CLAIMS

1. A method of making a polymer or copolymer, the method comprising:

irradiating a biomass to reduce the recalcitrance of the biomass;

saccharifying the biomass to form a saccharified biomass comprising glucose and xylose;

selectively fermenting the glucose, while the xylose is not consumed, to produce a hydroxy-carboxylic acid;

producing a poly hydroxy-carboxylic acid from the hydroxy-carboxylic acid;

transferring the poly hydroxy-carboxylic acid to a surface of a thin film evaporator;

evaporating water as it is formed during condensation of a hydroxy-carboxylic acid polymer as it traverses the surface of the thin film evaporator.

2. The method of claim 1, where the thin film evaporator comprises a thin film polymerization/devolatilization device.

3. The method of claim 2, where an extruder is in fluid communication with the thin film polymerization/devolatilization device and the effluent of the extruder is the poly hydroxy-carboxylic acid polymer or effluent of the extruder is recycled to the thin film evaporator.

4. The method of claim 3, where the extruder is a twin screw extruder.

5. The method of any one of claims 1-4 wherein the hydroxy-carboxylic acid is selected from the monomer group consisting of glycolic acid, D-lactic acid and/or L-lactic acid, D-malic acid, L-malic acid, citric acid, L-tartaric acid and D-tartaric acid and mixtures thereof.

6. The method of claim 5, wherein the hydroxy-carboxylic acid is D-lactic acid and/or L-lactic acid.

7. The method of any one of claims 1-6, where at least a part of the thin film evaporator operates at a temperature of 100 to 260°C; and/or

where at least a part of the thin film evaporator operates at a pressure of 0.0133 Pa [0.0001 torr] or lower.

8. The method of any one of the claims 2-7, where prior to transferring the poly hydroxy-carboxylic acid to a thin film polymerization/devolatilization device or during operation of the thin film polymerization/ devolatilization device a catalyst deactivator and/or stabilizer agent is added.

9. The method of any one of claims 2-8, where an aliphatic or aromatic dicarboxylic acid and an aliphatic or aromatic diol is added just prior to transferring the poly hydroxy-carboxylic acid to the thin film polymerization/devolatilization device.

10. The method of claim 9, where the mole ratio of the aliphatic or aromatic dicarboxylic acid to the aliphatic or aromatic diol is 0.95:1 to 1.05:1, and/or

where the mole ratio of the sum of the aliphatic or aromatic dicarboxylic acid and the aliphatic or aromatic diol to the hydroxy-carboxylic acid monomer of the poly hydroxy-carboxylic acid is 0.1 or less, or where the mole ratio of the sum of the aliphatic or aromatic dicarboxylic acid and the aliphatic or aromatic diol to the hydroxy-carboxylic acid monomer of the poly hydroxy-carboxylic acid 0.05 or less.

11. The method of any one of the claims 1-10, where a polymerization catalyst is added to the poly hydroxy-carboxylic acid and the polymerization catalyst is selected from the group consisting of protonic acids, such as H_3PO_4 and H_2SO_4, methane sulfonic acid, p-toluene sulfonic acid, polymerically supported sulfonic acid, metals, such as Mg, Al, Ti, Zn, Sn, and tin powder, metal oxides, such as TiO_2, ZnO, GeO_2, ZrO_2, SnO, SnO_2, and Sb_2O_3, metal halides, $ZnCl_2$, $SnCl_2$, $SnCl_4$, $Mn(AcO)_2$, $Fe_2(LA)_3$, $Co(AcO)_2$, $Ni(AcO)_2$, $Cu(OA)_2$, $Zn(LA)_2$, $Y(OA)_3$, $Al(i\text{-}PrO)_3$, $Ti(BuO)_4$, $TiO(acac)_2$, $(Bu)_2SnO$, Sn(II)octoate, Li carbonate, Zn diacetate dehydrate, Ti tetraisopropoxide, potassium carbonate, solvates of any of these and mixtures of any of these.

12. The method of any one of claims 2-7, where at least a part of the thin film polymerization/ devolatilization device operates at a pressure of less than 0.133Pa [0.001 torr]; or

where at least a part of the thin film polymerization/ devolatilization device operates at a pressure of less than 1.33 Pa [0.01 torr]; or

where at least a part of the thin film polymerization/ devolatilization device operates at a pressure of less than 13.3 Pa [0.1 torr]; or

where at least a part of the thin film polymerization/ devolatilization device operates at a pressure of less than 133 Pa [1 torr].

13. The method of any one of claims 1-12, further comprising branching or cross linking the poly hydroxy-carboxylic acid.

14. The method of claim 13, wherein a branching or cross linking agent is utilized to cross link the poly hydroxy-carboxylic acid and the cross-linking agent selected from the group consisting of 5,5'-bis(oxepane-2-one)(bis- ε -caprolactone)), spiro-bis-dimethylene carbonate, peroxides, dicumyl peroxide, benzoyl peroxide, unsaturated alcohols, hydroxyethyl methacrylate, 2-butene-1,4-diol, unsaturated anhydrides, maleic anhydride, saturated epoxides, glycidyl methacrylate, irradiation and combinations of these.

15. The method of any one of claims 1-14, wherein the poly hydroxy-carboxylic acid is blended with a second polymer either when the poly hydroxy-carboxylic acid is transferred to the thin film polymerization/devolatilization device or after the thin film polymerization/devolatilization device.

16. The method of claim 15, wherein the second polymer is selected from the group consisting of polyglycols, polyvinyl acetate, polyolefins, styrenic resins, polyacetals, poly(meth)acrylates, polycarbonate, polybutylene succinate, polyesters, polyurethanes, natural rubber, polybutadiene, neoprene, silicone, other poly hydroxy carboxylic acids, and combinations of these.

17. The method of any one of claims 1-16, comprising combining the poly hydroxy-carboxylic acid with fillers.

18. The method of claim 17, wherein the filler is selected from the group consisting of silicates, layered silicates, polymer and organically modified layered silicate, synthetic mica, carbon, carbon fibers, glass fibers, boric acid,

talc, montmorillonite, clay, starch, corn starch, wheat starch, cellulose fibers, paper, rayon, non-woven fibers, wood flours, whiskers of potassium titanate, whiskers of aluminum borate, 4,4'-thiodiphenol, glycerol and mixtures of these.

19. The method of any one of claims 1-18, further comprising combining the poly hydroxyl-carboxylic acid with a dye or pigment.

20. The method of claim 19, wherein the dye is selected from the group consisting of blue3, blue 356, brown 1, orange 29, violet 26, violet 93, yellow 42, yellow 54, yellow 82 and combinations of these.

21. The method of any one of claims 1-20, further comprising combining the poly hydroxy-carboxylic acid with a fragrance.

22. The method of claim 21, wherein the fragrance is selected from the group consisting of wood, evergreen, redwood, peppermint, cherry, strawberry, peach, lime, spearmint, cinnamon, anise, basil, bergamot, black pepper, camphor, chamomile, citronella, eucalyptus, pine, fir, geranium, ginger, grapefruit, jasmine, juniper berry, lavender, lemon, mandarin, marjoram, musk, myrrh, orange, patchouli, rose, rosemary, sage, sandalwood, tea tree, thyme, wintergreen, ylang ylang, vanilla, new car or mixtures of these fragrances.

23. The method claim 21 or 22, wherein the fragrances are combined with the poly hydroxy-carboxylic acid in an amount between 0.005 % by weight and 20 % by weight.

24. The method of any one of claims 1-23, wherein the poly hydroxy-carboxylic acid can be blended with a plasticizer.

25. The method of claims 24, wherein plasticizer is selected from the group consisting of triacetin, tributyl citrate, polyethylene glycol, acetic ester of monoglyceride, diethyl bishydroxymethyl malonate and mixtures of these.

26. The method of claim 8, where the stabilizer agent is selected from the group consisting of anhydrides, phosphites, polycarboxylic acids, polyamines, silica, functionalized silica, alumina, aluminosilicates, clays, functionalized clays and mixtures of these.

27. The method of claim 26, where the polycarboxylic acid is a poly methacrylic acid.

28. The method of claim 8 and claims 26-27, comprising removing the deactivated/stabilized catalyst prior to, during or after the thin film polymerization/ devolatilization device.

29. The method of any one of claim 5 and claims 26-28, comprising removing the deactivated/stabilized catalyst by a filtration device.

30. The method of claim 29, where the filtration device is in fluid communication with the thin film polymerization/ devolatilization device.

31. The method of claim 1 or 2, wherein the hydroxy-carboxylic acid is selected from the monomer group consisting of glycolic acid, D-lactic acid and/or L-lactic acid, beta-hydroxy beta-methylbutyric acid, 4-hydroxy-4-methylpentanoic acid, hydroxybutyric acid, 2-hydroxybutyric acid, beta-hydroxybutyric acid, gamma-hydroxybutyric acid 3-hydroxyisobutyric acid, 3-hydroxypentanoic acid, 3-hydroxypropionic acid alpha, beta, gamma or delta-hydroxyvaleric acid and mixtures thereof.