

Thermoplastic Polymer Compositions Including Silica-Containing Nucleating Agents

Field of the Embodiments

[0001] Embodiments relate to thermoplastic polymer compositions that include nucleating agents whereby the compositions have improved properties for use in carpet backing applications. Non-limiting examples of nucleating agents include silica-containing nucleating agents such as sand, glass, and specifically, ground, powdered, or crushed glass. The polymer compositions provide improved properties relating to processing, dimensional and thermal stability, improved crystalline structure, and flame retardant properties. The polymer compositions are useful, for example, for carpet backing applications.

Description of Related Art

[0002] It has long been recognized that filling polymers with inorganic materials can modify the polymer properties. There are a large number of such filled polymers that are used commercially. In many instances, fillers are utilized as much for economics as they are for performance. In some instances, however, fillers can result in improved properties for the underlying composition to which they are added.

[0003] Fiberglass reinforced resins have been commercially used for some time. These are generally thermosetting resins with polyester backbones dissolved or dispersed into a reactive diluent such as styrene that can be cross-linked into rigid or semi-rigid networks. These resins also can be set off with peroxide accelerators. Other resins used in similar applications include acrylics or epoxy polymers, or combinations of the two. Fiberglass reinforced resins typically are used in fabricating bathtubs, shower stalls, boats, boat hulls, and automotive parts.

- [0004] Other water-soluble or emulsion polymers have been filled with various ingredients to provide a more economical product. In some cases glass has been added to form a roughened surface after the polymer has been dried on the surface. Glass also has been added to provide a decorative finish to wall and floor coverings.
- [0005] It is important for the polymer or resin to have properties that allow it to "wet" out or bind with the filler. If this "wetting out" property is not achieved, then delamination or failure of the polymer/filler bond can occur. In many instances the polymer can only be loaded with a limited amount of filler before the wetting ability becomes consumed. It then becomes important to add wetting or coupling agents to boost the amount of filler the polymer composition may accept.
- [0006] The description herein of problems or disadvantages associated with known compositions, compounds, apparatus, and methods is not intended to limit the embodiments to their exclusion. Indeed, various embodiments may include one or more known compositions, compounds, apparatus, and methods without suffering from the previously known problems or disadvantages.

SUMMARY:

- [0007] It is a feature of the embodiments to provide polymer compositions having improved physical properties, and improved processability. It is an additional feature of the embodiments to provide a polymer composition and method of making the polymer composition that has improved properties suitable in carpet backing applications. It is a further feature of the embodiments to provide carpet backing compositions and carpet tiles prepared using the compositions, as well as methods of making the carpet tiles.

[0008] In accordance with these and other features of the embodiments, there is provided a thermoplastic polymer composition comprising a thermoplastic polymer and at least one nucleating agent, whereby the polymer composition may have one or more properties selected from:

- an MT4 value of less than about .125 and a CT4 value of less than about 0.1, when measured according to the AACHEN Test;
- a surface tackiness disappearance time of less than about 1 hour;
- a sufficient rigidity time of less than about 75 hours;
- a time to ignition of greater than about 13 seconds; and
- a time to self-extinguish of less than about 60 seconds.

[0009] In accordance with an additional feature of an embodiment, there is provided a thermoplastic polymer composition comprising a thermoplastic polymer and at least finely ground glass powder. Suitable thermoplastic polymers include those that are capable of wetting out large amounts of the ground glass filler. Dispersing agents may be added in some embodiments to allow greater amounts of ground glass fillers to be added to the composition.

[0010] Another feature of an embodiment includes a method of making a thermoplastic polymer composition having one or more of the properties described above, whereby a thermoplastic polymer is admixed with a nucleating agent filler material, the nucleating agent filler material being in an amount of from about 10 to about 70 percent by weight, based on the total weight of the thermoplastic polymer composition.

[0011] Another feature of an embodiment includes a carpet backing composition comprising the thermoplastic polymer composition described above. An additional feature of an embodiment includes a method of making a carpet

backing comprising heating the carpet backing composition, and applying the carpet backing composition to a plurality of carpet backing yarns, carpet cloths, or non-woven fabrics, to form a carpet backing. Suitable methods of making carpet tile backings are disclosed in U.S. Patent No. 5,834,087, the disclosure of which is incorporated by reference herein in its entirety. The thermoplastic polymer compositions of the invention are suitable in any method of forming a carpet backing for conventional carpet materials, or for carpet tiles.

- [0012] An additional feature of an embodiment includes a carpet tile comprising the thermoplastic polymer composition described above. These and other features of the embodiments will be readily apparent to those skilled in the art upon review of the detailed description that follows.

DETAILED DESCRIPTION

- [0013] The terminology used herein is for the purpose of describing particular embodiments only, and is not intended to limit the scope of the present invention. As used throughout this disclosure, the singular forms “a,” “an,” and “the” include plural reference unless the context clearly dictates otherwise. Thus, for example, a reference to “a polymer composition” is a reference to one or more compositions and equivalents thereof known to those skilled in the art, and so forth.

- [0014] Unless defined otherwise, all technical and scientific terms used herein have the same meanings as commonly understood by one of ordinary skill in the art to which these embodiments belong. Although any methods and materials similar or equivalent to those described herein can be used in the practice or testing of the embodiments, the methods, devices, and materials are now described. All publications mentioned herein are cited for the purpose of describing and disclosing the various components that are reported in the publications and that might be used in connection with

the embodiments. Nothing herein is to be construed as an admission that the embodiments are not entitled to antedate such disclosures by virtue of prior invention.

[0015] The polymer compositions described herein possess unexpected but highly beneficial increases in dimensional stability that may be achieved by using relatively large amounts of nucleating agents. In one embodiment, these beneficial increases are achieved by utilizing a finely ground glass filler in thermoplastic adhesive and/or layering compositions. This dimensional stability is believed to be important for applications such as backing of carpet tiles where the current art relies primarily on a fiberglass matt to achieve the needed dimensional stability.

[0016] While not intending on being bound by any theory of operation, the inventor believes that the finely ground glass filler materials act as a surprising source of nucleation sites in the thermoplastic polymers that are crystalline or semi-crystalline nature. The inventor further believes that smaller particle sizes of the ground glass filler material or other nucleating agent(s), or combinations thereof, contributes to an increased number of nucleation sites. The use of nucleating agents is well documented in industry and typically is described as controlling crystallinity during the application of certain polymers. Controlling the rate and degree of crystallinity is believed to be important in obtaining certain properties in certain applications, such as, for example, where the thermoplastic composition is being used for adhesive purposes.

[0017] The nucleating agents described herein also may provide an added benefit to the polymer composition in terms of fire retardancy. Fire retardancy is a desirable property for many polymer applications. Many of the fire retardants used with thermoplastics have the effect of ceramitizing the surface and thus preventing oxygen from getting to the fuel source.

Finely ground glass powder has this effect either alone in high concentrations or to augment other flame retardant systems.

[0018] The thermoplastic polymer composition includes a nucleating agent and may have one or more properties selected from:

- an MT4 value of less than about .125 and a CT4 value of less than about 0.1, when measured according to the AACHEN Test;
- a surface tackiness disappearance time of less than about 1 hour;
- a sufficient rigidity time of less than about 75 hours;
- a time to ignition of greater than about 13 seconds; and
- a time to self-extinguish of less than about 60 seconds.

[0019] The thermoplastic composition may have two or more of the properties listed above, and may have three or more, and may even possess all of the aforementioned properties.

[0020] Applications of thermoplastics are too numerous to specifically mention in this disclosure. Generally thermoplastics can be used to coat other substrates, as film formers either alone or applied to substrates, as adhesives or adhesive layers, and in forming articles by various molding concepts. The thermoplastic compositions described herein are suitable for use in any or all of these applications.

[0021] Fillers typically are added to compositions to decrease the cost of the composition (e.g., use less polymer by adding fillers that typically are inert). Some filler materials may provide beneficial properties, such as imparting impact resistance, altering the texture or feel of a finished object, etc. Generally, fillers are added to the molten polymer in a number of ways but most frequently they are added into an extruder as a mixture along with pellets of the thermoplastic or downstream in the extruder in a

side stuffer. It may be beneficial to add these fillers in a very carefully controlled environment and at a higher level than the end product requires, pelletize, and then mix the pellets with non-filled thermoplastic in an extruder again to produce a final product composition. In this regard, the filled resin could be called a "Masterbatch."

- [0022] Additional methods of providing fillers to thermoplastic polymers involve a batch process further upstream in the vessel in which the polymer itself is made. In these cases, the filler can be added to a vessel or reactor directly into the molten polymer. The composition may be agitated until the composition is thoroughly mixed and then the mixture is either applied directly or extruded into pellets, pillows, bricks, etc. for further processing.
- [0023] Suitable thermoplastics for use in the embodiments include, for example, any known thermoplastic polymer material. Suitable thermoplastics include esters of polyethylene terephthalate (PET), optionally with a modifying polymer, esters of polyethylene naphthalate (PEN), optionally with a modifying polymer, other polyester materials, polyesters (all copolymers), polyamides (all copolymers), ethylene vinyl acetates and polyethylene copolymers, polyolefins, polystyrenes, polystyrene butadienes, acrylonitrile butadiene styrene and copolymers, polyvinyl chloride, acrylics, styrene maleic acrylics, acetal, fluoropolymers and copolymers, polybutylene, polycarbonate, polyimides and polyetherimides, polysulfones, and polyethersulfones, polyvinylindene chlorides, silicones, and mixtures and combinations thereof. The optional modifying polymer, for example, may be one or more of polyethylene glycol, diethylene glycol, trimethylol propane, phthalic anhydride, adipic acid, and combinations or mixtures thereof. Additionally, esterification catalysts may be added to the mixture in order to promote esterification of the modifying polymers and trans-esterification with PET and PEN.

- [0024] The thermoplastic polymer may be mixed with additives to impart additional beneficial qualities to the finished carpet. Applicable additives include, but are not limited to, fire retardants, fillers, weighters, oxidization stabilizers, antibacterial agents, antimicrobial agents, antifungal agents, UV stabilizers, and combinations or mixtures thereof. One skilled in the art will recognize other applicable additives that may optionally be added to the hot melt adhesive, in accordance with the guidelines provided herein.
- [0025] One filler suitable for use in the embodiments is a nucleating agent that is capable of imparting one or more of the properties described above to the polymer composition. For example, a finely ground glass material or other silica-containing nucleating agent may be added to the thermoplastic polymer composition. These fillers include powdered glass, powdered sand, powdered quartz, powdered silica-containing ceramics, and the like. The filler can be added in an amount of from about 10 to about 70 weight percent, based on the total weight of the polymer composition, or it may be added in an amount of from about 40 to about 60 weight percent. The filler may have a mesh size of about 40 to about 250 mesh, or from about 50 to about 70 mesh.
- [0026] The thermoplastic polymer compositions described herein may be used in carpet tile backing applications, where a meltable composition is desirable. The composition can be applied to any known carpet backing material to provide a carpet backing having improved dimensional stability, improved fire retardance, and other desirable properties described herein. For example, the thermoplastic polymer composition can have a relatively lower viscosity when melted so that it may more fully penetrate the fiber tufts of the greige carpet typically used for carpet backings. The thermoplastic polymer compositions described herein may have a

viscosity of less than 300,000 centipoise at 325 °F, or the composition could have a viscosity of less 75,000 centipoise at 325 °F.

[0027] The thermoplastic composition described herein may be applied to the secondary backing material or primary backing material to form the carpet backing. Applying the thermoplastic composition to the carpet backing material may take place in any applicable manner. For example, the thermoplastic composition may be sprayed or rolled on the carpet backing material, or it may be applied in one application, or multiple applications to provide a multi-coated carpet backing material.

EXAMPLES

Example 1:

[0028] In the carpet industry, thermoplastic materials have been and are being used as a suitable adhesive layer for adhering tufts into a backing material. In this regard, they are applied to the back of the carpet onto the tufts protruding through the primary backing. Various materials have been used to achieve this, but more recently polyesters have been used. The polyester materials have the ability to wet out and adhere to the tufts providing both internal and external binding. To provide increased weight and improved economics, various fillers have been tried, some with marginal success.

[0029] In the batch process using thermoplastic polyester, finely ground glass powder of 60 mesh size or less was added to the finished polymer at levels of 10 to 70 percent, or from 40 to 60 percent prior to application on the carpet back. It was found to provide properties that none of the other previously tried fillers had, and even more so the resulting composition had a combination of properties not believed to have been previously achieved using conventional fillers and polymers. These properties provide the following added benefits.

[0030] Improved processing due to the flow properties of the thermoplastic composition allows for slight changes in running conditions without affecting the final product. Some of these flow properties can be attributed to the internal heat sinking effect of the composition containing the glass. The specific heat of the polymer/glass composition is believed to be considerably more than that of the polymer alone.

Example 2: Dimensional stability

[0031] This property was measured using a test for carpet tile dimensional stability called the AACHEN test. In this method the carpet is subjected to a series of conditions that mimic the action of steam, moisture, and heat on the carpet tile. The results are provided in table 1 below:

Table 1

DESCRIPTION	AACHEN TEST VALUES-Average
Control = 50 % Polyester/50% Magnetite filler with Fiberglass Matt	MT4=.127 CT4=.052
50% Polyester MHF/50% Magnetite filler with no Fiberglass Matt	MT4=.295 CT4=.102
50% Polyester MHF/50% Barium Sulfate filler with no Fiberglass Matt	MT4=.262 CT4=.181
50% Polyester MHF/50% Ground Glass Powder with no Fiberglass Matt	MT4=.123 CT4=.071

[0032] The results in the table above reveal that the polymer compositions of the embodiments provide a carpet back with improved dimensional stability, and in fact can provide the same or better dimensional stability as carpet backings that utilize a fiberglass matt. Thus, embodiments of the carpet backing may not include a fiberglass matt, yet still possess the requisite dimensional stability, thereby reducing carpet backing costs and processing time.

Example 3: Controlled nucleation of polyester formula

[0033] It was found during the processing of the polyester carpet backing that the crystallinity of the polyester may have had a significant influence on the properties of the finished carpet. If the crystallinity was too high initially then the desirable properties of tuft bond strength and Velcro fiber stability may have suffered. If the crystallinity was not high enough, then the carpet backed surface may have become too tacky resulting in numerous processing problems including, but not limited to blocking, fiber transfer, excessive drape, and dimensional stability as in above example. Using the guidelines provided herein, those skilled in the art will be capable of modifying the thermoplastic polymer composition to have the requisite crystallinity, depending on the particular application of the polymer composition.

[0034] Two test parameters were used in the following table 2. These parameters were surface tackiness after application and backing rigidity, both of which are believed to be directly related to polymer crystallinity. The addition of the ground glass powder resulted in the ability to control these parameters more sufficiently.

Table 2

Formulation	Running Temperature	Time to disappearance of surface tackiness	Time to sufficient rigidity
Polyester MDF/Magnetite 50/50	330 ° F.	~30 hours	~168 hours
Polyester MHF/ Magnetite 50/50	330 °F.	~24 hours	~120 hours
Polyester MHF/ Magnetite 50/50	350 °F.	~12 hours	~120 hours
Polyester MHF/ Barium Sulfate 50/50	330 °F.	~12 hours	~96 hours
Polyester MHF/ Calcium Carbonate 50/50	330 °F.	~5 hours	~96 hours
Polyester MHF/ Ground Glass 50/50	330 °F.	~3 minutes	~60 hours
Polyester MHF/ Ground Glass 50/50	350 °F.	~5 minutes	~48 hours

[0035] In this example the ground glass is apparently offering numerous sites for crystallinity to initiate, and consequently, is behaving as a nucleating agent.

Example 4:

[0036] It was also found that glass filled compositions offered flame retardant properties greater than the thermoplastic polyester formulation alone or thermoplastic polyester formulations filled with other known fillers. Two properties were tested. These properties were time to initial ignition when exposed to a torch flame and time for the ignition to self-extinguish once the torch flame was removed. It was determined that these two properties related well to the Radiant Panel Carpet Test that is used to standardize flame retardancy in the carpet industry. The results are listed in table 3 below:

Table 3

Formulation	Time to Ignition	Time to Self-Extinguish
Polyester Polymer MDF-100%	10 seconds	<1 minute
Polyester Polymer MHF-100%	15 seconds	<1 minute
Polyester Polymer MHF/Calcium Carbonate 50/50	15 seconds	<1 minute
Polyester Polymer MHF/Ground Glass 90/10	15 seconds	<1 minute
Polyester Polymer MHF/ Ground Glass 80/20	15 seconds	<1 minute
Polyester Polymer MHF/ Ground Glass 70/30	22 seconds	30 seconds
Polyester Polymer MHF/ Ground Glass 60/40	33 seconds	10 seconds
Polyester Polymer MHF/ Ground Glass 50/50	40 seconds	2 seconds

[0037] From these data it is clear to see that the effect of ground glass, especially in the higher loading levels, sufficiently increases the flame retardancy of the thermoplastic polymer. It was especially interesting that the char

formation on the surface seemed to be much harder indicating that a least some melting and subsequent ceramitizing of the surface was occurring.

[0038] Other embodiments, uses, and advantages of the embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the embodiments disclosed herein. The specification should be considered exemplary only, and the scope of the embodiments is accordingly not intended to be limited thereby.

What is claimed is:

1. A thermoplastic polymer composition comprising a thermoplastic and a nucleating agent, whereby the composition has at least one of the properties selected from the group consisting of:
 - an MT4 value of less than about .125 and a CT4 value of less than about 0.1, when measured according to the AACHEN Test;
 - a surface tackiness disappearance time of less than about 1 hour;
 - a sufficient rigidity time of less than about 75 hours;
 - a time to ignition of greater than about 13 seconds; or
 - a time to self-extinguish of less than about 60 seconds.
2. The thermoplastic polymer composition according to claim 1, whereby the composition has at least two of the properties selected from the group consisting of:
 - an MT4 value of less than about .125 and a CT4 value of less than about 0.1, when measured according to the AACHEN Test;
 - a surface tackiness disappearance time of less than about 1 hour;
 - a sufficient rigidity time of less than about 75 hours;
 - a time to ignition of greater than about 13 seconds; or
 - a time to self-extinguish of less than about 60 seconds.
3. The thermoplastic polymer composition according to claim 1, whereby the composition has at least three of the properties selected from the group consisting of:
 - an MT4 value of less than about .125 and a CT4 value of less than about 0.1, when measured according to the AACHEN Test;
 - a surface tackiness disappearance time of less than about 1 hour;
 - a sufficient rigidity time of less than about 75 hours;
 - a time to ignition of greater than about 13 seconds; or
 - a time to self-extinguish of less than about 60 seconds.

4. A thermoplastic polymer composition comprising a thermoplastic and a nucleating agent, whereby the composition has the properties of an MT4 value of less than about .125 and a CT4 value of less than about 0.1, when measured according to the AACHEN Test; a surface tackiness disappearance time of less than about 1 hour; a sufficient rigidity time of less than about 75 hours; a time to ignition of greater than about 13 seconds; and a time to self-extinguish of less than about 60 seconds.
5. A thermoplastic polymer composition of claim 1, wherein the nucleating agent is a silica-containing nucleating agent.
6. A thermoplastic polymer composition of claim 5, wherein the silica-containing nucleating agent is selected from the group consisting of powdered glass, powdered sand, powdered quartz, powdered silica-containing ceramics, and mixtures or combinations thereof.
7. A thermoplastic polymer composition of claim 5, wherein the silica-containing nucleating agent has a mesh size of about 40 to about 250 mesh.
8. A thermoplastic polymer composition of claim 5, wherein the silica-containing nucleating agent has a mesh size of about 50 to about 70 mesh.
9. A thermoplastic polymer composition of claim 5, wherein the silica-containing nucleating agent is present in an amount of from about 10 to about 70 weight percent, based on the total weight of the thermoplastic polymer composition.
10. A thermoplastic polymer composition of claim 5, wherein the silica-containing nucleating agent is present in an amount of from about 40 to

about 60 weight percent, based on the total weight of the thermoplastic polymer composition.

11. A thermoplastic polymer composition of claim 5, wherein the silica-containing nucleating agent is selected from the group consisting of ground glass, powdered glass, crushed glass, and mixtures or combinations thereof.
12. A thermoplastic polymer composition of claim 11, wherein the glass powder has about a 60 mesh size or less.
13. A thermoplastic polymer composition of claim 5, wherein the thermoplastic polymer composition has a viscosity of less than 300,000 centipoise at 325 °F.
14. A thermoplastic polymer composition of claim 5, wherein the thermoplastic polymer composition has a viscosity of less 75,000 centipoise at 325 °F.
15. A thermoplastic polymer composition of claim 5, wherein the thermoplastic is selected from the group consisting of esters of polyethylene terephthalate (PET), optionally with a modifying polymer; esters of polyethylene naphthalate (PEN), optionally with a modifying polymer; other polyester materials; polyesters, including all copolymers; polyamides, including all copolymers; ethylene vinyl acetates; polyethylene copolymers; polyolefins; polystyrenes; polystyrene butadienes; acrylonitrile butadiene styrene, including all copolymers; polyvinyl chloride; acrylics; styrene maleic acrylics; acetal; fluoropolymers, including all copolymers; polybutylene; polycarbonate; polyimides; polyetherimides; polysulfones; polyethersulfones; polyvinylindene chlorides; silicones; and mixtures and combinations thereof.

16. A thermoplastic polymer composition of claim 5, further comprising a dispersing agent.
17. A thermoplastic polymer composition of claim 5, further comprising an additive selected from the group consisting of fire retardants, fillers, weighters, oxidization stabilizers, antibacterial agents, antimicrobial agents, antifungal agents, UV stabilizers, and combinations or mixtures thereof.
18. A carpet backing composition comprising the thermoplastic polymer composition of claim 1.
19. A carpet backing composition comprising the thermoplastic polymer composition of claim 5.
20. A carpet tile comprising the thermoplastic polymer composition of claim 1.
21. A carpet tile comprising the thermoplastic polymer composition of claim 5.
22. A method of making a thermoplastic polymer composition comprising admixing a thermoplastic and a silica-containing nucleating agent, wherein the silica-containing nucleating agent is present in an amount of from about 10 to about 70 weight percent, based on the total weight of the thermoplastic polymer composition.
23. A method of making a thermoplastic polymer composition according to claim 22, wherein the silica-containing nucleating agent is present in an amount of from about 40 to about 60 weight percent, based on the total weight of the thermoplastic polymer composition.
24. A method of making a carpet backing comprising heating the carpet backing composition of claim 18, and applying the carpet backing

composition to a plurality of carpet backing yarns, carpet cloths, or non-woven fabrics, to form a carpet backing.