thereof. The chewing gum compositions herein comprise sorbitol powder at least as a portion of the bulking agent and in some embodiments as a majority of the bulking agent. Bulking agents can be used in amounts up to about 90 weight percent of the chewing gum composition, specifically about 25 weight percent to about 70 weight percent, and about 40 weight percent to about 65 weight percent of the chewing gum composition.

[0037] Suitable emulsifiers include distilled monoglycerides, acetic acid esters of mono and diglycerides, citric acid esters of mono and diglycerides, lactic acid esters of mono

and diglycerides, mono and diglycerides, polyglycerol esters of fatty acids, cetareth-20, polyglycerol polyricinoleate, propylene glycol esters of fatty acids, polyglyceryl laurate, glyceryl cocoate, gum arabic, acacia gum, sorbitan monostearates, sorbitan tristearates, sorbitan monolaurate, sorbitan monooleate, sodium stearyl lactylates, calcium stearyl lactylates, diacetyl tartaric acid esters of mono- and diglycerides, glyceryl tricaprilate-caprate / medium chain triglycerides, glyceryl dioleate, glyceryl oleate, glyceryl lacto esters of fatty acids, glyceryl lacto palmitate, glyceryl stearate, glyceryl laurate, glycerly dilaurate, glyceryl monoricinoleate, triglyceryl monostearate, hexaglyceryl distearate, decaglyceryl monostearate, decaglyceryl dipalmitate, decaglyceryl monooleate, polyglyceryl 10 hexaoleate, medium chain triglycerides, caprylic/capric triglyceride, propylene glycol monostearate, polysorbate 20, polysorbate 40, polysorbate 60, polysorbate 80, polysorbate 65, hexylglyceryl distearate, triglyceryl monostearate, the poly(oxyethylene) sorbitan fatty acid esters sold under the trade name TWEEN, the sorbitan fatty acid esters sold under the trade name SPAN, stearyl lactylates, calcium stearyl-2-lactylate, sodium stearyl-2-lactylate lecithin, ammonium phosphatide, sucrose esters of fatty acids, sucroglycerides, propane-1,2-diol esters of fatty acids, and combinations thereof.

[0038] Suitable thickening agents include cellulose ethers including hydroxyethylcellulose, hydroxypropylmethylcellulose, and hydroxypropylcellulose, methylcellulose, carboxymethylcellulose, and combinations thereof. Additional polymers useful as thickeners include the acrylic acid polymers and copolymer sold under the trade name CARBOMER; poly(vinyl pyrrolidone); poly(vinyl alcohol); sodium alginate; polyethylene glycol; natural gums like xanthan gum, tragacantha, guar gum, acacia gum, arabic gum; water-dispersible polyacrylates like poly(acrylic acid); methyl methacrylate copolymers; carboxyvinyl copolymers; and combinations thereof.

[0039] Suitable hydrophilic softeners include glycerol, sorbitol syrup, maltitol syrup, hydrogenated starch hydrolysates (HSH), water, propylene glycol, and combinations thereof. The softeners can be included in the chewing gum composition in amounts of about 0.1 to about 18 weight percent, specifically about 0.5 to about 15 weight percent, more specifically about 2 to about 12 weight percent, based on the total weight of the chewing gum composition.

[0040] Suitable hydrogenated starch hydrolysates include those disclosed in U.S. Pat. No. 4,279,931 and various hydrogenated glucose syrups and/or powders which contain sorbitol, maltitol, hydrogenated disaccharides, hydrogenated higher polysaccharides, or mixtures thereof. Hydrogenated starch hydrolysates are primarily prepared by the controlled

catalytic hydrogenation of corn syrups. The resulting hydrogenated starch hydrolysates are mixtures of monomeric, dimeric, and polymeric saccharides. The ratios of these different saccharides give different hydrogenated starch hydrolysates different properties. Mixtures of hydrogenated starch hydrolysates, such as LYCASIN®, a commercially available product manufactured by Roquette Freres of France, and HYSTAR®, a commercially available product manufactured by SPI Polyols, Inc. of New Castle, Del., are also useful.

[0041] Disclosed herein in various embodiments are chewing gum compositions which comprise a gum base, sorbitol powder and a hydrophilic softener. The sorbitol is a combination of a first sorbitol crystals and second sorbitol crystals. The ratio of the number of first sorbitol crystals to number of second sorbitol crystals can be from 10:90 to 90:10, specifically, from 25:75 to 75:25, and more specifically 50:50. As used herein, the ratio refers to the number of first sorbitol crystals to the number of second sorbitol crystals. Analysis of a chewing gum sample using SEM methods provides a method to count the number of crystals within a given section of the gum sample. In general, there is a direct correlation between the number of sorbitol crystals and the amount by weight of sorbitol used. Thus for manufacturing purposes the ratio of first sorbitol crystals to second sorbitol crystals can be used to determine the amount of sorbitol to be used to prepare the gum.

[0042] In some embodiments, the second sorbitol powder comprises sorbitol crystals having a crystal size that is at least 3 times larger than the crystal size of the first sorbitol powder. Specifically, the second sorbitol crystals are at least 3.5 times larger, more specifically at least 4 times larger than the first sorbitol crystals.

[0043] The first sorbitol crystals can have an average crystal size of about 0.06 μm to about 0.3 μm in diameter as measured by SEM. Specifically, the first sorbitol crystals have an average crystal size of about 0.08 μm to about 0.24 μm in diameter, more specifically, about 0.08 μm to about 0.23 μm in diameter, as measured by SEM.

[0044] The second sorbitol crystals can have an average crystal size of about 0.7 μm to about 3 μm in diameter as measured by SEM. Specifically, the second sorbitol crystals have an average crystal size of about 0.8 μm to about 2.8 μm in diameter, more specifically, about 0.85 μm to about 2.6 μm in diameter, as measured by SEM.

[0045] The sorbitol is powdered (particulate) material and is included in the chewing gum composition as a bulking agent. The amount of sorbitol in the chewing gum composition can be up to about 90 weight percent, specifically, from about 25 to about 70 weight percent, more specifically about 40 to about 65 weight percent, based on the total weight of the chewing gum composition.

[0046] Suitable hydrophilic softeners include glycerol, sorbitol syrup, maltitol syrup, hydrogenated starch hydrolysates, water, propylene glycol, and combinations thereof. The softeners can be included in the chewing gum composition in amounts of about 0.1 to about 18 weight percent, specifically about 0.5 to about 15 weight percent, more specifically about 2 to about 12 weight percent, based on the total weight of the chewing gum composition.

[0047] The rheological properties of the chewing gum, for example the hardness and stiffness (elasticity) of the chewing gum composition, can be measured using known methods. For example, the hardness of a chewing gum composition can be determined by measuring the peak force (PF) and compressive modulus (Young's modulus; YM) of the chewing gum. The rheological properties can be measured immediately following the manufacture of the chewing gum, or after aging of the chewing gum for a predetermined time.

[0048] The chewing gum can have a Young's modulus of about 40,000 Pascals (Pa) to about 300,000 Pa as measured 24 hours after the formation of the chewing gum. Specifically, the chewing gum can have a Young's modulus of about 40,000 Pa, 50,000 Pa, 60,000 Pa, 70,000 Pa, 80,000 Pa, 90,000 Pa, 100,000 Pa, 110,000 Pa, 120,000 Pa, 130,000 Pa, 140,000 Pa, 150,000 Pa, 160,000 Pa, 170,000 Pa, 180,000 Pa, 190,000 Pa, 200,000 Pa, 210,000 Pa, 220,000 Pa, 230,000 Pa, 240,000 Pa, 250,000 Pa, 260,000 Pa, 270,000 Pa, 280,000 Pa, 290,000 Pa, or 300,000 Pa, or any number falling between the listed numbers, as measured 24 hours after the formation of the chewing gum.

[0049] The chewing gum can have a Young's modulus of about 60,000 Pa to about 450,000 Pa as measured after aging the chewing gum for a period of about seven days at a temperature of 13°C and a relative humidity of 20%. Specifically, the Young's modulus is about 60,000 Pa, 70,000 Pa, 80,000 Pa, 90,000 Pa, 100,000 Pa, 110,000 Pa, 120,000 Pa, 130,000 Pa, 140,000 Pa, 150,000 Pa, 160,000 Pa, 170,000 Pa, 180,000 Pa, 190,000 Pa, 200,000 Pa, 210,000 Pa, 220,000 Pa, 230,000 Pa, 240,000 Pa, 250,000 Pa, 260,000 Pa, 270,000 Pa, 280,000 Pa, 290,000 Pa, 300,000 Pa, 310,000 Pa, 320,000 Pa, 330,000 Pa, 340,000 Pa, 350,000 Pa, 360,000 Pa, 370,000 Pa, 380,000 Pa, 390,000 Pa, 400,000 Pa, 410,000 Pa, 420,000 Pa, 430,000 Pa, 440,000 Pa or 450,000 Pa, or any number falling between the listed numbers, as measured after aging the chewing gum for a period of about seven days at a temperature of 13°C and a relative humidity of 20%.

[0050] The chewing gum can have a Peak Force (PF) of about 20 Newtons (N) to about 150 N as measured 24 hours after the formation of the chewing gum. Specifically, the Peak Force is about 20 N, 30 N, 40 N, 50 N, 60 N, 70 N, 80 N, 90 N, 100 N, 110 N, 120 N,

130 N, 140 N, or 150 N, or any number falling between the listed numbers, as measured 24 hours after the formation of the chewing gum.

[0051] The chewing gum can have a Peak Force (PF) of about 20 N to about 150 N as measured after aging the chewing gum for a period of about seven days at a temperature of 13°C and a relative humidity of 20%. Specifically, the Peak Force is about 20 N, 30 N, 40 N, 50 N, 60 N, 70 N, 80 N, 90 N, 100 N, 110 N, 120 N, 130 N, 140 N, or 150 N, or any number falling between the listed numbers, as measured after aging the chewing gum for a period of about seven days at a temperature of 13°C and a relative humidity of 20%.

[0052] Disclosed herein also are methods of manufacturing a chewing gum comprising selecting a ratio of a first sorbitol powder to a second sorbitol powder that results in a chewing gum having rheological properties within a target range, and mixing the first sorbitol powder and the second sorbitol powder with a gum base to form the chewing gum having rheological properties within the target range. The second sorbitol powder comprises sorbitol crystals having a predetermined crystal size that is at least three times larger than a crystal size of the first sorbitol powder. Specifically, the second sorbitol crystals are at least 3.5 times larger, more specifically at least 4 times larger than the first sorbitol crystals. The first and second sorbitol powders can be pre-blended before the introduction of the gum base. Alternatively, the different sorbitol powders can be added separately in the process.

[0053] The selected ratio of first sorbitol crystals to second sorbitol crystals can be from 10:90 to 90:10, specifically, from 25:75 to 75:25, and more specifically 50:50. As used herein, the ratio refers to the actual number of first sorbitol crystals to the number of second sorbitol crystals. In general, there is a direct correlation between the number of sorbitol crystals and the amount by weight of sorbitol used. Thus for manufacturing purposes the ratio of first sorbitol crystals to second sorbitol crystals can be used to determine the amount of sorbitol to be used to prepare the gum.

[0054] The method can further comprise determining the crystal size of two or more batches of sorbitol powder and selecting at least one batch to be the first sorbitol powder and at least one batch to be the second sorbitol powder.

[0055] The first sorbitol crystals can have an average crystal size of about 0.06 μm to about 0.3 μm in diameter as measured by SEM. Specifically, the first sorbitol crystals have an average crystal size of about 0.08 μm to about 0.24 μm in diameter, more specifically, about 0.08 μm to about 0.23 μm in diameter, as measured by SEM.

[0056] The second sorbitol crystals can have an average crystal size of about 0.7 μm to about 3 μm in diameter as measured by SEM. Specifically, the second sorbitol crystals

have an average crystal size of about 0.8 μm to about 2.8 μm in diameter, more specifically, about 0.85 μm to about 2.6 μm in diameter, as measured by SEM.

[0057] In some embodiments, the method further comprises mixing a hydrophilic softener with the gum base and the first and second sorbitol powders. The hydrophilic softener is glycerol, maltitol syrup, sorbitol syrup, hydrogenated starch hydrolysate, water, propylene glycol, or a combination thereof.

[0058] As discussed above, the disclosed methods allow for the manufacture of a chewing gum composition having the desired rheological properties by calculating the ratio of small and large crystals to match the texture produced by the crystal size of the previously used sorbitol, without having to run multiple trials, stability studies, and consumer testing. Thus, in some embodiments, the method of manufacturing a chewing gum consists essentially of selecting a ratio of a first sorbitol powder to a second sorbitol powder that results in a chewing gum having rheological properties within a target range, and mixing the first sorbitol powder and the second sorbitol powder with a gum base to form the chewing gum having rheological properties within the target range, wherein the second sorbitol powder comprises sorbitol crystals having a predetermined crystal size that is at least three times larger than a crystal size of the first sorbitol powder.

[0059] The chewing gum compositions can be prepared using any standard techniques and equipment known to those skilled in the art. The apparatus useful in accordance with some embodiments comprises mixing and heating apparatus well known in the chewing gum manufacturing arts, and therefore the selection of the specific apparatus will be apparent to the artisan.

[0060] The sorbitol, hydrophilic softener and other conventional chewing gum additives can be incorporated into a chewing gum composition using standard techniques and equipment. In one exemplary process, a gum base is heated to a temperature sufficiently high to soften the base without adversely affecting the physical and chemical make-up of the base, which will vary depending upon the composition of the gum base used, and is readily determined by those skilled in the art without undue experimentation. For example, the gum base can be melted to about 60°C to about 160°C, or melted to about 150°C to about 175°C, for a period of time sufficient to render the base molten, for example, about thirty minutes, just prior to being admixed incrementally with the remaining ingredients of the base such as the plasticizer, fillers, the bulking agent or sweeteners, the softener and coloring agents to plasticize the blend as well as to modulate the hardness, viscoelasticity and formability of the base, and the flavor enhancing composition (as a concentrate with other additives or

separately). Mixing is continued until a uniform mixture of the gum composition is obtained. Thereafter the gum composition mixture can be formed into desirable gum shapes, i.e., stick, slab, pellet, ball, or the like. The sized chewing gum can be conditioned for about one day prior to packaging the chewing gum.

[0061] Also disclosed are chewing gum compositions prepared by the above-described methods.

[0062] The features and advantages are more fully shown by the following examples that are provided for purposes of illustration, and are not to be construed as limiting the invention in any way.

[0063] The foregoing and other embodiments are further illustrated by the following examples, which are not intended to limit the effective scope of the claims. All parts and percentages in the examples and throughout the specification and claims are by weight of the final composition unless otherwise specified.

EXAMPLES

[0064] The hardness and elasticity of chewing gum samples were determined by measuring the Peak Force (PF) and compressive modulus (Young's modulus; YM) of the prepared gums. The YM and PF of the chewing gum samples were measured using an SMS Texture Analyzer (model TAXT Plus), including a Peltier temperature control cabinet and a stainless steel cylindrical probe having a diameter of 0.25 inches. The Peltier temperature cabinet was used to adjust the sample temperature prior to testing. The temperature of the Peltier temperature cabinet was set at 20°C and the chewing gum sample placed inside the cabinet for at least 5 minutes, until the temperature of the sample had equilibrated to the temperature of the cabinet. More than 10 minutes was needed in cases where temperature difference between the chewing gum sample and the inside of the chamber was larger than 5°C.

[0065] Test samples having a length of 15 millimeters (mm), a width of 10 mm and a thickness of 5 mm were used in the test. The test sample was centered under the probe and carefully aligned to make sure that the probe touched the center of the sample during the test. The probe descended at an initial a high speed (5 mm/s) and at a position of 5 mm or 8 mm above the test sample, switched to a lower approach speed (0.2 mm/s) until it touched the test sample and pre-compressed it to 150 gram force. The probe was then held in position for 10 seconds prior to initiation of the compression test. Once 40% compression was reached, the probe was returned to the start position (20 mm above the sample). The test was repeated

three times for each gum sample. The data is then analyzed to determine the PF (maximum force required to drive the probe through a thickness of chewing gum) and the YM (ratio of stress to strain in compression) of the chewing gum sample.

Example 1: Measurement of Sorbitol Crystal Size From Multiple Suppliers

[0066] The size of the sorbitol crystals in at least twenty four different sorbitol powders obtained from various suppliers was determined using x-ray diffraction (XRD) measurement and by scanning electron microscopy (SEM).

[0067] XRD measurement of crystal size was conducted by powder x-ray diffraction using a x-ray diffractometer (Rigaku) with Cu-K α radiation, and analyzing the X-ray diffraction pattern of the sorbitol crystals.

[0068] SEM analysis of crystal size was conducted as follows. Sorbitol powders were placed on an SEM stub using carbon tape and then sputter coated. Imaging was performed on a Zeiss EVO MA-10 with an accelerating voltage of 20 kV. Crystal width measurements were performed using the ImageJ software package (Version 1.46r, NIH). For each sorbitol powder examined, at least 30 crystal width measurements were made for each image, and at least 5 images of each sorbitol were examined. Data was further processed (mean, standard deviation, number of measurements) in Excel (Version 14.0.7015.1000). For finished product samples, gum was sectioned using a razor blade, placed with the cut surface exposed on an SEM stub using carbon tape, and then sputter coated. Imaging and measurements were performed as described above.

[0069] The crystals from each supplier were grouped into small, medium and large-sized crystals based on XRD and SEM measurements, as shown below in Table 1.

Table 1. Crystal Size Range of Sorbitol Products.

Particle size	XRD (μm)	SEM (μm)
Small	0.00187 – 0.0065	0.13 – 0.34
Medium	0.0099 – 0.0213	0.12 – 0.69 (average about 0.43)
Large	0.022 – 0.0357	1.15 – 1.37 (average about 1.2)

Example 2: Effect of Crystal Size on Chewing Gum Hardness

[0070] Chewing gum samples were prepared according the composition in Table 2 below.

Table 2. Chewing Gum Composition

Ingredient	Weight percent
Gum base	28.5
Sorbitol (powdered)	43.7
Other polyols	10.9
Water-soluble Softener (glycerin)	8.5
Lecithin/Acetylated Monoglycerides	0.9
Flavors	3.0
High intensity sweeteners	4.5
Total	100

[0071] A chewing gum sample was prepared for each of the sorbitol powders for which the crystal size had been determined in Example 1. The chewing gum composition was prepared by first melting the gum base at a temperature of about 150-175 degrees Fahrenheit. Once melted and placed in a standard mixer, the remaining ingredients were added and thoroughly mixed for about 1 to about 20 minutes.

[0072] The resulting mix then was formed into the desired final shape employing conventional techniques, e.g., extruded, rolled and cut into sticks, cast into pellets and then optionally coated, or pressed into tablets, among others

[0073] Figure 1 shows the PF of the chewing gum versus the average crystal size of the sorbitol as determined by XRD. As shown in Figure 1, there is an inverse correlation between the hardness of the chewing gum and the crystal size of the sorbitol.

Example 3: Effect of Sorbitol Crystal Combinations on Chewing Gum Properties

[0074] Chewing gum samples were prepared using sorbitol powder having a small crystal size and sorbitol powder having a large crystal size. The sorbitol powders were used either alone or blended together in weight ratios of small crystal size to large crystal size of

25:75, 50:50 and 75:25. The total amount of sorbitol in each gum sample was kept the same (43.7 weight percent). The gum formulations were prepared as described in Example 2.

[0075] The YM and PF of the chewing gum samples was measured after storage at a temperature of 13°C and a relative humidity (RH) of 20%, for a period of 24 hours or seven days. The YM and PF values for each of the chewing gum samples are shown in Figures 2 and 3, respectively.

[0076] Figure 2 shows the YM values versus the ratio of small crystal size sorbitol to large crystal size sorbitol, while Figure 3 shows the PF values. As shown in Figure 2, the YM of the chewing gum increases as the ratio of small crystal size to large crystal size in the sorbitol blend is increased. This effect is evident after 24 hours of aging as well as after seven days of aging. Similarly, the PF of the chewing gum is also affected by the ratio of small crystal size to large crystal size in the sorbitol blend (Figure 3). There is a linear trend between the ratio of small and large crystal size and gum texture, when glycerin is used as a softener.

Example 4: Effect of Softeners and Sorbitol Combinations on Chewing Gum Texture.

[0077] Chewing gum samples were prepared as described in Example 3, with the exception that the glycerin was replaced with either Lycasin (100%) or a blend of Lycasin (70%) and glycerin (30%). The YM and PF of the chewing gum samples was measured immediately (0H) or after storage at a temperature of 13°C and a relative humidity (RH) of 20%, for a period of 24 hours or seven days.

[0078] The YM and PF values for chewing gum samples containing 100% Lycasin are shown in Figures 4 and 5, respectively. The YM and PF values for chewing gum samples containing 70% Lycasin/30% glycerin are shown in Figures 6 and 7, respectively. As can be seen in Figures 4-7, there is a linear trend between the ratio of small and large crystal size and gum texture, when Lycasin is used as a softener, and when a blend of 70/30 Lycasin/glycerol is used.

[0079] As used herein the terms “comprising” (also “comprises,” etc.), “having,” “containing” and “including” is inclusive or open-ended and does not exclude additional, unrecited elements or method steps regardless of its use in the preamble or the body of a claim.

[0080] The singular forms “a,” “an,” and “the” include plural referents unless the context clearly dictates otherwise.

[0081] The endpoints of all ranges directed to the same characteristic or component are independently combinable, and inclusive of the recited endpoint.

[0082] The term “combination” is inclusive of a homogenous or non-homogenous blend, mixture, or alloy of the named components into an integrated whole. The term “homogenous” refers to a uniform blend of the components.

[0083] The word “or” means “and/or.”

[0084] Providing can be accomplished by a manufacturer, distributor, or other seller that makes the product available to the consumer.

[0085] While the invention has been described with reference to an exemplary embodiment, it will be understood by those skilled in the art that various changes can be made and equivalents can be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications can be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

CLAIMS:

1. A method of manufacturing a chewing gum, comprising:
selecting a ratio of a first sorbitol powder to a second sorbitol powder that results in a chewing gum having rheological properties within a target range,
wherein the second sorbitol powder comprises sorbitol crystals having a predetermined crystal size that is at least three times larger than a crystal size of the first sorbitol powder; and
mixing the first sorbitol powder and the second sorbitol powder with a gum base to form the chewing gum having rheological properties within the target range.
2. The method of claim 1, wherein the second sorbitol powder comprises sorbitol crystals having an average crystal size that is at least 3.5 times larger than the average crystal size of the first sorbitol powder.
3. The method of any of claims 1-2, further comprising determining the crystal size of two or more batches of sorbitol powder and selecting at least one batch to be the first sorbitol powder and at least one batch to be the second sorbitol powder.
4. The method of any of claims 1-3, wherein the ratio of the number of first sorbitol powder crystals to the number of second sorbitol powder crystals is 10:90 to 90:10.
5. The method of any of claims 1-4, wherein the ratio of the number of first sorbitol powder crystals to the number of second sorbitol powder crystals is 25:75 to 72:25.
6. The method of any of claims 1-5, further comprising mixing a hydrophilic softener with the gum base and the first and second sorbitol powder.
7. The method of claim any of claims 1-6, wherein the hydrophilic softener is glycerol, maltitol syrup, sorbitol syrup, hydrogenated starch hydrolysate, water, propylene glycol, or a combination thereof.
8. The method of any of claims 1-7, wherein the sorbitol crystals of the first sorbitol powder have an average size of about 0.06 μm to about 0.3 μm in diameter as measured by scanning electron microscopy (SEM).
9. The method of any of claims 1-8, wherein the sorbitol crystals of the second sorbitol powder have an average size of about 0.7 μm to about 3 μm in diameter as measured by SEM.
10. The method of any of claims 1-9, wherein the chewing gum has a Young's modulus of about 40,000 Pa to about 300,000 Pa as measured 24 hours after the formation of the chewing gum.

11. The method of any of claims 1-10, wherein the chewing gum has a Peak Force of about 20 N to about 150 N as measured 24 hours after the formation of the chewing gum.
12. The method of any of claims 1-11, wherein the chewing gum has a Young's modulus of about 60,000 Pa to about 450,000 Pa as measured after aging the chewing gum for a period of about seven days at a temperature of 13°C and a relative humidity of 20%.
13. The method of any of claims 1-12, wherein the chewing gum has a Peak Force of about 20 N to about 150 N as measured after aging the chewing gum for a period of about seven days at a temperature of 13°C and a relative humidity of 20%.
14. A chewing gum prepared by the method of any of claims 1-13.
15. A chewing gum, comprising:
 - gum base;
 - sorbitol powder; and
 - a hydrophilic softener,wherein the sorbitol is a combination of first sorbitol crystals and second sorbitol crystals in a ratio of 10:90 to 90:10 of a number of first sorbitol crystals to a number of second sorbitol crystals; and
 - wherein the first sorbitol crystals have an average crystal size of about 0.06 μm to about 0.3 μm in diameter and the second sorbitol crystals have an average crystal size of about 0.7 μm to about 3 μm in diameter as measured by scanning electron microscopy (SEM).
16. The chewing gum of claim 15, wherein the second sorbitol powder comprises sorbitol crystals having an average crystal size that is at least 3.5 times larger than the average crystal size of the first sorbitol powder.
17. The chewing gum of any of claims 15-16, wherein the ratio of the number of first sorbitol crystals to number of second sorbitol crystals is 25:75 to 75:25.
18. The chewing gum of any of claims 15-17, wherein the hydrophilic softener is glycerol, maltitol syrup, sorbitol syrup, HSH, water, propylene glycol or a combination thereof.
19. The chewing gum of any of claims 15-18, wherein the chewing gum has a Young's modulus of about 40,000 Pa to about 300,000 Pa as measured 24 hours after the formation of the chewing gum.
20. The chewing gum of any of claims 15-19, wherein the chewing gum has a Peak Force of about 20 N to about 150 N as measured 24 hours after the formation of the chewing gum.

21. The chewing gum of any of claims 15-20, wherein the chewing gum has a Young's modulus of about 60,000 Pa to about 450,000 Pa as measured after aging the chewing gum for a period of about seven days at a temperature of 13°C and a relative humidity of 20%.
22. The chewing gum of any of claims 15-21, wherein the chewing gum has a Peak Force of about 20 N to about 150 N as measured after aging the chewing gum for a period of about seven days at a temperature of 13°C and a relative humidity of 20%.

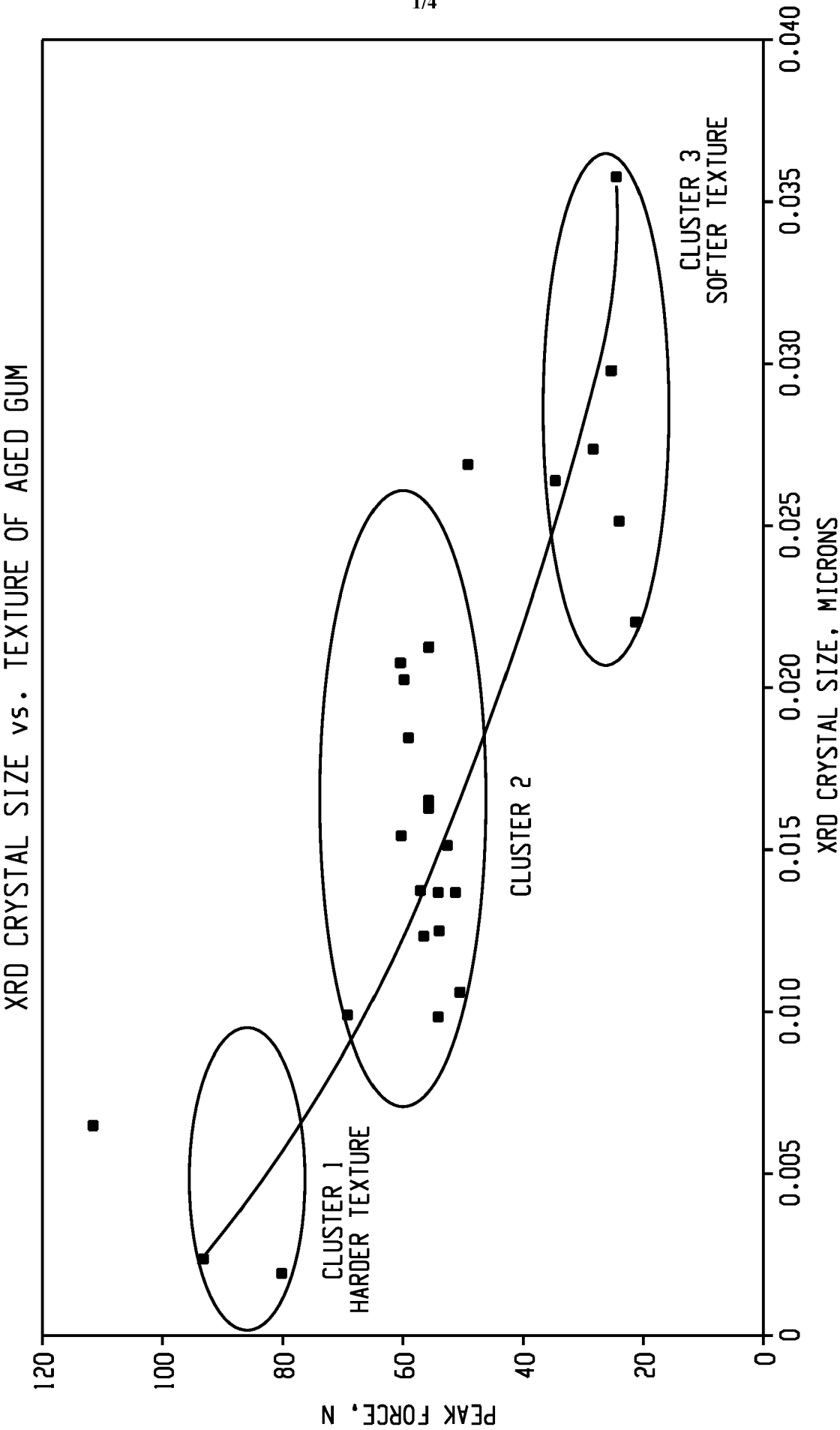
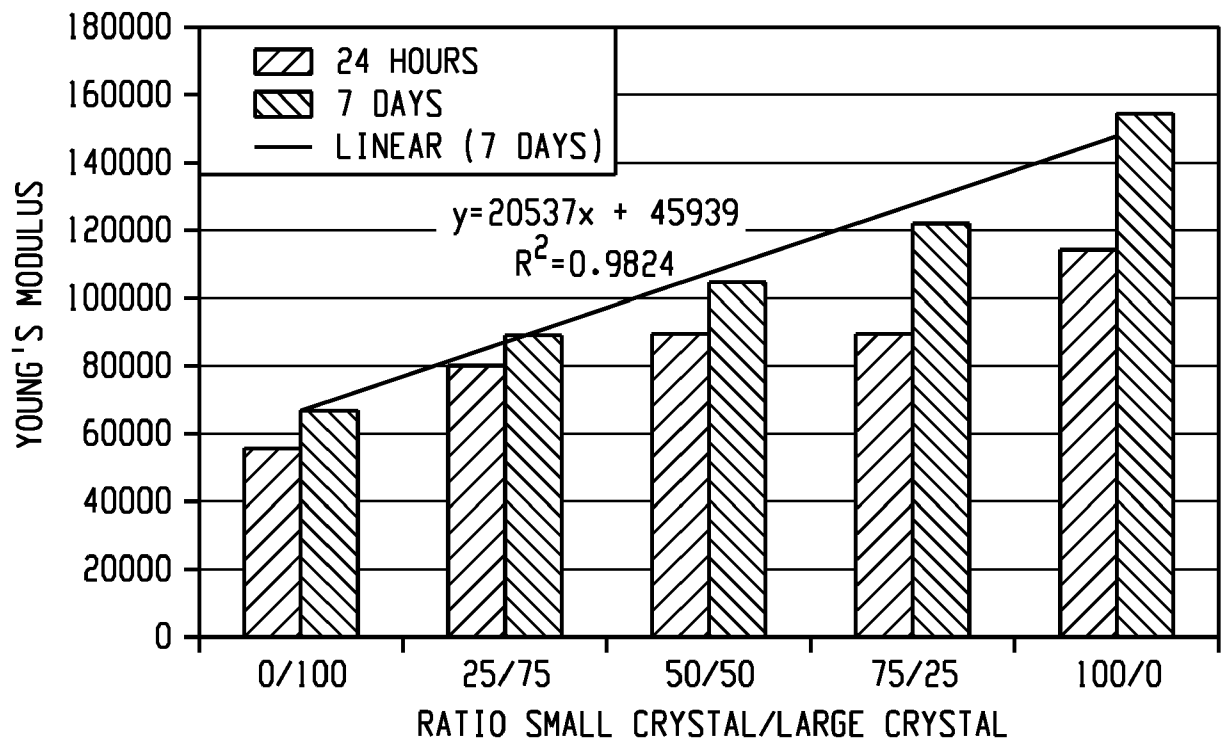
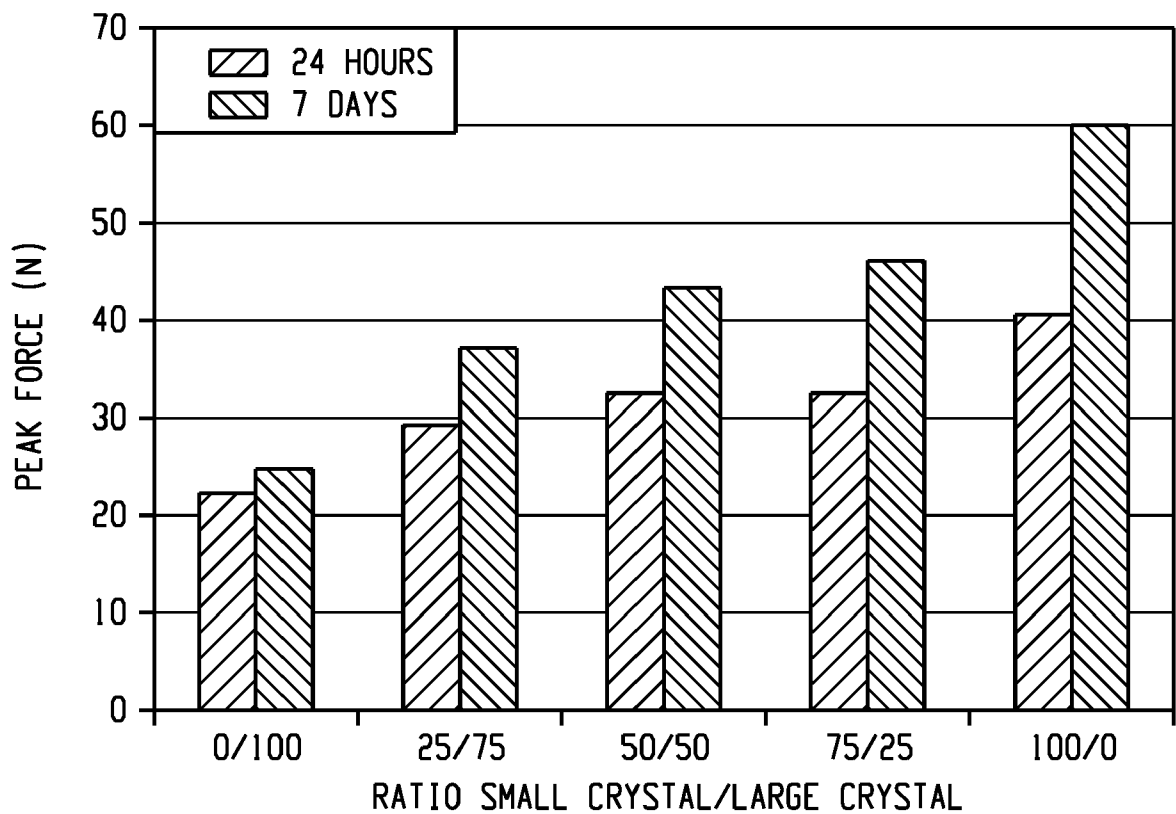
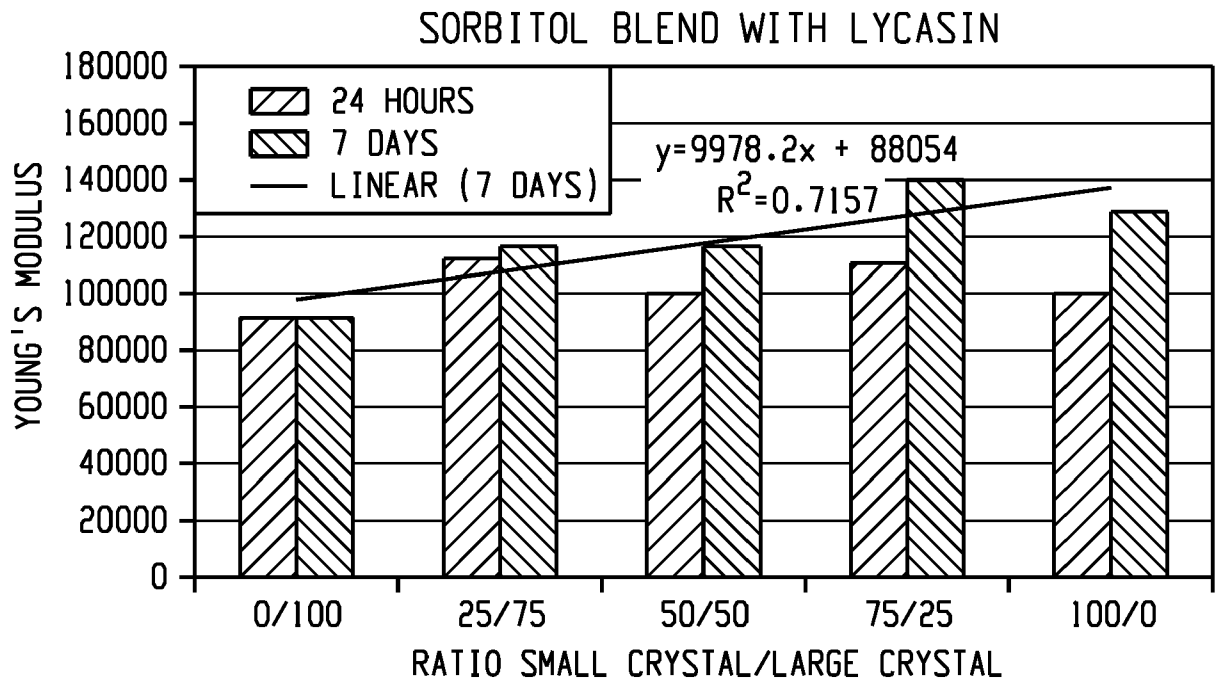
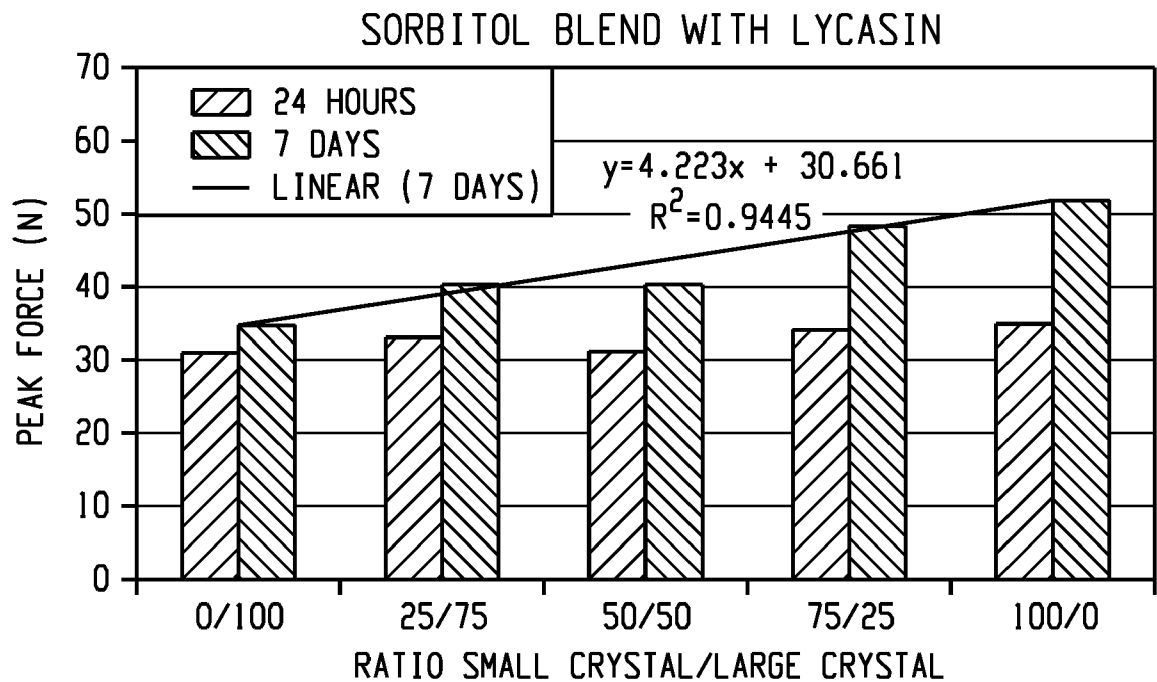
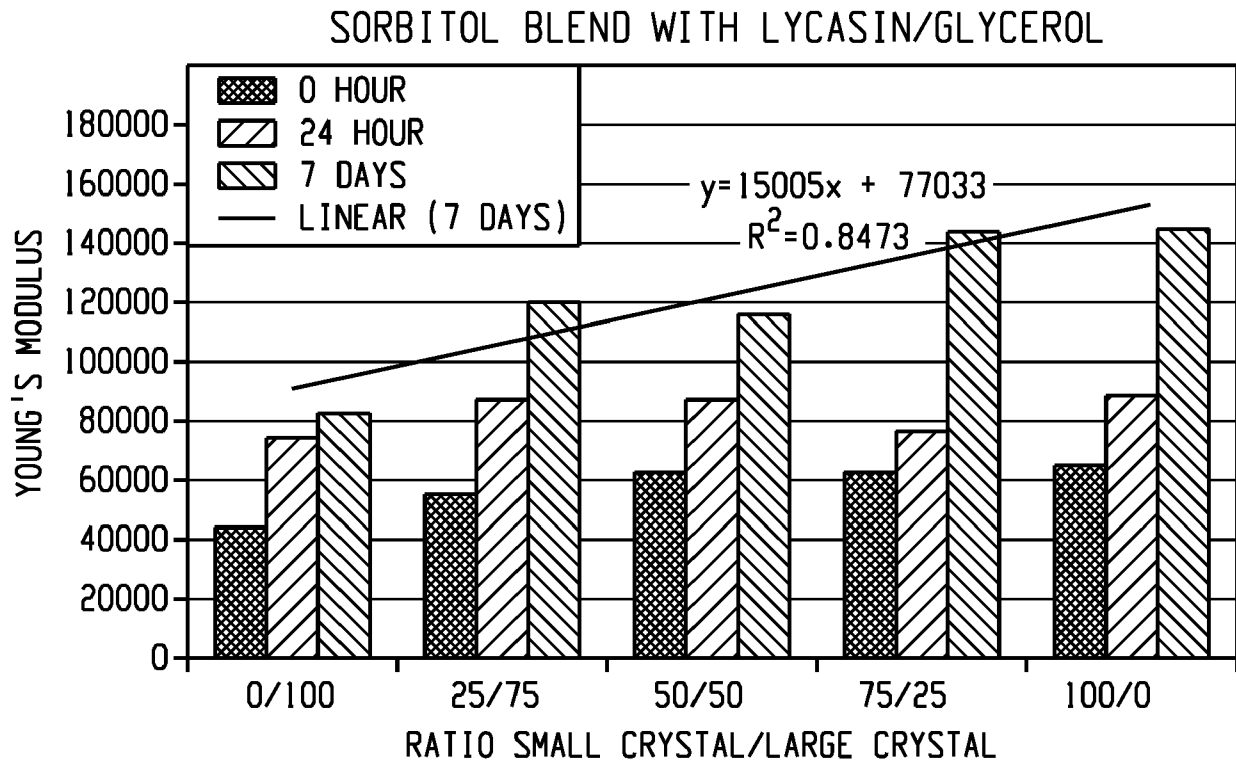
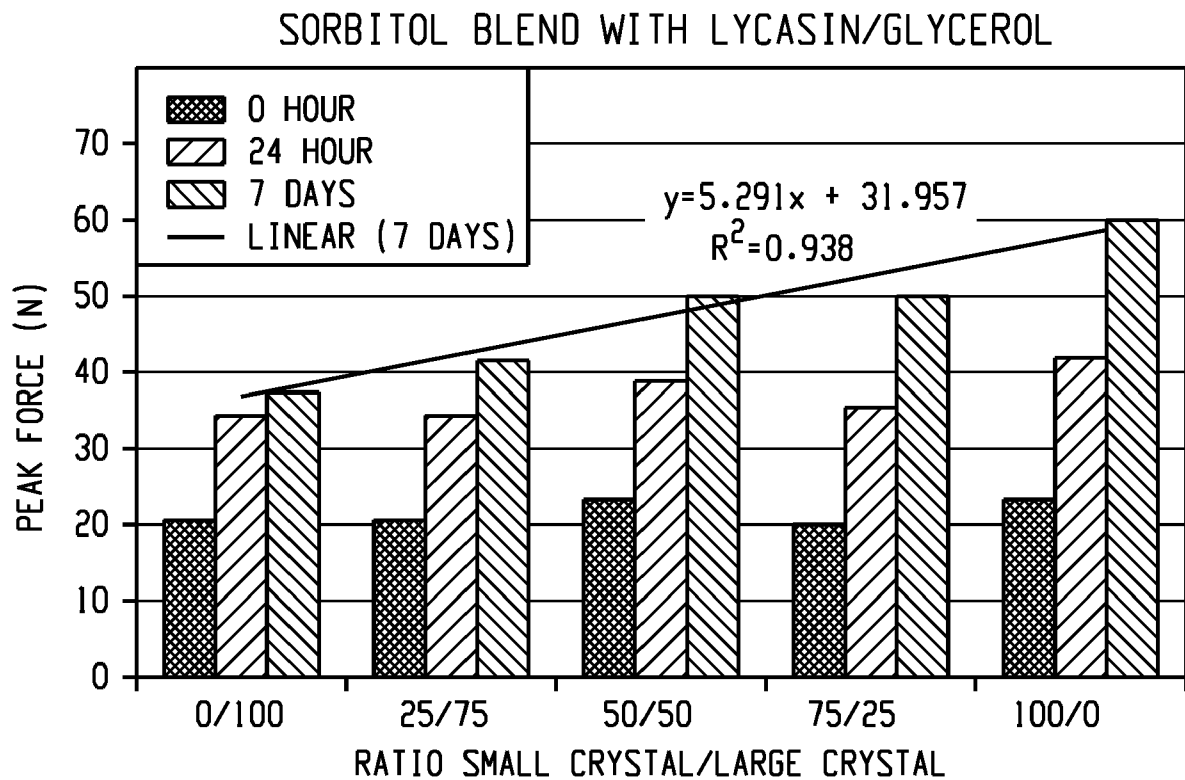


Fig. 1

*Fig. 2**Fig. 3*

*Fig. 4**Fig. 5*

*Fig. 6**Fig. 7*

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2016/020319

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23G4/10
ADD.

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)
A23G

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

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

EP0-Internal, WPI Data, FSTA

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C.



See patent family annex.

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Date of the actual completion of the international search

20 June 2016

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2016/020319

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