CLAIMS

1. A method of converting CO_2 and/or a related form thereof to one or more small organic compounds, the method comprising exposing the CO_2 and/or the related form thereof to a beta particle activated high band-gap semiconductor and thereby converting the CO_2 and/or the related form thereof to the one or more small organic compounds.

2. The method according to claim 1, wherein the one or more small organic compounds comprises one or more of carbon monoxide, formaldehyde, methane, methanol, formic acid, ethanol, acetaldehyde and acetic acid.

3. The method according to claims 1 or 2, wherein the semiconductor has a band-gap of at least 2.6 eV.

4. The method according to any one of claims 1 to 3, wherein the semiconductor has a conduction band edge energy of less than -0.15 volts, with respect to the standard hydrogen electrode.

5. The method according to any one of claims 1 to 4, wherein the semiconductor has a conduction band edge energy of less than -0.8 volts with respect to the standard hydrogen electrode.

6. The method according to any one of claims 1 to 5, wherein the semiconductor comprises one or more of a titanate, zirconate, molybdate, vanadate, technetate, pertechnetate, tungstate, niobate, tantalate, chromate, doped tin oxides, doped zinc oxide, a hafnate, a germanium oxide, a simple oxide, an oxide of manganese, cobalt and iron, a sulphide, a chalcogenide and a carbon allotrope.

7. The method according to any one of claims 1 to 6, wherein the beta particle activated high band-gap semiconductor comprises beta particle activation via continuous excitation by beta particles.

8. The method according to any one of claims 1 to 7, wherein the beta particle

activated semiconductor comprises beta particle activation via emission from a radionuclide.

9. The method according to claim 8, wherein the radionuclide comprises one or more of ^{14}C, ^{90}Sr, ^{99}Tc, ^{3}H, ^{63}Ni, ^{137}Cs, ^{147}Pm, ^{151}Sm, ^{121m}Sn, ^{155}Eu, ^{93}Zr, ^{210}Pb and ^{126}Sn.

10. The method according to claims 8 or 9, wherein the beta particle activated semiconductor comprises beta particle activation via emission from a radionuclide located at a distance to the semiconductor.

11. The method according to claims 8 or 9, wherein the beta particle activated semiconductor and the radionuclide are coupled to form a radioactive catalyst.

12. The method according to claim 11, wherein the radioactive catalyst comprises the radionuclide in contact with the high band-gap semiconductor, the radionuclide proximal to the high band-gap semiconductor, the radionuclide physically admixed with the high band-gap semiconductor, the radionuclide chemically incorporated into the high band-gap semiconductor, the radionuclide loaded into the high band-gap semiconductor, and/or the high band-gap semiconductor is located externally to the radionuclide.

13. The method according to claims 11 or 12, wherein the radioactive catalyst is porous.

14. The method according to any one of claims 11 to 13, wherein the radioactive catalyst is in the form of a particle, a granule, a bead, a powder, a pellet or a frit.

15. A method of converting CO_2 and/or a related form thereof to one or more small organic compounds, the method comprising exposing a high band-gap semiconductor undergoing electronic excitation by energetic beta-particles to CO_2 and/or a related form thereof and thereby converting the CO_2 and/or the related form thereof to the one or more small organic compounds.

16. A method of converting CO_2 and/or a related form thereof to one or more small

organic compounds, the method comprising exposing CO_2 and/or a related form thereof to a beta particle emitting radionuclide coupled with a high band-gap semiconductor and thereby converting the CO_2 and/or the related form thereof to the one or more small organic compounds.

17. A method of converting CO_2 and/or a related form thereof to one or more small organic compounds, the method comprising exposing CO_2 and/or a related form thereof to a high band-gap semiconductor activated by beta particles from a radionuclide and thereby converting the CO_2 and/or the related form thereof to the one or more small organic compounds.

18. A method of producing one or more small organic compounds, the method comprising using a method according to any one of claims 1 to 17 to convert the CO_2 and/or a related form thereof to the one or more small organic compounds.

19. A method of producing one or more small organic compounds, the method comprising exposing CO_2 and/or a related form thereof to a beta particle activated high band-gap semiconductor and thereby producing the one or more small organic compounds from the CO_2 and/or the related form thereof.

20. A method of producing one or more small organic compounds, the method comprising exposing a high band-gap semiconductor undergoing electronic excitation by energetic beta particles to CO_2 and/or a related form thereof and thereby producing the one or more small organic compounds from the CO_2 and/or the related form thereof.

21. A method of producing one or more small organic compounds, the method comprising exposing CO_2 and/or a related form thereof to a beta particle emitting radionuclide coupled with a high band-gap semiconductor and thereby producing the one or more small organic compounds from the CO_2 and/or the related form thereof.

22. A method of producing one or more small organic compounds, the method comprising exposing CO_2 and/or a related form thereof to a high band-gap semiconductor activated by beta particles from a radionuclide and thereby producing the one or more

small organic compounds from the CO_2 and/or the related form thereof.

23. One or more small organic compounds produced by the method according to any one of claims 18 to 22.

24. The one or more small organic compounds according to claim 23, wherein the compound is methanol.

25. A system for converting CO_2 and/or a related form thereof to one or more small organic compounds, the system comprising:

a source of CO_2 and/or a related form thereof;

a reaction container comprising a high band-gap semiconductor coupled closely with a beta particle emitting radionuclide for exposure to the CO_2 and/or the related form thereof; and

means for extracting the one or more small organic compounds produced by exposure of the CO_2 and/or the related form thereof to the high band-gap semiconductor and the radionuclide.

26. A system for converting CO_2 and/or a related form thereof to one or more small organic compounds, the system comprising:

a source of CO_2 and/or a related form thereof;

a reaction container comprising a radioactive catalyst comprising a high band-gap semiconductor and a beta particle emitting radionuclide for exposure to the CO_2 and/or the related form thereof; and

means for extracting one or more small organic compounds produced by exposure of the CO_2 and/or the related form thereof to the radioactive catalyst.

27. The system according to claims 25 or 26, wherein the source of CO_2 comprises one or more of waste CO_2, atmospheric CO_2, liquid CO_2, sequestered CO_2, CO_2 complexed with another agent, a bicarbonate, a carbonate, a carbonate ore, or a chemical compound that provides CO_2.

28. The system according to any one of claims 25 to 27, wherein the means for

extracting the one or more small organic molecules comprises a distillation means and/or a condensing means, or a differential adsorption means.

29. One or more small organic compounds produced by the system according to any one of claims 25 to 28.

30. A method of activating a high band-gap semiconductor for the conversion of CO_2 and/or a related form thereof to one or more small organic compounds, the semiconductor having a conduction band edge energy sufficient to enable the reduction of CO_2, the method comprising exposing the high band-gap semiconductor to a beta particle emitting radionuclide and thereby activating the semiconductor.

31. A high band-gap semiconductor activated by the method according to claim 30.

32. A method of identifying a high band-gap semiconductor for converting CO_2 and/or a related form thereof to one or more small organic compounds by beta particle activation of the semiconductor, the method comprising:

exposing CO_2 and/or a related form thereof to a beta particle emitting radionuclide coupled closely with a candidate high band-gap semiconductor; and determining the ability of the candidate high band-gap semiconductor to convert the CO_2 and/or the related form thereof to one or more small organic compounds, thereby identifying the candidate high band-gap semiconductor as a high band-gap semiconductor for converting CO_2 and/or a related form thereof to one or more small organic compounds by beta particle activation of the high band-gap semiconductor.

33. A semiconductor identified according to the method claim 32.