[0015] In some cases, the disclosure relates to a process for controlling the caprolactam content of a final polyamide composition, the process comprising the steps of providing a base polyamide composition having residual caprolactam content greater than 0.6 wt%; determining a desired residual caprolactam content for the final polyamide composition; selecting at least one processing condition from catalyst content, delta end group level, temperature, pressure, and moisture content; and processing the base polyamide composition under the at least one condition and based on the desired residual caprolactam content to form the final polyamide composition having a residual caprolactam content less than 0.4 wt%.

[0016] In one example, the disclosure relates to a process for manufacturing a final polyamide composition, the process comprising the steps of providing a base polyamide composition having one or more initial properties comprising initial caprolactam content, initial relative viscosity, and initial color index; determining one or more desired final properties for the final polyamide composition product, the properties comprising final caprolactam content, final relative viscosity, and color index; and processing the base polyamide composition under one or more process conditions comprising catalyst content, delta end group level, temperature, pressure, and moisture content and based on the desired final property to provide the final polyamide composition.

[0017] In some examples, the present disclosure relates to a process for producing a polyamide composition having a low residual caprolactam concentration, the process comprising the steps of: (a) providing a base polyamide composition comprising: a nylon mixture having caprolactam units; from 1 wppb to 50 wppm of a catalyst composition; and residual caprolactam, and having an initial residual caprolactam concentration and an initial relative viscosity; (b) processing the base polyamide composition to form the final polyamide composition having a final residual caprolactam concentration and a final relative viscosity. In some cases, the base polyamide composition has a delta end group level ranging from 30 μeq/gram to 90 μeq/gram. In one aspect, the present disclosure relates to a process for producing a polyamide composition having a low residual caprolactam concentration, the process comprising the steps of: (a) providing a base polyamide composition, wherein the base polyamide composition has a delta end group level ranging from 30 μeq/gram to 90 μeq/gram, comprising: a nylon mixture having caprolactam units; from 1 wppb to 50 wppm of a catalyst composition; and residual caprolactam, and having an initial residual caprolactam concentration and an initial relative viscosity; (b) processing the base polyamide composition to form the final polyamide composition having a final residual caprolactam concentration and a final relative viscosity, wherein the final residual caprolactam concentration is less than the initial residual caprolactam concentration and the final relative viscosity is larger than the initial relative viscosity. In some cases, the initial residual caprolactam concentration is greater than 0.75 wt%, based on the total weight of the base polyamide composition, and the final residual caprolactam concentration is less than 0.75 wt%, based on the total weight of the final polyamide composition. In some cases, the final relative viscosity ranges from 40 to 350. In some cases, the processing is conducted for a build time ranging from 2 hours to 30 hours, and a temperature ranging from 150°C – 250°C. In some cases, the final polyamide composition has a color index ranging from -6 to 5, as measured by ASTM E313 (2018). In some cases, the final relative viscosity is greater than the initial relative viscosity, wherein the final

pyridylethyl phosphonic acid; hypophosphorous acid; alkyl-, aryl- and alkyl-/aryl- substituted phosphinic acids; phosphoric acid; esters and salts of these phosphorous-containing acids; manganese hypophosphite; sodium hypophosphite; benzene phosphinic acid; monosodium phosphate; or any combinations thereof.

[0019] In some examples, the present disclosure relates to a film formed from a final polyamide composition comprising: polyamide monomers; less than 0.75 wt% residual caprolactam, wherein the final polyamide composition has a delta end group level ranging from 30 μeq/gram to 90 μeq/gram and a melting point ranging from 205ºC to 255ºC. In some cases, the film demonstrates: a puncture resistance greater than 3J/mm as measured via ASTM F1366 (2018), an impact resistance greater than 1500 grams as measured via ASTM D1709. A (2018), and/or a tear resistance greater than 50 grams as measured via ASTM D1922 (2018). In one example, the present disclosure relates to a film formed from a final polyamide composition comprising: polyamide monomers; less than 0.75 wt% residual caprolactam, wherein the final polyamide composition has a delta end group level ranging from 30 μeq/gram to 90 μeq/gram and a melting point ranging from 205ºC to 255ºC, wherein the film demonstrates: a puncture resistance greater than 3J/mm as measured via ASTM F1366 (2018), an impact resistance greater than 1500 grams as measured via ASTM D1709. A (2018), and/or a tear resistance greater than 50 grams as measured via ASTM D1922 (2018).

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The disclosure references the appended drawings.

[0021] FIG. 1 is a graph showing residual caprolactam concentration in final polyamide compositions at various build times.

[0022] FIG. 2 is a contour plot showing desirable DEG and catalyst (phosphorus) concentration in base polyamide compositions.

[0023] FIG. 3 is a plot showing desirable final RV and residual caprolactam in the base polyamide compositions of Examples 9-14.

[0023a] FIG. 4 is a plot showing demonstrating the BYK Gardner unit's correlation.

DETAILED DESCRIPTION

Introduction

[0024] Conventional processes for producing final polyamide compositions often employ a polymerization step to form a base polyamide composition followed by solid phase polymerization (SSP) of the base polyamide to form the final polyamide compositions. As noted above however, these processes yield final polyamide compositions that have, among other drawbacks, high residual caprolactam concentrations and/or undesirable relative viscosities (RVs). In addition to these compositional and performance deficiencies, the overall pellet quality of conventional final polyamide compositions has been found to be poor. For example, typical final polyamide compositions exhibit poor color quality, e.g., high yellowing indices; high levels of black specks; and/or high degrees of pellet size non-uniformity. It is postulated that the use of the SSP process

We Claim:

1. A process for producing a polyamide composition having a low residual caprolactam concentration, the process comprising the steps of:

(a) providing a base polyamide composition, wherein the base polyamide composition has a delta end group level ranging from 30 μeq/gram to 90 μeq/gram, comprising:

a nylon mixture having caprolactam units;

from 1 wppb to 50 wppm of a catalyst composition; and

residual caprolactam, and having an initial residual caprolactam concentration and an initial relative viscosity;

(b) processing the base polyamide composition to form the final polyamide composition having a final residual caprolactam concentration and a final relative viscosity, wherein the final residual caprolactam concentration is less than the initial residual caprolactam concentration and the final relative viscosity is larger than the initial relative viscosity.

2. The process of claim 1, wherein the initial residual caprolactam concentration is greater than 0.75 wt%, based on the total weight of the base polyamide composition, and wherein the final residual caprolactam concentration is less than 0.75 wt%, based on the total weight of the final polyamide composition.

3. The process of any one of claims 1 or 2, wherein the final relative viscosity ranges from 40 to 350.

4. The process of any one of claims 1-3, wherein the processing is conducted for a build time ranging from 2 hours to 30 hours, and a temperature ranging from 150°C – 250°C.

5. The process of any one of claims 1-4, wherein the final polyamide composition has a color index ranging from -6 to 5, as measured by ASTM E313 (2018).

6. The process of any one of claims 1-5, wherein the final relative viscosity is greater than the initial relative viscosity, wherein the final relative viscosity is at least 10% greater than the initial relative viscosity and the final residual caprolactam concentration is at least 5% less than the initial residual caprolactam concentration.

7. The process of any one of claims 1-6, wherein the base polyamide composition has a melting point ranging from 180ºC to 255ºC.

8. The process of any one of claims 1-7, wherein the nylon mixture of the base polyamide composition comprises:

from 1 wt% to 80 wt% nylon-6; and

from 20 wt% to 99 wt% nylon-6/6.

9. The process of any one of claims 1-8, wherein processing comprises solid state polymerization, which comprises heating the base polyamide.

10. The process of any one of claims 1-9, wherein the base polyamide composition is produced by melt polymerizing a polyamide composition and pelletizing the melted polyamide composition to form polyamide pellets.

11. The process of any one of claims 1-10, wherein the catalyst composition comprises phosphorous acid; phosphonic acid; alkyl- and aryl- substituted phosphonic acids; 2-pyridylethyl phosphonic acid; hypophosphorous acid; alkyl-, aryl- and alkyl-/aryl- substituted phosphinic acids; phosphoric acid; esters and salts of these phosphorous-containing acids; manganese hypophosphite; sodium hypophosphite; benzene phosphinic acid; monosodium phosphate; or any combinations thereof.

12. The process of any one of claims 1-11, wherein the base polyamide composition comprises from 0.1 wppm to 35 wppm catalyst composition, from 1 wt% to 8 wt% residual caprolactam, has a delta end group level ranging from 50 μeq/gram to 75 μeq/gram, and has initial relative viscosity less than 35, and

wherein the final polyamide composition comprises less than 0.6 wt% residual caprolactam and has a final relative viscosity greater than 45.

13. The process of any one of claims 1-12, wherein the base polyamide composition comprises from 1 wppb to 15 wppm phosphorus, greater than 1.5 wt% residual caprolactam, a delta end group level greater than 50 μeq/gram and has initial relative viscosity less than 33,

wherein the processing is conducted at a pressure less than atmospheric pressure and a temperature ranging from 175ºC to 185ºC, and

wherein the final polyamide composition comprises less than 0.4 wt% residual caprolactam and has a final relative viscosity greater than 55.

14. The process of any one of claims 1-13, wherein, during processing, the RV build rate ranges from 1 to 30 RV units/hour.

15. A base polyamide composition comprising:

a nylon mixture having caprolactam units;

from 1 wppb to 50 wppm catalyst composition; and

greater than 0.75 wt% residual caprolactam;

wherein the base polyamide composition has a delta end group level ranging from 30 μeq/gram to 90 μeq/gram.

16. The base polyamide composition of claim 15, wherein the base polyamide composition has a delta end group level greater than or equal to 45 μeq/gram.

17. The base polyamide composition of any one of claims 15 or 16, wherein the base polyamide comprises greater than 1.4 wt% caprolactam units, based on the total weight of the base polyamide composition, and wherein the base polyamide has a relative viscosity less than 55.

18. The base polyamide composition of any one of claims 15-17, wherein the nylon mixture of the base polyamide composition comprises:

from 1 wt% to 50 wt% nylon-6; and

from 20 wt% to 99 wt% nylon-6/6,

wherein the catalyst composition comprises phosphorous acid; phosphonic acid; alkyl- and aryl-substituted phosphonic acids; 2-pyridylethyl phosphonic acid; hypophosphorous acid; alkyl-, aryl- and alkyl-/aryl- substituted phosphinic acids; phosphoric acid; esters and salts of these phosphorous-containing acids; manganese hypophosphite; sodium hypophosphite; benzene phosphinic acid; monosodium phosphate; or any combinations thereof.