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(54) Title: POLYESTER ARTICLES HAVING SIMULATED METALLIC OR PEARLESCENT APPEARANCE

Fig. 1

Example 3 (left)
Example 4 (right)

Example 5 (left)
Example 6 (right)

Example 7

(57) Abstract: A polyester article is made to appear lustrously metallic or pearlescent by the addition of polylactic acid, optionally non-metallic, non-pearlescent colorant; and optionally other functional additives. The colorant can be one or more pigments, one or more dyes, or combinations thereof. A plastic article, such as a stretch blow molded bottle or injection plaque, using the polylactic acid in the polyester can simulate the appearance of a metallic surface or a pearlescent luster without metallic or pearlescent colorants.

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POLYESTER ARTICLES HAVING SIMULATED METALLIC OR PEARLESCENT APPEARANCE

CLAIM OF PRIORITY

[0001] This application claims priority from Chinese Patent Application Serial Number 201611011209.3 bearing Attorney Docket Number 1201643CN and filed on November 17, 2016, which is incorporated by reference.

FIELD OF THE INVENTION

[0002] This invention relates to use of a polymer and colorant combination to simulate metallic or pearlescent appearance in a colored polyester article.

COLOR DRAWING

[0003] The file of this patent contains at least one drawing executed in color. To the extent that the Patent Cooperation Treaty does not publish patent applications with colorful drawings, Applicant reserves the right to amend the drawings in the National and Regional Stages to restore the drawings to their colorful condition as shown in the priority document and the PCT application as filed. Copies of this patent with color drawings will be provided by the Patent and Trademark Office upon request and payment of the necessary fee.

BACKGROUND OF THE INVENTION

[0004] Plastic has taken the place of other materials in a variety of industries. In the packaging industry, plastic has replaced glass to minimize breakage, reduce weight, and reduce energy consumed in manufacturing and transport. In other industries, plastic has replaced metal to minimize corrosion, reduce weight, and provide color-in-bulk products.

[0005] Attracting consumers to purchase individually-sized or family-sized containers includes branding and trade dress. Among the elements of

valuable trade dress is the color of the container. Moreover, such color may need to co-exist with translucency, transparency, or other special effects for the bottle, such as metallic or pearlescent appearance.

[0006] Modern consumer products demand eye-catching attention. Producers of consumer products compete for available shelf space in retail businesses. The outer appearance of a product, including its shape, color, texture, and labeling is the first impression for a consumer. Producers undertake considerable efforts to display a desired appearance to attract the consumer to the product. Such outer appearance, over time and with exclusivity, achieves a form of intellectual property for the producer, called trade dress, which offers a visual differentiation for commodity products and another differentiation for unique products.

[0007] Thermoplastic resins are used for the production of consumer products. Ranging from the clear, plastic, large soft drink bottles to the miniature colored cosmetic vials, polyethylene terephthalate (PET, one type of the class of polymers called polyesters) as a resin has been frequently used because of its low cost and ability to be compounded with colorants. Most importantly, polyesters such as PET can be formed into products by conventional blow-molding techniques. Molded products made by the blow-molding techniques take the shape and outer texture according to the mold used.

[0008] Films have previously included polyolefins in transparent polyesters to impart translucency or opacity, including such as disclosed in U.S. Pat. No. 4,368,295 (Newton et al.). But Newton et al. did not address use of polyesters and polyolefins in colored polymeric films.

[0009] Also, U.S. Pat. No. 8,575,296 (Vernon et al.) has disclosed a polyester article made to appear lustrously metallic or pearlescent by the addition of polymethylpentene and non-metallic, non-pearlescent colorant; and optionally other functional additives. The colorant could be one or more pigments, one or more dyes, or combinations thereof. A stretch blow molded plastic article, such as a bottle, using the polymethylpentene in the polyester

could simulate the appearance of a metallic surface or a pearlescent luster even though non-metallic and non-pearlescent colorants are used.

SUMMARY OF THE INVENTION

[00010] Metallic colorants can be supplied in the form of concentrates formulated to give a brushed-metal look to thermoplastic parts. These concentrates (also called "masterbatches"), upon blending into the thermoplastic resin, allow the plastic article to duplicate the look of brushed metals such as aluminum, bronze, copper, gold or antique brass. Custom metal color matches also can be formulated, depending on the colorant combination employed. The concentrates are supplied in a pelletized, non-dusting form tailored to a specific resin system. A typical dilution or "letdown" ratio for a metallic colorant concentrate ranges from about 100:1 to about 10:1 and preferably about 25:1 (4%), which varies with the desired effect. Typical applications for metallic effect plastic articles include packaging, personal care, toys, sporting goods, and transportation.

[00011] Pearlescent colorants can be supplied in the form concentrates formulated to give a lustrous effect varying from a satin to a sparkling sheen using pearlescent or iridescent pigments. The pearlescent colorant concentrates can be formulated in a range of hues and are compatible with most thermoplastic resins. Effects range from satin to sparkle. The strongest pearlescent effects are seen in pastel colors. As with metallic colorant concentrates, pearlescent colorant concentrates are supplied in pelletized, non-dusting form, tailored to suit a specific resin system. Again, a typical letdown ratio ranges from about 100:1 to about 10:1 and preferably about 25:1 (4%), which varies with the desired effect. Pearlescent effect plastic articles can have the same or different uses as metallic effect plastic articles.

[00012] Commercially available concentrates used to generate a metallic or pearlescent effect in the coloration of a polyester article are OnColor™ FX colorant concentrates from PolyOne Corporation of Avon Lake, Ohio, USA.

[00013] In the case of both metallic and pearlescent colorant concentrates, the colorant which provides the special effect can be viewed by a customer as costly because conventional colorants used to produce metallic or pearlescent appearance are higher in specific gravity and have a tendency to produce unsightly flow-lines due to the flake geometry of the conventional metallic or pearlescent colorant material. Furthermore, when subjected to shear stresses the conventional metallic or pearlescent colorant materials can bend or break, thus changing the overall surface appearance of the thermoplastic article in its final shape. In addition, many of the conventional metallic or pearlescent colorant materials are not able to produce a highly uniform pearl-like appearance – the flakes produce a grain-like appearance which may be undesirable to the customer.

[00014] The present invention solves the problem in the art by using polylactic acid (PLA) as a component or carrier for color concentrates for polyester articles, in order to simulate metallic or pearlescent effects in the coloration of a polyester article when the polyester article is produced by stretch blow molding or other stress formation process. As previously reported, the interaction of PLA in polyester results in increasing translucency toward opacity. But totally unexpectedly, that increasing translucency toward opacity is accompanied by a simulation by the non-metallic, non-pearlescent colorants of the brushed metal appearance of a metallic colorant concentrate or the lustrous appearance of a pearlescent colorant concentrate, or both. More precisely, the chromaticity and the brightness of the resulting molded polyester container using concentrates of the present invention have dramatically different values as one tilts the container in the presence of a light source at a constant angle.

[00015] For purposes of the present invention, "non-metallic, non-pearlescent colorant" means a conventional dye or pigment which is not formed of, or derived from, metal, mica, or glass.

[00016] Unpredictably, a conventional, non-metallic, non-pearlescent colorant can replace more expensive and more dispersion-difficult metallic colorants or pearlescent colorants, if one employs PLA as a carrier for the colorant being employed in a polyester plastic article. It is believed with current costs that the combination of PLA and non-metallic, non-pearlescent colorant is less expensive than the use of a metallic or pearlescent colorant.

[00017] One aspect of the invention is a plastic article, comprising (a) a matrix of polyester and (b) polylactic acid dispersed throughout the matrix, and optionally, (c) at least one non-metallic, non-pearlescent colorant dispersed throughout the matrix, wherein surfaces of the article have a brightness and chromaticity which simulates the appearance of metallic pigment or pearlescent pigment throughout the matrix because the brightness and chromaticity values change as the angle of the surface of the article changes relative to a constant light source.

[00018] Another aspect of the invention is a method of making the plastic article described above, comprising the steps of (a) mixing the matrix and the concentrate into a mixture; and (b) forming under stress the mixture into the plastic article, wherein the differences in brightness and chromaticity are a function of the amount of polylactic acid in the mixture.

[00019] Features will become apparent from a description of the embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[00020] Fig. 1 is a composite photo of Examples 3 and 4, Examples 5 and 6, and Example 7.

EMBODIMENTS OF THE INVENTION

[00021] Polyester

[00022] Any aromatic polyester is a candidate for use in the present invention. The formation of a polyester from a monool or a polyol and an acid

or its ester encompasses many different suitable types of polyesters for use in this invention. The monomeric units can be formed reactions of either aliphatic moieties, aromatic moieties, or both. Desirably, the polyester is transparent or semi-transparent in order to accentuate the effect of the stress forming event.

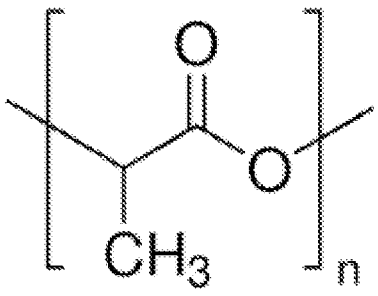
[00023] Non-limiting examples of polyesters include terephthalates, 1,4 butylene glycol, terephthalate glycols, copolyesters of terephthalic acid residues, 2,2,4,4-tetramethyl-1,3-cyclobutanediol, and 1,4-cyclohexanedimethanol, etc., or combinations, derivatives,thereof.

[00024] Additionally, one can use homopolyesters or copolyesters, such as homopolymers and copolymers of terephthalic acid and isophthalic acid. The linear polyesters may be produced by condensing one or more dicarboxylic acids or a lower alkyl diester thereof, e.g., dimethylterephthalate, terephthalic acid, isophthalic acid, phthalic acid, 2,5-, 2,6-, or 2,7-naphthalene dicarboxylic acid, succinic acid, sebacic acid, adipic acid, azelaic acid, bibenzoic acid and hexahydroterephthalic acid, or bis-p-carboxyphenoxyethane, with one or more glycols, e.g., ethylene glycol, pentyl glycol, and 1,4-cyclohexanedimethanol.

[00025] Of these various polyester candidates, because of commercial availability, the terephthalates, such as polyethylene terephthalate (PET) or polybutylene terephthalate (PBT), are desirable for use. PET is currently preferred because of its ubiquity and cost.

[00026] Polylactic Acid

[00027] At least a portion of the plastic polyester article needs to include PLA. Generally, PLA is an aliphatic monomer having has a formula I:



I

[00028] in which n is high enough (e.g., at least 30) for the polymer to have a number average molecular weight higher than the number average molecular weight of an oligomer. The monomeric unit can homopolymerize or copolymerize. PLA has a melting point of about 170-180°C and is nearly transparent with a low specific gravity of about 1.25 g/cm^3. The reported haze is less than 2.5% with a transmittance of 90%. PLA has a refractive index of 1.46.

[00029] Often, PLA is used in consumer packaging because PLA is an environmental friendly material. For that reason, PLA has been used as a carrier in color concentrate products, but not intentionally for use with polyester for metallic or pearlescent simulation appearance purposes.

[00030] PLA is commercially available as Revode 190 brand grade from HISUN in China, among others located by searching the internet.

[00031] Optional Colorant

[00032] A colorant can be a pigment, a dye, a combination of pigments, a combination of dyes, a combination of pigments and dye, a combination of pigment and dyes, or a combination of pigments and dyes. The choice of colorants depends on the ultimate color desired by the designer for the plastic article.

[00033] The science of color is well known to those skilled in the art. Without undue experimentation, one can use color matching techniques to identify a particular location in spherical color space. For example, one skilled in the art can use the teachings of PCT Patent Publication WO/2004/095319 to digitally map color space using specific polymer carriers and colorants as raw material ingredients. Alternatively, one can make small samples called plaques for visual review.

[00034] Colorants are commercially available from a number of sources well known to those skilled in the art. Commercially available pigments are well known to those skilled in the art and include organic and inorganic colorant chemistries. Commercially available dyes are well known to those skilled in the

art and include all organic chemistries. Commercial sources for pigments and dyes include multinational companies such as BASF, Bayer, Color-Chem International, Sun Chemical, Zhuhai Skyhigh Chemicals, and others identified at Internet Web Sites such as www.colorpro.com/info/vendors/colorant.html and dir.yahoo.com/Business_and_Economy/Business_to_Business/Chemicals_and_Allied_Products/Pigments_and_Dyes/

[00035] Table 1 lists 8 commercially available pigment colorants in a variety of primary and secondary colors, 5 chromatics, 2 blacks, and 1 white.

Table 1
Commercial Pigment Colorants

Raw Material Name	CI_Name	Family	COLOR	FDA *
TIOXIDE R-FC6 WHITE	PIGMENT WHITE 6	INORGANIC	WHITE	Y
REGAL 660R BLACK POWDER	PIGMENT BLACK 7	ORGANIC		N
MPC CHANNEL BLACK	PIGMENT BLACK 7	ORGANIC		Y
HELIOGEN BLUE K7090	PIGMENT BLUE 15:3	ORGANIC	BLUE	Y
Heliogen Blue K6903	PIGMENT BLUE B 15:1	ORGANIC	BLUE	Y
34L2000 AZURE BLUE	PIGMENT BLUE 28	INORGANIC	BLUE	Y
SICOTAN YELLOW K 2001 FG	PIGMENT BROWN 24	INORGANIC	YELLOW	Y
SICOTAN YELLOW K 1011	PIGMENT YELLOW 53	INORGANIC	YELLOW	Y

* As publicized by the commercial producer or as tested by the applicant, or both.

[00036] Table 2 shows 14 commercially available dyes.

Table 2
Commercial Dye Colorants

Raw Material Name	CI Name	Family	Color	FDA *
Lambdaplast Blue NL	Solvent Blue 59	Anthraquinone	Blue	N
Macrolex Blue RR Granular	Solvent Blue 97	Anthraquinone	Blue	N
Macrolex Green G Granular	Solvent Green 28	Anthraquinone	Green	N
Macrolex Green 5B Granular	Solvent Green 3	Anthraquinone	Green	N
Macrolex Orange R Granular	Disperse Orange 47	Polymethine	Orange	N
Macrolex Orange 3G Granular	Solvent Orange 60	Perinone	Orange	N
Macrolex Red EG Granular	Solvent Red 135	Perinone	Red	N
Macrolex Red E2G Granular	Solvent Red 179	Perinone	Red	N
Thermoplast Red 454	Solvent Red 195	Anthraquinone	Red	N
Macrolex Red Violet R Granular	Disperse Violet 26	Anthraquinone	Violet	N
Macrolex Violet B Granular	Solvent Violet 13	Anthraquinone	Violet	N
Macrolex Violet 3R Granular	Solvent Violet 36	Anthraquinone	Violet	N
Key Plast Yellow 3G	Solvent Yellow 93	Pyrazolone	Yellow	N
Key Plast Yellow AG	Solvent Yellow 114	Quinophthalone	Yellow	N

* As publicized by the commercial producer or as tested by the applicant, or both.

[00037] Colorants for this invention can include colorants intended for transparent or translucent plastic polyester articles and colorants intended for opaque plastic articles. The colorant itself, when used, in this invention determines the color of the metal or pearl which is simulated by the interaction of the PLA with the polyester.

[00038] Achievement of a color match of a plaque with a desired color from the creativity of a designer or a pre-arranged color standard such as Pantone® color standards from an inventory of commercially available colorants is relatively straightforward for a skilled color matcher, even if a few iterations are required to satisfy the customer.

[00039] Though the more convenient method of manufacture is to assemble the colorant and PLA as a concentrate to be added into the polyester matrix, it is certainly contemplated that each ingredient can be added separately. Significantly, the amount of PLA in the polyester affects the change in brightness and chromaticity of the colorants as the wall thickness of the polyester article changes from a preform to a final article. The simulated metallic or pearlescent surface appearance can be achieved using this invention, whether by compounding all ingredients together or compounding a concentrate of colorant and PLA into polyester.

[00040] When making a concentrate, the concentration of colorant into a carrier is significant because of the relative cost of the colorant ingredient(s) and the need for that color to consistently and precisely mix and disperse into the carrier and then to consistently and precisely dilute into the plastic resin and other compound ingredients during "letdown" of the concentrate in mixing equipment prior to formation of the preform embryonic bottles or other articles. Letdown ratios depend on the concentration of colorant in the color concentrate and whether the final molded product is intended to be opaque, translucent, or transparent.

[00041] The amount of PLA in the final molded product, as a function of plastic article (e.g., polyester part) wall thickness above about 0.01mm can range from about 0.5 to about 60 weight percent, and preferably from about 3 to about 10 weight percent for plastic article.

[00042] Without undue experimentation but using the examples of the invention later, a person having ordinary skill in the art can adjust the amount of

PLA relative to polyester part wall thickness to tailor the amount of simulate metallic or pearlescent appearance.

[00043] The mixing equipment used to make the color concentrate can be any suitable equipment already used in the art of mixing highly concentrated solids. For example, such equipment includes high speed Henschel mixers, ribbon blenders, shakers, and the like.

[00044] Mixing equipment can operate at mixing speeds ranging from about 10 rpm to about 10,000 rpm, and preferably from about 500 to about 8000 rpm. Mixing equipment can operate at temperatures ranging from about 25°C to about 100°C, and preferably from about 40°C to about 80°C.

[00045] Optional Functional Additives

[00046] Additives to improve processing or performance of the concentrate of the present invention or the polyester compound, or both, can be added according to preferences of those skilled in the art. For example, functional additives for polyester bottles can include anti-oxidants, anti-stats, acetaldehyde scavengers, oxygen scavengers, blowing agents, biocides, exfoliated nanoclays, thickeners, and the like, and combinations thereof. Generally, minor amounts of such additives provide improvement of performance to the color concentrate during processing with the other ingredients in the polyester resin or in performance of the polyester molded article after manufacturing. One skilled in the art without undue experimentation can determine the appropriate concentration.

[00047] Frequently, the preparation of a colored plastic article does not involve merely color but also special effect features, such as Granite, Translucent, Fluorescents, Iridescents, Marbles, Metallics, Pearls, etc. With metallics and pearls already simulated by use of the PLA color concentrate in polyester, these other special effects can be added to create even more eye-catching effects for the plastic article in use or on sale.

[00048] Non-limiting examples of such additives are commercially available from PolyOne Corporation of Avon Lake, Ohio, USA (www.polyone.com) and marketed under the following brands: OnColor FX colorants, PolyOne colorants, etc.

[00049] Plastic articles exposed to natural sunlight are exposed to ultraviolet rays that can harm the color of the article. Therefore, for certain applications, it is customary but not required to include ultraviolet light stabilizers in the color concentrate. This optional additive being included in the color concentrate adds value to that concentrate as a masterbatch in polymer compounding because the ultraviolet stabilizer also helps protect the polymer resin from adverse effects arising from exposure to the ultraviolet rays. Being included in a masterbatch as an additive makes the introduction of the stabilizer easier, due to better dispersion.

[00050] Table 3 shows acceptable, desirable, and preferable ranges of ingredients useful for polymeric articles of compounds containing PLA additives, all expressed in weight percent (wt. %) of the entire compound. The compound can comprise, consist essentially of, or consist of these ingredients. Any number between the ends of the ranges is also contemplated as an end of a range, such that all possible combinations are contemplated within the possibilities of Table 1 as candidate compounds for use in this invention.

Table 3- Final Compound Ingredients

Ingredient (Wt. %)	**Acceptable Range**	**Desirable Range**	**Preferred Range**
Polyester Resin	27-99.5%	75-99%	83-97%
Polylactic Acid	0.5-60%	1-15%	3-10%
Optional Colorant	0 – 3%	0.0001 – 2%	0.0005 – 2%
Optional Functional Additives	0 – 10%	0 – 8%	0 – 5%

[00051] The polylactic acid can be delivered into the final compound via a masterbatch using a carrier. The carrier can be entirely PLA or a mixture of

PLA and polyester depending on the amount of total PLA desired in the polyester part wall thickness.

USEFULNESS OF THE INVENTION

[00052] Concentrates of the present invention can be letdown into plastic resins and other ingredients useful for making molded or extruded articles.

[00053] As stated previously, the plastic resins can be any aromatic polyester, but especially PET.

[00054] The invention has particular applicability to plastic articles which are personal care or hygiene product containers, such as shampoo bottles, lotion containers, etc. The method of making such plastic articles is via stretch blow molding.

[00055] Stretch blow molding is a subset of conventional blow molding, often used in making containers. The final shape is achieved via one stage or two stages.

[00056] In a one stage blow molding, a "parison" is formed having some final dimensions (the "finish" such as the screw cap portion of the ultimate container) and nearly immediately then subjected to blow molding with a deliberate stretch of the non-final dimensions expanded to their intended shape. Depending on the design, the stretching occurs both in the axial direction of the parison and in the hoop or radial direction also.

[00057] In a two stage blow molding, a "preform" is formed via conventional injection molding and having some final dimensions (the "finish" such as the screw cap portion of the ultimate container) and the remainder having shrunken dimensions for convenience of transport and storage until final stress formation.

[00058] In the second stage, the preform is heated to an appropriate softening temperature and gas is used to deliberately stretch to its final intended shape. Depending on the design, the stretching occurs both in the axial direction of the preform and in the hoop or radial direction also.

[00059] It is known that polyester can be strengthened by stretch blow molding because the resulting strain is hardened into the plastic article after cooling. This strengthening in a container can assist in the storage of fluids having a high vapor pressure, such as carbonated soft drinks and the like.

[00060] The plastic article (of polyester and PLA which are both polymers having high clarity approaching transparency) becomes translucent or even opaque. The ability of standard colorants to simulate metallic pigments or pearl pigments is totally unexpected but arises from the use of PLA and the effect of stress formation into final polyester article shape. Other embodiments appear in the examples.

EXAMPLES

[00061] Table 4 shows the formulations of the two masterbatches used in the compounds of the remaining examples, including the source of the raw materials. Table 5 shows the formulations of the compounds and the test results.

Table 4 Formulations of Masterbatch

Ingredient (Wt. %)	**Example 1**	**Example 2**
PET CR-8863 (Hualei, China)	36.92%	36.95%
PLA Revode 190 (HISUN, China)	60%	60%
Macrolex Yellow G (Lanxess)		0.05%
Brown RS-AT (Longxin, China)	0.08%	
Elvaloy® PTW (DuPont)	3%	3%

Table 5 Formulations of final products and effect of metallic appearance

Example	3	4	5	6	7
Processing	Injection blowing	Injection blowing	Plate injection	Plate injection	Injection blowing
Masterbatch of Example	1	1	1	1	2

Table 5 Formulations of final products and effect of metallic appearance					
Example	3	4	5	6	7
Wt. % of Masterbatch	5	10	3	5	10
Wt. % of Polyester	95	90	97	95	90
Wt. % of PLA	3	6	1.8	3	6
Shape	Blown bottle	Blown bottle	Injection plaque	Injection plaque	Blown bottle
Aesthetic	Metallic color	Metallic color	Metallic color	Metallic color	Metallic color

[00062] Fig. 1 is a photographic lineup showing the metallic or pearlescent glossy appearance of Examples 3-7 in the shape of bottles and plaques.

[00063] A different approach to employing conventional non-metallic, non-pearlescent colorants to simulate a metallic or pearlescent surface in a stretch blow molded bottle or an injection plaque has been achieved. Unexpectedly, the use of one type of thermoplastic resin, PLA, with the use of conventional colorants in polyester and stretch blow molded into a bottle gives that bottle an appearance that looks as if it were made of metal or mother-of-pearl.

[00064] As compared with U.S. Pat. No. 8,575,296 (Vernon et al.), similar appearances have been achieved with what is believed to be the same theory of polymer physics disclosed in detail in Vernon et al. and incorporated by reference herein.

[00065] An advantage of this approach compared with use of PMP by Vernon et al. is that PLA itself is a polyester and hence more able to obtain a more homogeneous and effective metallic or pearlescent appearance in injection blow molded bottles or injection plaques substituting for other polymer shapes.

[00066] Once the visual dazzle of the present invention is known by reviewing the Examples and the Tables, one having ordinary skill in the art

without undue experimentation can create all different combinations of polyester articles having the benefit of the invention. One could utilize multiple different concentrates, all containing PLA but in different amounts. One could utilize multiple different concentrates, at least one containing PLA and at least one not. By complex molding techniques, one could have a simulated metallic or pearlescent surface on the polyester article for only one region of the article and a different simulated metallic or pearlescent surface or a conventional colorant or a special effects colorant or both in another region or additional regions of the same article. The possibilities are endless.

[00067] The molded plastic article can be made by other molding techniques. The molded plastic article can be used for any purpose imaginable. Any molded polyester article which utilizes a calculable wall thickness can benefit from the explanations in this invention to achieve any desired level of simulated metallic or pearlescent appearance.

[00068] With this knowledge, a person having ordinary skill in the art, without undue experimentation, can engineer a variety of plastic article shapes using stretch blow molding manufacturing or other stress-inducing formation techniques in order to produce beautiful metallic or pearlescent appearances from conventional colorants.

[00069] The invention is not limited to the above embodiments. The claims follow.

What is claimed is:

1. A plastic article, comprising:

(a) a matrix of polyester and

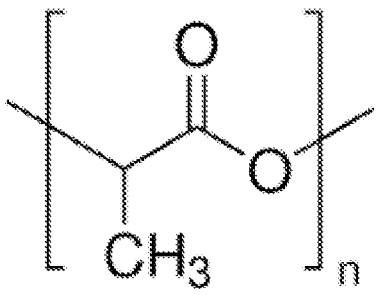
(b) polylactic acid dispersed throughout the matrix, and, optionally

(c) at least one non-metallic, non-pearlescent colorant dispersed throughout the matrix, wherein surfaces of the article have a brightness and chromaticity which simulates the appearance of metallic pigment or pearlescent pigment throughout the matrix.

2. The article of Claim 1,

wherein the article has a wall thickness;

wherein polylactic acid is an aliphatic monomer based having a formula I:



I

in which n is high enough for the polymer to have a weight average molecular weight higher than the weight average molecular weight of an oligomer; and

wherein the amount of polylactic acid in the plastic article, as a function of plastic article wall thickness can range from 0.5 to 60 weight percent of the plastic article for a plastic article having a wall thickness above 0.01mm.

3. The plastic article of Claim 2, wherein the amount of polylactic acid referred ranges from 3 to 10 weight percent of the plastic article for a plastic article having a wall thickness above 0.01mm.

4. The plastic article of any one of Claims 1-3, wherein the at least one colorant can be a pigment, a dye, a combination of pigments, a combination of dyes, a combination of pigments and dye, a combination of pigment and dyes, or a combination of pigments and dyes.

5. The plastic article of any one of the above Claims, wherein the polyester comprises a terephthalate, terephthalate glycol, and copolyester of terephthalic acid, 2,2,4,4-tetramethyl-1,3-cyclobutanediol, and 1,4-cyclohexanedimethanol, or combinations, or derivative thereof.

6. The plastic article of any one of the above Claims wherein the article further comprises an anti-oxidant, an anti-stat, an acetaldehyde scavenger, an oxygen scavenger, a blowing agent, a biocide, an exfoliated nanoclay, a thickener, a special effect feature, or combinations thereof.

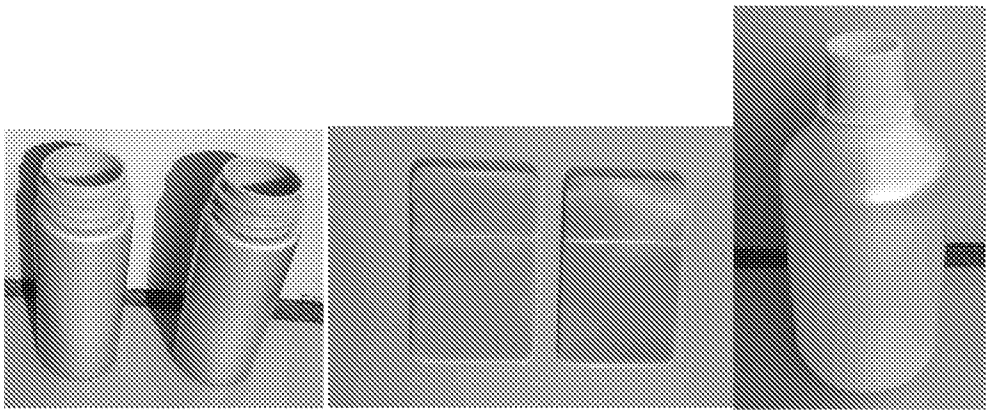
7. A method of making the plastic article of any one of the above Claims, comprising the steps of:

(a) mixing the matrix and the concentrate into a mixture; and

(b) forming under stress the mixture into the plastic article, wherein the differences in brightness and chromaticity are a function of the amount of polylactic acid in the mixture.

8. The method of Claim 7, wherein the step(b) includes forming methods comprising injection blowing molding, blowing, injection molding, or extrusion.

Fig. 1



Example 3 (left)
Example 4 (right)

Example 5 (left)
Example 6 (right)

Example 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2017/110675

A. CLASSIFICATION OF SUBJECT MATTER

C08L 67/04(2006.01)i; C08L 67/02(2006.01)i; C08K 5/00(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)

C08L67/04; C08L67/02; C08K5/00

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)

WPI, EPODOC, CNPAT, CNKI:色剂，聚对苯二甲酸丁二醇酯，聚酯，染料，色料，颜料，聚对苯二甲酸乙二醇酯，聚乳酸, polyester, polylactic w acid, dye?, pigment?, color+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2014/0357764 A1 (BASF SE) 04 December 2014 (2014-12-04) description, paragraphs [0001] to [0008], [0050] to [0057], [0081] to [0084] and [0103]	1-8
A	CN 105073879 A (RELIANCE IND. CO. LTD.) 18 November 2015 (2015-11-18) description, paragraphs [0024] to [0052]	1-8
A	CN 102516789 A (SHANGHAI KUMHO SUNNY PLASTICS CO. LTD.) 27 June 2012 (2012-06-27) description, paragraphs [0007] to [0027]	1-8

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

* Special categories of cited documents:

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"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

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 December 2017	**12 February 2018**

Name and mailing address of the ISA/CN	Authorized officer
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INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2017/110675

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2014357764	A1	04 December 2014	JP	2014526591	A	06 October 2014
				WO	2013041423	A1	28 March 2013
				CN	103827222	A	28 May 2014
				EP	2758474	A1	30 July 2014
				EP	2573142	A1	27 March 2013
CN	105073879	A	18 November 2015	WO	2014108914	A1	17 July 2014
				EP	2943532	A1	18 November 2015
				US	2015353709	A1	10 December 2015
				US	9701814	B2	11 July 2017
				JP	2016514167	A	19 May 2016
				EP	2943532	A4	15 June 2016
				KR	20150105371	A	16 September 2015
CN	102516789	A	27 June 2012	CN	102516789	B	04 March 2015