WHAT IS CLAIMED:

1. A method comprising:

providing a feedstock comprising a type-I cellulose;

converting at least a portion of the type-I cellulose to form a composition comprising a cellulose product, wherein the cellulose product comprises unconverted type-I cellulose and a type-II cellulose; and

hydrolyzing, in a different step from the converting, at least a portion of the unconverted type-I cellulose at the same or different conditions as the converting.

2. The method of claim 1, wherein the feedstock is selected from the group consisting of lignocellulosic biomass, cellulosic biomass, processed cellulosic biomass, municipal solid waste, and any combination thereof.

3. The method of claim 1 or claim 2, wherein the converting comprises contacting the feedstock with a fluid comprising supercritical water.

4. The method of any one of claims 1-3, wherein the converting is carried out at a temperature of about 150 °C to about 450 °C.

5. The method of claim 1, wherein at least one of conditions (1) and (2) is satisfied:

(1) the cellulose product comprises cellulose having a weight-average molecular weight of about 3,000 g/mol to about 25,000 g/mol as determined on a sample of the cellulose product that has been prepared for gel-permeation chromatography analysis according to a first condition; and

(2) cellulose in the cellulose product has a carbonyl content of at least about 60 μmol/g, as determined on a sample of the cellulose product that has been prepared for

gel-permeation chromatography analysis according to a second condition.

6. The method of claim 1 or claim 5, wherein the hydrolyzing is carried out on the composition.

7. The method of claim 5 or claim 6, wherein the cellulose product further comprises lignin.

8. The method of any one of claims 5-7, wherein the cellulose product has a weight-average molecular weight that is less than about 0.5 times the weight-average molecular weight of microcrystalline cellulose.

9. The method of claim 7 or claim 8, further comprising separating the lignin from the cellulose product using gravity separation, centrifugal separation, centripetal separation, filtration, or a combination thereof.

10. The method of claim 8 or claim 9, further comprising separating the lignin from the cellulose product using a hydrocyclone.

11. The method of claim 10, wherein at least a portion of the lignin is removed in an underflow of the hydrocyclone.

12. The method of claim 10 or claim 11, wherein at least a portion of the cellulose product is removed in an overflow of the hydrocyclone.

13. The method of any one of claims 1-4 or 5-12, wherein the hydrolyzing is carried out at a lower temperature than the converting.

14. The method of any one of claims 1-4 or 5-13, wherein the hydrolyzing comprises employing a fluid comprising hot compressed water.

15. The method of any one of claims 1-4 or 5-14, wherein the hydrolyzing is carried out using thermal energy originating from the converting.

16. The method of any one of claims 1-4 or 5-15, wherein the converting is conducted at a

temperature above 100 °C, and the type-II cellulose produced in the converting is maintained at a temperature above 100 °C prior to the hydrolyzing.

17. The method of any one of claims 1-4 or 5-16, wherein the converting produces a stream at a first temperature, and the method further comprises:

lowering the first temperature of the stream to a second temperature;

maintaining the stream at the second temperature for a period of time, and

changing the stream to a third temperature prior to the hydrolyzing;

wherein the hydrolyzing is conducted at a fourth temperature that is the same as or different from the third temperature.

18. The method of any one of claims 1-4 or 5-17, wherein the hydrolyzing comprises acid hydrolysis.

19. The method of any one of claims 1 or 5-12, further comprising employing at least a portion of the cellulose product as at least a portion of the feedstock, and repeating the method at least one time.

20. The method of claim 1, wherein at least a portion of the feedstock is fractionated biomass.

21. The method of claim 1, wherein the converting is conducted at a temperature of about 350 °C to about 450 °C.

22. The method of claim 1 or claim 21, wherein the converting is conducted at a pressure of at least about 200 bar.

23. The method of claim 1 or claim 21, wherein the converting is conducted for a residence time of about 0.05 sec to about 20 sec.

24. The method of claim 1, wherein the converting is conducted at a temperature of about

350 °C to about 450 °C, a pressure of at least about 200 bar, and for a residence time of about 0.05 sec to about 20 sec.

25. The method of any one of claims 1-4, 5-12, 14-16, 18, or 19-24, wherein the hydrolyzing is carried out at the same temperature as the converting.

26. The method of any one of claims 1-4, 5-18, or 19-25, wherein the hydrolyzing comprises supercritical hydrolysis.

27. The method of any one of claims 1-4, 5-18, or 19-24, wherein the hydrolyzing comprises enzyme hydrolysis.

28. The method of any one of claims 1-4, 5-18, or 19-24, wherein the hydrolyzing comprises hot compressed water hydrolysis.

29. The method of any one of claims 16-18, wherein the converting is conducted at a temperature above 100 °C, and the type-II cellulose produced in the converting is maintained at a temperature above 100 °C prior to the hydrolyzing and during the hydrolyzing.

30. The method of any one of claims 1, 2, 5-12, 19, or 20, wherein the hydrolyzing and the converting are conducted at the same conditions.

31. The method of claim 30, wherein the conditions comprise mercerization.

32. The method of claim 30, wherein the conditions comprise regeneration.

33. The method of claim 30, wherein the conditions comprise near-critical water.

34. The method of claim 30, wherein the conditions comprise supercritical water.

35. The method of claim 30, wherein the conditions comprise ball milling in the presence of water.

36. The method of any one of claims 3, 4, 14-17, or 21-29, wherein the hydrolyzing and the

converting are conducted at the same conditions.

37. The method of any one of claims 1, 2, 5-12, 19, or 20, wherein the hydrolyzing and the converting are conducted at different conditions.

38. The method of claim 37, wherein the different conditions are independently selected from the group consisting of mercerization, regeneration, near-critical water, supercritical water, and ball milling in the presence of water.

39. The method of claim 38, wherein the converting comprises supercritical water and the hydrolyzing comprises mercerization.

40. The method of claim 38, wherein the converting comprises mercerization and the hydrolyzing comprises supercritical water.

41. The method of claim 38, wherein the converting comprises near-critical water and the hydrolyzing comprises mercerization.

42. The method of claim 38, wherein the comprises mercerization and the hydroloyzing comprises near-critical water.

43. The method of any one of claims 3, 4, 14-17, or 21-29, wherein the hydrolyzing and the converting are conducted at different conditions.

44. The method of any one of claims 1-4, 5-18, or 19-43, wherein the feedstock comprises lignocellulosic biomass.

45. A method comprising:

providing a feedstock, wherein the feedstock comprises a type-I cellulose and lignin;

converting at least a portion of the type-I cellulose to a type-II cellulose; and

hydrolyzing, in a different step from the converting, at least a portion of the type-

II cellulose.

46. The method of claim 45, wherein the converting comprises contacting the lignocellulosic feedstock with a fluid comprising supercritical water.

47. The method of claim 45 or 46, wherein the converting is carried out at a temperature of about 150 °C to about 450 °C.

48. The method of any one of claims 45-47, wherein the converting produces a composition comprising a cellulose product, wherein the cellulose product comprises an unconverted type-I cellulose and the type-II cellulose.

49. The method of claim 48, wherein at least one of conditions (1) and (2) is satisfied:

(1) the cellulose product comprises cellulose having a weight-average molecular weight of about 3,000 g/mol to about 25,000 g/mol as determined on a sample of the cellulose product that has been prepared for gel-permeation chromatography analysis according to a first condition; and

(2) cellulose in the cellulose product has a carbonyl content of at least about 60 μmol/g, as determined on a sample of the cellulose product that has been prepared for gel-permeation chromatography analysis according to a second condition.

50. The method of claim 48 or claim 49, wherein the hydrolyzing is carried out on the composition.

51. The method of any one of claims 48-50 wherein the cellulose product further comprises lignin.

52. The method of any one of claims 48-51, wherein the cellulose product has a weight-average molecular weight that is less than about 0.5 times the weight-average molecular weight of microcrystalline cellulose.

53. The method of claim 51 or claim 52, further comprising separating the lignin from the cellulose product using gravity separation, centrifugal separation, centripetal separation, filtration, or a combination thereof.

54. The method of claim 51 or claim 52, further comprising separating the lignin from the cellulose product using a hydrocyclone.

55. The method of claim 54, wherein at least a portion of the lignin is removed in an underflow of the hydrocyclone.

56. The method of claim 54 or claim 55, wherein at least a portion of the cellulose product is removed in an overflow of the hydrocyclone.

57. The method of any one of claims 45-56, wherein the hydrolyzing is carried out at a lower temperature than the converting.

58. The method of any one of claims 45-57, wherein the hydrolyzing comprises employing a fluid comprising hot compressed water.

59. The method of any one of claims 45-58, wherein the hydrolyzing is carried out using thermal energy originating from the converting.

60. The method of any one of claims 45-59, wherein the converting is conducted at a temperature above 100 °C, and the type-II cellulose produced in the converting is maintained at a temperature above 100 °C prior to the hydrolyzing.

61. The method of any one of claims 45-60, wherein the converting produces a stream at a first temperature, and the method further comprises:

lowering the first temperature of the stream to a second temperature;

maintaining the stream at the second temperature for a period of time, and

changing the stream to a third temperature prior to the hydrolyzing;

wherein the hydrolyzing is conducted at a fourth temperature that is the same as or different from the third temperature.

62. The method of any one of claims 45-61, wherein the hydrolyzing comprises acid hydrolysis.

63. The method of any one of claims 45-62, further comprising employing at least a portion of the cellulose product as at least a portion of the feedstock, and repeating the method at least one time.

64. The method of any one of claims 45-63, wherein at least a portion of the feedstock is fractionated biomass.

65. The method of any one of claims 45 or 47-64, wherein the converting is conducted at a temperature of about 350 °C to about 450 °C.

66. The method of any one of claims 45-65, wherein the converting is conducted a pressure of at least about 200 bar.

67. The method of any one of claims 45-65, wherein the converting is conducted for a residence time of about 0.05 sec to about 20 sec.

68. The method of any one of claims 45 or 47-65, wherein the converting is conducted at a temperature of about 350 °C to about 450 °C, a pressure of at least about 200 bar, and for a residence time of about 0.05 sec to about 20 sec.

69. The method of any one of claims 45-68, wherein the hydrolyzing is carried out at the same temperature as the converting.

70. The method of any one of claims 45-69, wherein the hydrolyzing comprises supercritical hydrolysis.

71. The method of any one of claims 45-70, wherein the hydrolyzing comprises enzyme

hydrolysis.

72. The method of any one of claims 45-71, wherein the hydrolyzing comprises hot compressed water hydrolysis.

73. The method of any one of claims 45-70 or 72, wherein the converting is conducted at a temperature above 100 °C, and the type-II cellulose produced in the converting is maintained at a temperature above 100 °C prior to the hydrolyzing and during the hydrolyzing.

74. The method of any one of claims 45, 48-56, or 59, wherein the hydrolyzing and the converting are conducted at the same conditions.

75. The method of claim 74, wherein the conditions comprise mercerization.

76. The method of claim 74, wherein the conditions comprise regeneration.

77. The method of claim 74, wherein the conditions comprise near-critical water.

78. The method of claim 74, wherein the conditions comprise supercritical water.

79. The method of claim 74, wherein the conditions comprise ball milling in the presence of water.

80. The method of any one of claims 46, 47, 58, or 60-73, wherein the hydrolyzing and the converting are conducted at the same conditions.

81. The method of any one of claims 45, 48-56, or 59, wherein the hydrolyzing and the converting are conducted at different conditions.

82. The method of claim 81, wherein the different conditions are independently selected from the group consisting of mercerization, regeneration, near-critical water, supercritical water, and ball milling in the presence of water.

83. The method of claim 82, wherein the converting comprises supercritical water and the

hydrolyzing comprises mercerization.

84. The method of claim 83, wherein the converting comprises mercerization and the hydrolyzing comprises supercritical water.

85. The method of claim 84, wherein the converting comprises near-critical water and the hydrolyzing comprises mercerization.

86. The method of claim 85, wherein the converting comprises mercerization and the hydrolyzing comprises near-critical water.

87. The method of any one of claims 46, 47, 58, or 60-73, wherein the hydrolyzing and the converting are conducted at different conditions.