Abstract:

Described is a method for the preparation of an article, in particular a biodegradable article, from a thermoplastic composition comprising starch by thermoforming, comprising the steps of providing a sheet of the thermoplastic composition in rubber phase at a temperature of at least 100°C, stretching the sheet into or onto a mould, cooling the sheet to form the article, removing the article from the mould, wherein the mould in step b. has a temperature of 5°C or less, the sheet in step c. is cooled to a temperature of 40°C or less, steps b. and c. being performed in 10 s. or less. Further, a thermoformed article, obtainable by the said method and the use of such an article is described.
AMENDED CLAIMS
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1. Method for the preparation of an article from a thermoplastic composition comprising starch by thermoforming, comprising the steps of:
   a. providing a sheet of the thermoplastic composition in rubber phase at a temperature of at least 100°C,
   b. stretching the sheet of step a) into or onto a mould,
   c. cooling the sheet while stretched in or on the mould to form the article,
   d. remove the article formed in step c) from the mould,

wherein the mould in step b) has a temperature of 15°C or less, the sheet in step c) is cooled to a temperature of 40°C or less, steps b) and c) being performed in 10 s. or less.

2. Method of claim 1, wherein the mould in step b) has a temperature of 10°C or less.

3. Method of claim 1, wherein the mould in step b) has a temperature of 8°C or less.

4. Method of any of the preceding claims, wherein the sheet in step c) is cooled to a temperature of 30°C or less.

5. Method of any of the preceding claims, wherein the sheet in step c) is cooled to a temperature of 20°C or less.

6. Method of any of the preceding claims, wherein the sheet in step c) is cooled to a temperature of 15°C or less.

7. Method of any of the preceding claims, wherein steps b) and c) are performed simultaneously.

8. Method of any of the preceding claims, wherein steps b) and c) and preferably also step d) are performed in 5 s. or less.
9. Method of any of the preceding claims, wherein steps b) and c) and preferably also step d) are performed in 2.5 s. or less.

10. Method of any of the preceding claims, wherein steps a)-d) are repeated in a continuous process.

11. Method of any of the preceding claims, wherein the thermoplastic sheet in step a) has a temperature of at least 110°C.

12. Method of any of the preceding claims, wherein the thermoplastic sheet in step a) has a temperature of 135°C or less.

13. Method of any of the preceding claims, wherein the thermoplastic composition comprises at least 50 w/w% starch, based on the total dry weight of the composition.

14. Method of claim 13, wherein the thermoplastic composition comprises at least 55 w/w% starch, based on the total dry weight of the composition.

15. Method of claim 14, wherein the thermoplastic composition comprises at least 60 w/w% starch, based on the total dry weight of the composition.

16. Method of any of the preceding claims, wherein the thermoplastic composition comprises 85 w/w% or less starch, based on the total dry weight of the composition.

17. Method of claim 16, wherein the thermoplastic composition comprises 80 w/w% or less starch, based on the total dry weight of the composition.

18. Method of claim 17, wherein the thermoplastic composition comprises 75 w/w% or less starch, based on the total dry weight of the composition.

19. Method of claim 18, wherein the thermoplastic composition comprises 70 w/w% or less starch, based on the total dry weight of the composition.
20. Method of any of the preceding claims, wherein the starch in the thermoplastic composition is derived from potato, wheat, corn, rice, peas, tapioca starch, preferably from potato.

21. Method of claim 20, wherein the potato starch is derived from potato skin.

22. Method of any of the preceding claims, wherein the thermoplastic composition comprises a starch plasticizer.

23. Method of claim 22, wherein the thermoplastic composition comprises 3-30 w/w% starch plasticizer, based on the dry weight of the starch.

24. Method of any of the claims 22-23, wherein the starch plasticizer is chosen from the group, consisting of polyols, citric acid ester, urea or combinations of two or more thereof.

25. Method of claim 24, wherein the starch plasticizer is a polyol, chosen from the group, consisting of glycol, alkylene glycol, polyalkylene glycol, glycerol, glycerol monoester or combinations of two or more thereof, preferably glycerol.

26. Method of any of the preceding claims, wherein the thermoplastic composition of step a) comprises an elastomer.

27. Method of claim 26, wherein the thermoplastic composition comprises 20-50 w/w% elastomer, based on the total dry weight of the composition.

28. Method of claim 27, wherein the thermoplastic composition comprises 30-40 w/w% elastomer, based on the total dry weight of the composition.

29. Method of any of claims 26-28, wherein the elastomer is chosen from the group, consisting of vinyl ester polymers, styrene-butadiene copolymers and isoprene-butadiene copolymers or a combination of two or more thereof.
30. Method of claim 29, wherein the elastomer is a vinyl ester, chosen from the group, consisting of homo-, co- or terpolymers.

31. Method of claim 30, wherein the vinyl ester is a vinyl acetate, preferably a copolymer of ethylene and vinyl acetate.

32. Method of any of the preceding claims, wherein the thermoplastic composition comprises an elastomer plasticizer.

33. Method of claim 32, wherein the thermoplastic composition comprises 0.5-25 w/w%, preferably 3-13 w/w% elastomer plasticizer, based on the dry weight of the elastomer.

34. Method of any of claims 32-33, wherein the elastomer plasticizer is chosen from the group, consisting of glycerine acetates, alkyl citrates, alkyl citrate esters, paraffin, micro waxes, vegetable oil or a combination of two or more thereof.

35. Method of claim 34, wherein the plasticizer comprises a glycerine acetate, preferably diacetyl glycerol.

36. Method of any of the preceding claims, wherein the prepared article is biodegradable.

37. Method of any of the preceding claims, wherein the thermoplastic composition as defined in any of claims 18-35 is blended with one or more additional polymers to form a thermoplastic blend, and wherein in step a) a sheet of the thermoplastic blend in rubber phase is provided.

38. Method of claim 37, wherein the thermoplastic blend comprises, based on the total weight of the blend, 30-90 w/w% of the thermoplastic composition and 10-70 w/w% additional polymers.
39. Method of claim 38, wherein the thermoplastic blend comprises, based on the total weight of the blend, 50-80 w/w% of the thermoplastic composition and 20-50 w/w% additional polymers.

40. Method of any of claims 37-39, wherein the one or more additional polymers in the thermoplastic blend comprise one or more biodegradable polymers.

41. Method of claim 40, wherein the biodegradable polymers are chosen from the group, consisting of polylactic acid, polycaprolacton, polybutylene succinate, polyhydroxybutyrate, poly(butylene-adipate-co-terephthalate) or a combination of two or more thereof.

42. Method of any of the preceding claims, wherein the thermoplastic composition as defined in any of claims 18-35 or the thermoplastic blend as defined in any of the claims 37-41 comprises a filler.

43. Method of claim 42, wherein the thermoplastic composition or thermoplastic blend comprises 0.5-30 w/w%, preferably 5-20 w/w% and more preferably 8-15 w/w% fillers.

44. Method of claim 42 or 43, wherein the filler comprises a cellulosic filler.

45. Method of claim 44, wherein the cellulosic filler comprises vegetable fibres.

46. Method of claim 45, wherein the vegetable fibres comprise Miscanthus fibres.

47. Method of any of the claims 42-46, wherein the filler has a diameter of 700 μm or less, preferably of 600 μm or less, more preferably of 500 μm or less.

48. Method of any of the preceding claims, further comprising a step e) of preparing a particulate of the article obtained in step d).

49. Method of any of the preceding claims, wherein the sheet in step a) has a thickness of 0.2-5 mm.
50. Thermoformed article obtainable by the method of any of the claims 1-49, comprising 85 w/w% or less starch.

51. Thermoformed article according to claim 50, comprising at least 50 w/w% starch.

52. Thermoformed article according to claim 50, comprising at least 55 w/w% starch.

53. Thermoformed article according to claim 50, comprising at least 60 w/w% starch.

54. Thermoformed article of any of the claims 50 - 53, the article being biodegradable.

55. Thermoformed article of any of the claims 50 - 54, being a container, in particular a food container.

56. Thermoformed article of claim 55, being a food container comprising food, in particular vegetables or fruit.

57. Thermoformed article of claim 55 or 56, having a bottom and a circumferential wall, which is open and sealable by a foil.

58. Thermoformed article of any of the claims 50 - 57, comprising a non-laminated single layer of the thermoplastic composition or blend.

59. Use of a thermoformed article of any of the claims 55 - 57, as fruit, vegetable or meat container.

60. Particulate obtainable by the method of claim 48.
61. Particulate of claim 60, having a particle diameter of 0.5 to 5 mm.

62. Use of a thermoformed article of claim 48 or the particulate of claim 60 or 61 as a desiccant.

63. Container comprising goods susceptible to deterioration by humidity, said container further comprising the article of claim 48 or the particulate of claim 60 or 61.