

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 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.
2. The process of claim 1, wherein the base polyamide composition has a delta end group level ranging from 30 $\mu\text{eq/gram}$ to 90 $\mu\text{eq/gram}$.
3. The process of any one of claims 1 or 2, 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.
4. The process of any one of claims 1-3, wherein the final relative viscosity ranges from 40 to 350.
5. The process of any one of claims 1-4, 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.
6. The process of any one of claims 1-5, wherein the final polyamide composition has a color index ranging from -6 to 5, as measured by ASTM E313 (2018).
7. The process of any one of claims 1-6, 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.

8. The process of any one of claims 1-7, wherein the base polyamide composition has a melting point ranging from 180°C to 255°C.
9. The process of any one of claims 1-8, 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.
10. The process of any one of claims 1-9, wherein processing comprises solid state polymerization, which comprises heating the base polyamide.
11. The process of any one of claims 1-10, wherein the base polyamide composition is produced by melt polymerizing a polyamide composition and pelletizing the melted polyamide composition to form polyamide pellets.
12. The process of any one of claims 1-11, 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.
13. The process of any one of claims 1-12, 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.

14. The process of any one of claims 1-13, 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 $\mu\text{eq}/\text{gram}$ 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 175°C to 185°C, and
wherein the final polyamide composition comprises less than 0.4 wt% residual caprolactam and has a final relative viscosity greater than 55.
15. The process of any one of claims 1-14, wherein, during processing, the RV build rate ranges from 1 to 30 RV units/hour.
16. 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 $\mu\text{eq}/\text{gram}$ to 90 $\mu\text{eq}/\text{gram}$.
17. The base polyamide composition of claim 16, wherein the base polyamide composition has a delta end group level greater than or equal to 45 $\mu\text{eq}/\text{gram}$.
18. The base polyamide composition of any one of claims 16 or 17, 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.
19. The base polyamide composition of any one of claims 16-18, 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.

20. 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 $\mu\text{eq/gram}$ to 90 $\mu\text{eq/gram}$ and a melting point ranging from 205°C to 255°C,
 - 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).