~~WHAT IS CLAIMED IS:~~

1. A method comprising:

utilizing a microorganism that is immobilized on a substrate to convert a low molecular weight sugar to a product.

2. The method of claim 1 wherein the substrate comprises inorganic fibers.

3. The method of claim 1 or 2 wherein the substrate comprises a synthetic material.

4. The method of any of the above claims wherein the substrate is functionalized.

5. The method of any of the above claims wherein immobilization occurs as a result of interaction between functional groups on the substrate and functional groups on the microorganism.

6. The method of claim 4 wherein the substrate is functionalized with functional groups selected from the group consisting of aldehyde groups, nitroso groups, nitrile groups, nitro groups, ketone groups, amino groups, alkyl amino groups, alkyl groups, chloroalkyl groups, chlorofluoroalkyl groups, and enol groups.

7. The method of any of the above claims wherein the low molecular weight sugar is converted to an alcohol.

8. The method of any of the above claims wherein the microorganism comprises a yeast.

9. The method of claim 8 wherein the yeast is selected from the group consisting of ~~S. cerevisiae and P. stipitis.~~

~~10. The method of any of the above claims wherein the microorganism comprises~~ a bacterium.

11. The method of claim 10 wherein the bacterium comprises Zymomonas mobilis.

12. The method of any of the above claims wherein the low molecular weight sugar is selected from the group consisting of sucrose, glucose, xylose, and mixtures thereof.

13. The method of claim 4 further comprising irradiating a starting material to produce the functionalized substrate.

14. The method of claim 13 wherein irradiating comprises irradiating with ionizing radiation.

15. The method of claim 13 wherein irradiating is performed using a particle beam.

16. The method of any of the above claims wherein the substrate comprises fibers or particles having a BET surface area of greater than 100 m^2/g.

13. The method of any of the above claims wherein converting comprises fermentation.

14. The method of any of the above claims, wherein the substrate comprises a material selected from the group consisting of calcium carbonate, aragonite clay, orthorhombic clays, calcite clay, rhombohedral clays, kaolin, bentonite clay, dicalcium phosphate, tricalcium phosphate, calcium pyrophosphate, insoluble sodium metaphosphate, magnesium orthophosphate, trimagnesium phosphate, hydroxyapatites, ~~synthetic apatites, alumina, hydrated alumina, silica xerogel, metal aluminosilicate~~

complexes, sodium aluminum silicates, zirconium silicate, silicon dioxide graphite, wollastonite, mica, glass, fiber glass, silica, talc, carbon fibers, conductive carbon black, ceramic powders and ceramic fibers, alumina trihydrate, ground construction waste, ground tire rubber, lignin, maleated polypropylene, thermoplastic fibers, fluorinated polymers, and mixtures thereof.

15. The method of any of the above claims wherein the substrate comprises fibers or particles having a porosity greater than 70%.

16. The method of any of the above claims wherein the fibers or particles have a porosity greater than 90%.

17. The method of any of the above claims further comprising recovering the substrate after conversion and reusing the substrate in a second, subsequent conversion process.

18. The method of claim 2 wherein the inorganic fibers are provided in the form of a single or multi-layer sheet.

19. The method of claim 2 wherein the inorganic fibers are provided in the form of a fibrous material that is overlaid, folded, or in the form of a screen or mesh.

20. The method of claim 2 wherein the inorganic fibers are extruded or coextruded.

21. The method of any of the above claims wherein the substrate comprises particles having a nano-scale average particle size.

22. A mixture comprising:

a particulate material having polar functional groups,

a microorganism or enzyme having complementary attractive functional groups, and

a liquid medium.

23. A composition comprising fibers having functional groups, and a microorganism or enzyme having complementary attractive functional groups, the microorganism or enzyme being immobilized on the fibers.

24. A method comprising utilizing a saccharifying agent that is immobilized on fibers or particles to saccharify a cellulosic or lignocellulosic material.

25. The method of claim 24 wherein the saccharifying agent comprises an enzyme.

26. The method of claim 24 or 25 wherein the particles or fibers comprise an inorganic material.

27. The method of any one of claims 24-26 wherein the particles comprise a synthetic material.

28. The method of any one of claims 24-27 wherein the particles or fibers have a BET surface area of greater than 100 m^2/g.

29. The method of any one of claims 24-28, wherein the particles or fibers comprise a material selected from the group consisting of calcium carbonate, aragonite clay, orthorhombic clays, calcite clay, rhombohedral clays, kaolin, bentonite clay, dicalcium phosphate, tricalcium phosphate, calcium pyrophosphate, insoluble sodium metaphosphate, magnesium orthophosphate, trimagnesium phosphate, hydroxyapatites, synthetic apatites, alumina, hydrated alumina, silica xerogel, metal aluminosilicate complexes, sodium aluminum silicates, zirconium silicate, silicon dioxide graphite, wollastonite, mica, glass, fiber glass, silica, talc, carbon fibers, conductive carbon black,

ceramic powders and ceramic fibers, alumina trihydrate, ground construction waste, ground tire rubber, lignin, maleated polypropylene, thermoplastic fibers, fluorinated polymers, and mixtures thereof.

30. The method of any one of claims 24-29 wherein the particles or fibers have a porosity greater than 70%.

31. The method of any one of claims 24-30 wherein the particles or fibers have a porosity greater than 90%.

32. The method of any one of claims 24-31 wherein the particles or fibers are functionalized.

33. The method of any one of claims 24-32 wherein immobilization is due to interaction between functional groups on the particles or fibers and functional groups on the microorganism.

34. The method of claim 33 wherein the particles or fibers are functionalized with functional groups selected from the group consisting of aldehyde groups, nitroso groups, nitrile groups, nitro groups, ketone groups, amino groups, alkyl amino groups, alkyl groups, chloroalkyl groups, chlorofluoroalkyl groups, and enol groups.

35. The method of any one of claims 24-34 further comprising recovering the particles or fibers after saccharification and reusing the particles in a second, subsequent saccharification process.

36. The method of claim 26 wherein the inorganic fibers or particles are provided in the form of a single or multi-layer sheet.

37. The method of claim 26 wherein the inorganic fibers or particles are provided in the form of a fibrous material that is overlaid, folded, or in the form of a screen or mesh.

38. The method of claim 26 wherein the inorganic fibers or particles are extruded or coextruded.

39. The method of any one of claims 24-38 wherein the particles or fibers have a nano-scale average particle size.

CLAIMS

1. A mixture comprising:

an inorganic material in the form of particles or fibers and said inorganic material having polar functional groups,

a microorganism or enzyme each having complementary functional groups and having an attractive interaction to the functional groups of the inorganic material,

a saccharified material, and

a solvent,

wherein the inorganic material has been functionalized by irradiating the material with ionizing radiation and subsequently quenching the irradiated material with a quenching agent suitable for producing the polar functional groups, and

wherein the inorganic material is selected from the group consisting of calcium carbonate, aragonite clay, orthorhombic clays, calcite clay, rhombohedral clays, kaolin, bentonite clay, dicalcium phosphate, tricalcium phosphate, calcium pyrophosphate, insoluble sodium metaphosphate, magnesium orthophosphate, trimagnesium phosphate, hydroxyapatites, synthetic apatites, alumina, hydrated alumina, silica xerogel, metal aluminosilicate complexes, sodium aluminum silicates, zirconium silicate, silicon dioxide, graphite, wollastonite, mica, glass, fiber glass, silica, talc, carbon fibers, conductive carbon black, ceramic powders and ceramic fibers, alumina trihydrate, ground construction waste, and mixtures thereof.

2. The mixture as claimed in claim 1, wherein the microorganism or enzyme is attached to the inorganic material by the attractive interaction between the complementary functional group on the microorganism or enzyme and the polar functional groups on the inorganic material.

3. The mixture as claimed in claim 1 wherein the inorganic material is a synthetic material.

4. The mixture as claimed in claim 1 wherein the polar functional groups on the inorganic material are carboxylate groups.

5. The mixture claimed as in claim 1, wherein the polar functional groups on the inorganic material is selected from the group consisting of aldehyde groups, nitroso groups, nitrile groups, nitro groups, ketone groups, amino groups, alkyl amino groups, alkyl groups, chloroalkyl groups, chlorofluoroalkyl groups, and enol groups.

6. The mixture as claimed in claim 1, wherein the microorganism is yeast.

7. The mixture as claimed in claim 1, wherein the microorganism is a bacterium.

8. The mixture as claimed in claim 1 wherein the enzyme is a cellulase.

9. The mixture as claimed in claim 1, wherein the particles or fibers have a Brunauer Emmett Teller (BET) surface area of greater than 100 m^2/g.

10. The mixture as claimed in claim 1 wherein the particles or fibers have a porosity of greater than 70%.

11. The mixture as claimed in claim 1 wherein the particles or fibers have a porosity of greater than 90%.

12. The mixture as claimed in claim 1 wherein the particles or fibers are provided in the form of a single or multi-layer sheet.

13. The mixture as claimed in claim 1 wherein the particles or fibers are provided in the form of a fibrous material that is overlaid, folded, or in the form of a screen or mesh.

14. The mixture as claimed in claim 1 wherein the fibers or particles are extruded or coextruded.

15. The mixture as claimed in claim 1 wherein the fibers or particles have a nano-scale average particle size.

16. The mixture as claimed in claim 1, wherein the saccharified material comprises a sugar selected from the group consisting of sucrose, glucose, xylose, or a mixture thereof.

17. The mixture as claimed in claim 1 further comprising ethanol.