WHAT IS CLAIMED :

1. A method for converting a sugar, the method comprising;

chemically converting xylose to a product or an intermediate, the xylose being obtained by treating biomass with irradiation and saccharification.

2. The method of claim 1 where the product or intermediate comprises furfural.

3. The method of claim 1 wherein chemical converting further comprises converting the xylose over an acid catalyst.

4. The method of claim 2 where the furfural is further chemically converted to a furfural-derived product.

5. The method of claim 4 wherein the chemically converted furfural comprises reactions selected from the group consisting of cyclization reactions, polymerization reactions, condensation reactions, reduction reactions, oxidation reactions, esterification reactions, alkylation reactions, decarbonylation reactions, aldol reactions, amination reactions, hydrogenation reactions, disproportionation reactions, dearomatization reaction, Diels Alder reactions, and combinations thereof.

6. The method of claim 4 chemically converted furfural comprises at least two successive reactions selected from the group consisting of cyclization reactions, polymerization reactions, condensation reactions, reduction reactions, oxidation reactions, esterification reactions, alkylation reactions, decarbonylation reactions, aldol reactions, amination reactions, hydrogenation reactions, disproportionation reactions, dearomatization reaction, Diels Alder reactions, and combinations thereof.

7. The method of claim 3 wherein the acid catalyst is selected from the group consisting of acidified Zeolites, acidified silica, surface grafted silicas, functionalized mesoporous silicas, poly acids, acid functionalized polymers, poly sulfonic acids, poly acetic acids, poly phosphonic acids, polystyrene sulfonic acids, tetraorthosilicates, 3-(mercaptopropyl)trimethoxysilane, Lewis acids, microporous silicoaluminaphosphate, metal oxides, ZrO_2, $Al2O_3$, TiO_2, SiO_2, V_2O_3, sulfate salts, $(NH_4)_2SO_4$, metal halides, $MgCl_2$, $LaCl_3$, $FeCl_3$, metal carbonates, Cs_2CO_3, ionic liquids, Tungtsen oxides, Tungstate, Phosphoric acid, Phosphonic acid, sulfuric acid, hydrochloric acid, nitric acid, perfluorinated resin-sulfonic acid, and combinations thereof.

8. The method of claim 1 or 3 wherein converting comprises applying greater than atmospheric pressure to the xylose.

9. The method of claim 1 or 3 wherein converting comprises heating the xylose to a temperature greater than 50°C up to 320°C.

10. The method of claim 1 further comprising isolating the product or the intermediate.

11. The method of claim 4 wherein the furfural-derived product is selected from the group consisting of furfuryl alcohol, levulinic acid, tetrahydrofurfuryl alcohol, dihydropyran, , furoic acid, methyl furan, methytetrahydrofuran, furan, tetrahydrofuran, pyrrole, thiofuran, 1,4-butanediol, maleic anhydride, furfuryl amine, furanacrylic acid, furanacrylonitrile, furfuryliden acrolein, alkyl furfurylidene ketone, Diels Alder adduct with cyclopentadiene, poly(furfuryl alcohol).

12. The method of claim 1 wherein the xylose is derived from the treated biomass material by a process comprising hydrolysis of the treated biomass material.

13. The method of claim 12 wherein hydrolysis comprises contacting the treated biomass material with at least one of an acid, a base, heat, microwave energy, sonic energy, mechanical energy, shearing, milling or an enzyme.

14. The method of claim 12 wherein hydrolysis comprises contacting the treated biomass with an enzyme.

15. The method of claim 14 wherein the enzyme is an enzyme complex including xylanase.

16. The method of any one of the above claims further comprising producing glucose.

17. The method of claim 16 further comprising separating the glucose from the xylose prior to chemically converting the xylose.

18. The method of claim 16 or 17 further comprising fermenting the glucose.

19. The method of claim 1 wherein biomass comprises hemicellulose further comprising xylan, glucuronoxylane, arabinoxylan, glucomannan and/or xyloglucan.

20. The method of any one of the above claims wherein the irradiation comprises a radiation dosage ofbetween 10 and 200 Mrad.

21. The method of claim 1 wherein the irradiation is provided by an electron beam.

22. The method of claim 21 wherein the electron beam has a power between 0.5 and 10 MeV.

23. The method of any one of the above claims wherein the biomass is selected from the group consisting of paper, paper products, paper waste, wood, particle board, sawdust, agricultural waste, sewage, silage, grasses, wheat straw, rice hulls, bagasse, cotton, jute, hemp, flax, bamboo, sisal, abaca, straw, corn cobs, corn stover, alfalfa, hay, coconut hair, seaweed, algae, and mixtures thereof.

24. A method for converting a sugar, the method comprising;

chemically converting xylose to a product or an intermediate, the xylose being obtained by treating biomass with irradiation and saccharification,

wherein the product comprises furfural which is further converted to a furfural-derived product, and

wherein the furfural-derived product is selected from the group consisting of furfuryl alcohol, levulinic acid, tetrahydrofurfuryl alcohol, dihydropyran, , furoic acid, methyl furan, methytetrahydrofuran, furan, tetrahydrofuran, pyrrole, thiofuran, 1,4-butanediol, maleic anhydride, furfuryl amine, furanacrylic acid, furanacrylonitrile, furfuryliden acrolein, alkyl furfurylidene ketone, Diels Alder product with cyclopentadiene, and polyfurfuryl alcohol.

CLAIMS

1. A method for producing furfuryl alcohol comprising:

irradiating biomass to reduce the recalcitrance of the biomass;

saccharifying the irradiated biomass with one or more enzymes to produce a first sugar composition comprising xylose and glucose;

fermenting the first sugar composition to produce a second sugar composition comprising xylose and glucose, wherein the concentration of xylose in the second sugar composition is increased relative to the first sugar composition;

isolating the xylose from the second sugar composition by simulated moving bed chromatography;

converting the isolated xylose to furfural; and

reducing the furfural to furfuryl alcohol.

2. The method of claim 1 wherein the biomass comprises one or more of paper, paper product, wood, wood-related material, particle board, grass, rice hulls, bagasse, cotton, jute, hemp, flax, bamboo, wheat straw, sisal, abaca, straw, corn cobs, corn stover, coconut hair, algae, seaweed, altered cellulose, regenerated cellulose, microbial material, municipal waste, waste from paper processing, newspaper, kraft paper, corrugated paper, cotton, rags, and animal waste.

3. The method of claim 1 wherein the biomass is densified before irradiating.

4. The method of claim 1 further comprising treating the biomass to reduce its recalcitrance, before or after irradiating, with one or more of mechanically treating, sonicating, pyrolyzing, oxidizing, steam exploding, and chemically treating.

5. The method of claim 1 wherein the biomass has been irradiated with one or more of microwave energy, ultraviolet rays, infrared radiation and ionizing radiation.

6. The method of claim 1 wherein the biomass has been irradiated with one or more of alpha particles, protons, gamma rays and X-rays.

7. The method of claim 1 wherein the biomass has been irradiated with ions heavier than electrons.

8. The method of claim 1 wherein the biomass has been irradiated with ionizing radiation delivered by electron beam.

9. The method of claim 8 wherein the ionizing radiation is delivered at a dosage that is between 10 Mrad and 200 Mrad.

10. The method of claim 8 wherein the electron beam has a power between 0.5 and 10MeV.

11. The method of claim 1 wherein the biomass has been irradiated with two or more radiation sources.

12. The method of claim 1 wherein the biomass has been treated to reduce its recalcitrance, before or after irradiating, by sonicating in an oxidizing medium.

13. The method of claim 1 further comprising partially or completely saccharifying the biomass during transporting to a manufacturing plant.

14. The method of claim 1 wherein the biomass has been saccharified partially or completely in a tank.

15. The method of claim 14 wherein the contents of the tank are jet mixed.

16. The method of claim 14 wherein conversion of the xylose to furfural occurs in the tank.

17. The method of claim 16 wherein conversion of the xylose to furfural occurs in a continuous process.

18. The method of claim 1 wherein the one or more enzymes comprise a ligninase, a xylanase, a hemicellulase, an endoglucanase, a cellobiohydrolase, or a beta-glucosidase.

19. The method of claim 1 wherein the one or more enzymes comprise an enzyme complex including xylanase.

20. The method of claim 1 wherein the sugars are at a concentration of at least 40% by weight.

21. The method of claim 1 further comprising isolating the glucose.

22. The method of claim 1 further comprising isolating the furfuryl alcohol.

23. The method of claim 1 wherein conversion of the xylose to furfural is catalyzed by a Lewis acid.

24. The method of claim 1 further comprising measuring the lignin content of the biomass.